EMBRACING THE FUTURE ECONOMY: STRIVING FOR INNOVATION, AUTOMATION, AND INCLUSION[1]

A high-level committee has recommended a strategy to transform Singapore into a global leader in the new digital age. The report acknowledges the disruptive potential of the new technologies for worker mobility, finance, and manufacturing. In response, and consistent with Singapore's holistic approach to policymaking, the government is proactively facilitating a transition to an innovation-based knowledge economy. It is cognizant that the transition to the new economy can have profound implications on inclusion and inequality. To mitigate this, and consistent with the principles of individual responsibility, equality of opportunity, and sound public finances, the government is providing students and workers with opportunities for life-long learning, acquisition of new-economy skills, and other active labor market policies.

A. Background

1. **Over the past half a century, Singapore has transformed itself from a developing trading center with very limited natural resources to an important trading and financial services hub on the global technological frontier.** Prudent economic management aligned with a longer-term vision; strong institutions and leadership; and relentless efforts at moving up the value chain have together created an environment of steadily improving in living standards. Through early recognition of the growth potential provided by openness to global manufacturing trade and foreign investment; subsequent upgradation to higher value-added activities, including in the services sector; and reforms in the labor, product, and financial markets, Singapore has achieved one of fastest rises in per capita income in the past fifty years.

2. **Singapore's economic growth has been supported by physical factor accumulations, including through accommodation of foreign worker inflows, human capital formation, and productivity improvements through increased reliance on high-tech manufacturing and modern services sectors.**[2] Continuing with this tradition, and in recognition of the evolving changes in demographics, technology and comparative advantages, Singapore is getting ready for yet another transformation of its economy. In that context, announcement of a high-level Committee on the Future Economy (CFE) in October 2015 followed in the footsteps of earlier high-level committees whose reports, issued in 1986, 2003, and 2010, guided policymaking over the past three decades.

[1] Prepared by Gerard Almekinders, Souvik Gupta, and Umang Rawat (all APD).

[2] High-tech manufacturing includes chemicals and chemical products; pharmaceutical and biological products; computer, electronic and optical products; and electrical equipment. Modern services include information and communications; finance and insurance; and business services. Between 1980 and 2016, the combined share of high-tech manufacturing and modern services sector increased from 25 percent of GDP to 40 percent of GDP.

B. The Singaporean Innovation Ecosystem

Innovation and economic growth

3. **Economic theory on endogenous growth highlights the importance of human capital and research and development (R&D) for long-term growth (for example, Lucas, 1988, and Romer, 1986).** Acemoglu and others (2006) argue that for a country which is closer to the technology frontier, innovation, rather than adoption of existing technologies, eventually attains greater importance as a source of productivity growth. When current research is determined by expected arrival of new research that replaces it in future, Aghion and Howitt (1992) discuss that the average growth rate and its variability will be positively related to the size of, but not necessarily productivity of, innovation. However, when there is some learning involved for the new firm before being able to replace the incumbent, Aghion and others (2005) show that a high level of product market competition could induce existing firms that are closer to the frontier to innovate. Fernald and Jones (2014) argue that considering the spillover from research across countries, it is the growth of the overall pool of worldwide researchers, and hence the total global population, that puts an upper limit on long-term growth. In such a scenario, they argue, the shape of the "idea production function" becomes important in moving to a different long-term equilibrium depending on whether innovations are taking place in spurts or waves.

4. **Using a framework developed by Jones (2002), previous staff analysis found that R&D and human capital together contributed about 70 percent of the growth in Singapore's real GDP per capita over 1991–2015 (IMF, 2016a).** Empirical studies have also found positive contributions from R&D on total factor productivity (TFP) growth in Singapore (Wong and Ping, 2016).

Innovation ecosystem and the Singaporean experience

5. **There is no unique definition of an innovation ecosystem, which derives its name from its biological or environmental equivalent.** However, Gobble (2014) summarizes the main aspects of innovation ecosystems as "…dynamic, purposive communities with complex, interlocking relationships built on collaboration, trust, and co-creation of value and specializing in exploitation of a shared set of complementary technologies or competencies."

6. **One of the best-known examples of such an ecosystem is Silicon Valley in the United States.** Other globally-recognized examples include Boston, New York, and Seattle in the United States, Tel Aviv in Israel, and London in the United Kingdom. There is a growing number of locations in Asia, Europe, and Latin America that are also becoming important players in the global innovation landscape.

7. **Among the Asian locations, Singapore is being increasingly recognized as a global hub for R&D collaboration.** In recent years, Singaporean start-ups in the areas of transportation ride sharing, fitness class management, and online food-ordering systems have expanded their reach regionally. Global partnerships are also emerging. These include TechSG (a National University of Singapore and IBM collaboration), the Campus for Research Excellence and Technological Enterprise

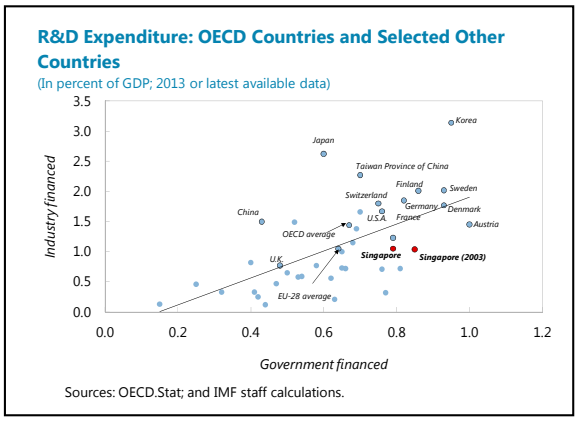
(CREATE, a collaboration between local and top-rated global universities), and the Agency for Science, Technology and Research (A*STAR, a partnership with leading global research centers).

8. **In Singapore, following the example of the United States and Israel, the government has played an important role in promoting R&D.** Singapore has used a cluster-based approach in building its R&D ecosystem, with participation from multinational corporations and indigenous companies. Singapore has also established hubs in areas of biomedical research (*Biopolis*), and information and communication technologies (*Fusionopolis*). Guided by various national plans, different government agencies, including SPRING, A*STAR, the National Science Foundation (NSF), and the Economic Development Board (EDB), are actively supporting R&D through enterprise financing and enhancing enterprises' capabilities, including by helping them connect to global players. Moreover, according to some estimates, Temasek and GIC are among the top equity investors in private technology companies globally (CB Insight, 2017). This may have indirectly contributed to strategic thinking within Singapore about the country's future technological landscape.

9. **Public budgetary commitments for research and innovation have grown over the years, from S$2 billion (2½ percent of 1991 GDP) under the National Technology Plan 1991–95 to S$19 billion (about 4½ percent of 2016 GDP) under the current Research, Innovation, and Enterprise (RIE) Plan 2016–20.** The RIE ecosystem is spearheaded by a high-level advisory board under the Prime Minister's office with support from the NSF, various ministries (e.g., Trade and Industry, Education, health, and defense), and R&D funding bodies (e.g., EDB, SPRING, A*STAR, and NSF).

10. **The 2017 Budget announced the *StartupSG* scheme to unify the support given to startups, set up an *International Partnership Fund* for co-investing in Singapore-based firms, and a *Global Innovation Alliance* to help Singaporeans network with counterparts in innovation centers globally.** The Monetary Authority of Singapore (MAS) has also recently relaxed certain rules for private venture capital. The MAS itself is actively experimenting with new financial technology (fintech) and providing regulatory sandbox facilities to aspirant innovators (see Box 1).

11. **However, relative to peers with comparable public sector funding-to-GDP ratio of R&D, Singapore's industry-financed research expenditure-to-GDP ratio has historically remained low.** The Global Innovation Index report shows that while Singapore ranks high in terms of innovation inputs, it is among the bottom half in terms of efficiency of innovation. This implies Singapore's innovation output is relatively low compared to the inputs used. This is an important observation given that Singapore is one of the top places globally in terms of doing business; competitiveness; network readiness; innovation; and entrepreneurship (World Bank, 2016a; World Economic



Sources: OECD.Stat; and IMF staff calculations.

Forum, 2016a and 2016b; Cornell University and others, 2016; and Acs and others, 2015). Singapore also has a highly-educated population, with some of its universities already among the top 100 globally (The Times Higher Education World University Rankings 2016–2017).

12. **This raises the question why, despite having favorable conditions for quite some time, Singapore's private-sector led R&D and innovations are beginning to bloom only in recent years.** There is no easy answer to this question. In essence, innovation is about disruption, and breaking away from conventions and rules. The mere existence of the necessary inputs does not necessarily lead to an "eureka" moment. As mentioned earlier, it is a complex interaction among many players and factors, some of which are noneconomic in nature. Thus, the outcome is not always easy to predict. To understand these questions, Frenkel and Maital (2014) proposed studying the following four key dimensions: culture, markets, context, and institutions.

- *Culture*. Shared values, diversity, sense of empowerment, and history of entrepreneurial success play vital roles across innovation ecosystems. Studies have also found important contributions from immigrants in driving innovation, for example, see studies on the United States by Hunt and Gauthier-Loiselle (2008), Moser and others (2014), and Akcigit and others (2017). In the case of Singapore, a rules-based, meritocratic, culturally-diverse society with a stable political environment has imparted confidence and a competitive spirit. However, there may be scope for further instilling a culture of risk taking and accepting failures. The growing reach of digital technologies and Singaporean success stories in recent years could potentially help in further encouraging risk taking. In this context, policies should take a more holistic approach, support new firms, and manage cyclical stabilization of aggregate demand while maintaining cost effectiveness of private risk taking toward innovation, adoption, and adaptation of new technologies.
- *Markets*. Singapore has a small domestic market. But this is somewhat offset by its strong regional and global ties, and proximity to large population centers. However, diverse institutional settings across countries in the region pose challenges to scaling up. The successful experiences of startups in Silicon Valley, Tel Aviv, and Sweden illustrates that improved access to regional markets and necessary funding for scaling up of operations will be important for the Singaporean startups. In addition to continuing with regional integration, in ASEAN and the wider South and South-East Asia region, the ecosystem should be willing to maintain financial support to a continuum from basic research to commercial application of research and avoid the "valley of death" (Jackson, undated): the gap between publicly-funded basic research and industry-funded commercial development. Recognizing some of these challenges, the CFE report, for example, has appropriately highlighted the importance of continued reliance on global integration and more private sector funding to help enterprises scale up and innovate. In fact, such funding is growing in Singapore in recent years. Moreover, as ASEAN chair in 2018, Singapore could spearhead new avenues to encourage people-to-people connectivity in the region.
- *Context*. In Singapore, the R&D agenda is largely government driven, although the ability of different ministries and agencies to work toward common goals, guided by various national

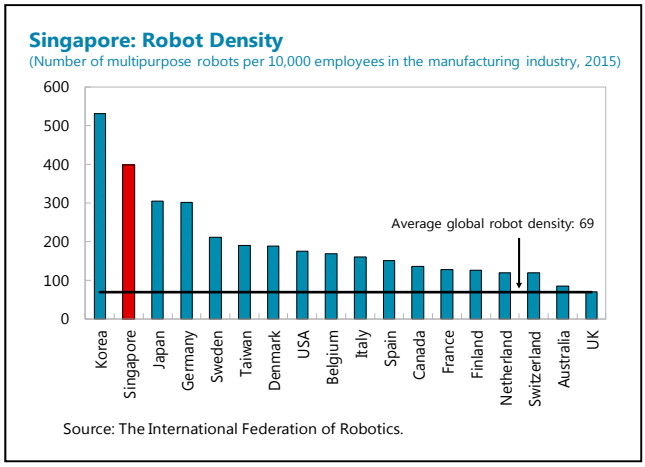
plans, is somewhat unique. The private sector's role has also increased in recent years, including through collaborations within academia and with global players. Identified processes for fostering Singapore's innovation are tilted heavily on the supply-side practices and policies. Researchers have argued that for innovation ecosystems to succeed in "co-creating values", it is also important to allow an equally important role for the demand-side signals. Demand-management policies also help in sustaining the drive for R&D and innovation amid failures (for example, see IMF, 2016b). The authorities are currently focusing on various *Industry Transformation Maps*, and under the RIE 2020, based on existing comparative advantages, public funding will be prioritized in four areas: advanced manufacturing and engineering; health and biomedical sciences; urban solutions and sustainability; and services and digital economy. However, a more general-purpose growth strategies should be considered, rather than focusing on industry specific plans.

- *Institutions.* Singapore is a global leader and center of excellence. However, it is the interplay among all four dimensions of an innovation ecosystem that eventually helps in sustaining its growth. Singapore's high-quality institutions, including protection of intellectual property rights, provide incentives for global players to setup their research centers in Singapore.

13. **To summarize, recent success stories of Singaporean startups bode well for future efforts at innovations and R&D.** However, a cultural shift away from government-driven targeted measures to one more focused on risk taking by the private sector, with appropriate changes in the education system and support from fiscal policy to new firms and also focused on minimizing excessive demand-side fluctuations, could help usher in a new future for Singapore's relatively young new technology startup sector. Improved access to markets in the region and availability of adequate private financing at the matured stage of commercialization and scaling up of new products will support future growth.

C. Automation and Artificial Intelligence: Opportunities and Challenges

14. **The 2016 World Robotics Report forecasts that the number of industrial robots deployed worldwide will increase to around 2.6 million units by 2019, about one million units more than in 2015.** Asia is emerging as the fastest growing market for industrial robots where deployment of robots soared by 70 percent over 2010–15. China, Korea, and Japan lead as the world's largest sales markets for industrial robots. Singapore ranks second, only after Korea, in terms of robot density in manufacturing activities.



15. **The impact of automation has always attracted debate in policy circles.** Predictions that automation will make humans redundant have been made going as far back as the Industrial

Revolution, when the Luddites (textile workers), protested that machines and steam engines would destroy their livelihoods. Subsequently, in the 1930s, Keynes coined the term technological unemployment, as "a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come" (Keynes 1963).

16. **Technology optimists argue that advances in technology may displace certain types of work, but historically they have been a net creator of jobs. In general, every wave of automation and computerization has increased productivity without depressing employment.** Technology pessimists, however, fear that we are headed toward an economic dystopia of extreme inequality and class conflict. Summers (2016), for instance, predicted that a third or more of prime-age American males will be out of work by mid-century in the absence of an aggressive policy response.

17. **While debate on the impact of current and future automation trends on labor market is ongoing, Gregory and others (2016) document a positive effect of automation on the number of jobs.** In essence, reduced production costs result in better market prices, thereby increasing demand and triggering the creation of more jobs.

18. **Is this time different?** Ford (2015) points out in "Rise of the Robots", the impact of automation this time around is broader based. During previous waves of automation, workers could switch from one kind of routine work to another; but this time many workers will have to switch from routine, unskilled jobs to nonroutine, skilled jobs to stay ahead of automation. Another difference is that whereas the shift from agriculture to industry typically took decades, software can be deployed much more rapidly now and across sectors.

19. **The economics literature on the impact of automation on growth, labor market and inequality is growing.** In a seminal paper, Autor and others (2003) categorize tasks as routine and nonroutine and find that automation is associated with a shift of employment out of routine tasks.[3] Recent theoretical literature incorporates robots or automation as a special type of capital that greatly increases the supply of labor services while reducing the marginal product of human labor that competes for employment in the same production tasks.[4]

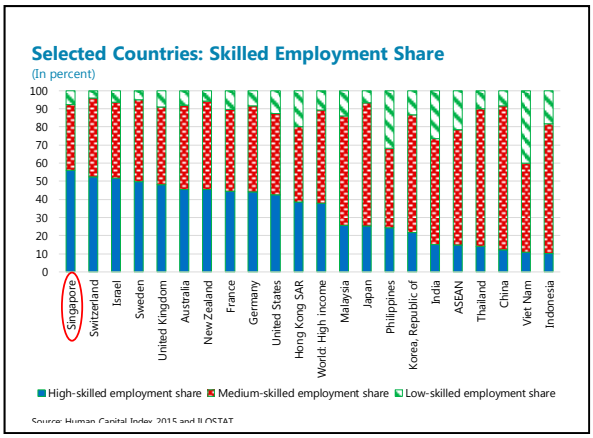
20. **Another trend attributed to automation is the polarization of the labor market, in which wage gains went disproportionately to those at the top and at the bottom of the**

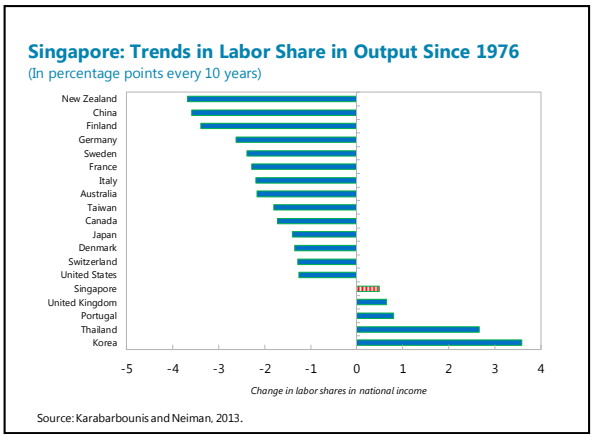
[3] They call a task routine "if it can be accomplished by machines following explicit programmed rules." In contrast, nonroutine tasks are those "for which rules are not sufficiently well understood to be specified in computer code and executed by machines."

[4] Earlier literature has focused on technological change that increases the supply of some factor in efficiency units. In this formulation, skill-biased technological change exacerbates wage inequality if the elasticity of substitution (EOS) between low- and high-skill labor exceeds unity. Similarly, capital-augmenting technological progress lowers or raises labor's share in national income depending on whether the EOS between capital and labor is above or below unity. IMF (2017a) finds that on average, the EOS for the aggregate economy is larger than one for advanced economies, while it is less than one for EMDEs. Sachs and Kotlikoff (2012) show that when the elasticity of substitution between robots and unskilled labor is sufficiently high, an improvement in robot productivity reduces the demand for unskilled workers. This results in lower investment in human capital and robots as well as reduced welfare of the current young generation and all future generations.

income and skill distribution, not to those in the middle (Autor and others 2006; Autor and Dorn 2013; Graetz and Michaels 2015 among others). This can be squared with the evidence on automation of routine versus nonroutine tasks. Nonroutine tasks can be divided into abstract (high skill) and manual (low skill) tasks. Abstract tasks require high level of education and analytical capability and therefore training (lawyers, researchers etc.), while manual tasks require innate abilities and little training (fast food preparers, waiters, home aides etc.). Both these categories are more immune to automation than middle wage, middle education jobs. Feng and Graetz (2015) have a different take on this and consider firms' incentives to automate certain jobs over others. To explain labor market polarization, they contend that low skill workers are shielded from automation not only because some of the tasks they perform are nonroutine, but also because firms will first automate the tasks performed by middle skill workers as these workers are more expensive and require higher training cost.

21. **According to recent estimates by Frey and Osborne (2017), McKinsey Co. (2015), and the World Bank (2016b), anticipated advances in automation threaten 45–57 percent of all jobs in the United States over the next two decades.** Chang and Huynh (2016) find that for ASEAN-5 (Cambodia, Indonesia, the Philippines, Thailand and Vietnam), about 56 percent of all employment has a high risk of automation in the next couple decades. The risks of automation however differ widely across countries, ranging from 44 percent in Thailand to 70 percent in Vietnam. In general, higher skill jobs[5] are at a lesser risk of being automated than medium or low skill jobs. Singapore, with the highest share of high-skilled employment share is therefore more immune to automation risk than other countries. This is also reflected in increasing labor shares of national income in Singapore, while they have been falling in many other advanced economies. According to a study in 2015 by the Centre for Strategic Futures (CSF), Singapore around one-third of the jobs held by Singapore citizens are at risk of automation within 5 to 20 years, based on Frey and Osborne methodology. This is lower than similar estimates for the U.S and other ASEAN countries.





[5] High skill jobs are defined as ISCO groups 1 (managers), 2 (professionals) and 3 (technicians and associate professionals); medium-skill jobs include ISCO groups 4 (clerks), 5 (service and sales workers), 6 (skilled agricultural and fishery workers), 7 (craft and related trade workers) and 8 (plant and machine operators and assemblers); and low-skill occupations consists of ISCO group 9 (elementary occupations).

22. **In assessing the impact of automation, technology pessimists often ignore the issue of the economic response to automation.**[6] While automation renders some jobs obsolete, it complements many others, especially jobs that place a premium on creativity, flexibility, and abstract reasoning. For example, self-driving vehicles may need remote operators to cope with emergencies. Furthermore, some jobs are always likely to be better done by humans, notably those involving empathy or social interaction. An analysis of the British workforce by Deloitte (2015), a consultancy firm, highlighted a profound shift over the past two decades toward caring jobs: the number of nursing assistants increased by 909 percent, teaching assistants by 580 percent, and careworkers by 168 percent.

23. **While labor-saving technological growth, including automation, can replace labor, it also provides avenues to deal with the shrinking labor force in an aging economy like Singapore.** Appendix II (see 2017 Article IV staff report) shows that aging is likely to have a significant impact on growth (particularly under tighter foreign worker policy). Labor-saving technologies can therefore counter the decline in growth both by negating the impact of declining labor force and fall in productivity due to aging.[7]

Policy implications

24. **Education and training.** One key question is if the educational system is adequately preparing individuals for new-economy skills and jobs. An effective way is to reach students as early as elementary school and focus on teaching skills that are advanced, technical, and suitable to give humans an edge over machines, like creativity and collaboration. Furthermore, since no one knows which jobs will be automated later, it may be most important to be adaptable. Singapore provides a great model for this, where the education system is rigorous, placing strong emphasis on technical skills, including vocational education. The authorities' initiatives such as SkillsFuture and life-long learning programs are aiding people to be flexible and adaptable to the changing needs of the new economy. While it is too early to assess the likely impact of these policies, it augments human capital and is therefore a step in the right direction.

25. **Creation of a knowledge economy.** There are substantial first-mover advantages and benefits in the sphere of automation and digital economy. Singapore is favorably placed to reap these benefits and the CFE report along with initiatives to implement its recommendations could place Singapore as a leader in this space. In this respect, the government could aid in boosting the innovation ecosystem, including making it easier to start small businesses and supporting venture capital funds. Automation will create new avenues, particularly in the information and

[6] Acemoglu and Restrepo (2016) consider the economic response to automation by accounting for the creation of new more complex tasks that only human labor can perform. The short- to medium-run impact on absolute labor demand is unclear in their model, but in the long run, labor's share in national income returns to its original level. When labor is divided into high- and low-skill workers, the same restrictions ensure that the skill premium increases in the short run but not in the long run. In contrast, Berg and others (2017) analyze various variants of a model with automation and find robust finding that automation is good for growth, but bad for equality.

[7] IMF (2017b) shows that an increase in the share of older workers is associated with a significant reduction in labor productivity growth. However, the impact is of second order magnitude when compared to the direct effect of shrinking labor force.

communication technology sector, and a vibrant startup environment (as being supported by the Singaporean authorities) will help put the city state in a strong position.

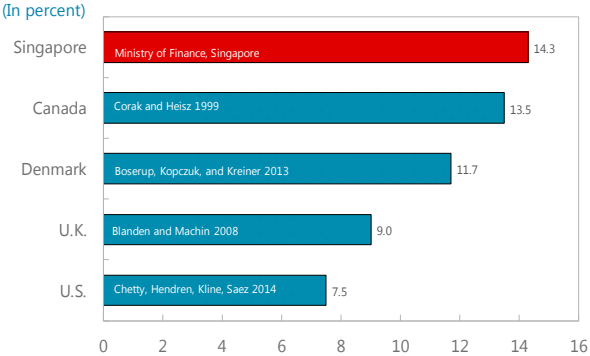
26. **Redistribution.** Technology has the potential to create large wealth, but this wealth could be highly concentrated among a relatively small group of "winners". This begs the question whether the new economy also needs innovative ways to redistribute income and wealth. Bill Gates recently suggested taxing robots (in other words, taxing companies that own robots) and redistributing the proceeds (Quartz interview). Another redistribution concept, is that of universal basic income (UBI), in which the government gives everyone a guaranteed amount of money. While this could discourage people from working, it would also free them to go back to school or do things they are passionate about. While the views on robot taxes and UBI are still evolving, flexible labor market policies (such as upgrading skills of the employed and unemployed, as under various initiatives and schemes introduced by the Singaporean authorities) along with redistribution (unemployment insurance, for instance) may prove effective in facilitating adjustment to the mainstreaming of disruptive technologies and other shocks.

D. A Future of Inclusion

27. **Singapore's consistent application of the principles of individual responsibility, equality of opportunity, and sound public finances has shown remarkable results and can hold important lessons for other countries.** In recent years, this has increasingly been complemented by direct and indirect support for low-income workers and households:

- The emphasis on individual responsibility, along with government incentives—which were enhanced in Budget 2017, has led to one of the highest homeownership rates in the world, with more than 90 percent of resident households owning a home, as well as broad coverage by a fully-funded pension system which holds assets worth 83 percent of GDP.
- The focus on equal opportunity is reflected in the sustained efforts to improve the quality and accessibility of healthcare, education and training, and urban planning. Cross-country comparisons rate Singapore's healthcare system and high school achievements among the best in the world. There are indications that this is raising intergenerational mobility above that in other advanced economies:
- A 2014 Economist Intelligence Unit study found Singapore's healthcare outcomes to be the second highest in a sample of 166 countries, at half the per capita cost of Japan, which recorded the best outcomes. Haseltine (2013) documents how Singapore's healthcare system works and how the government is now proactively expanding healthcare

Social Mobility in Singapore and other Advanced Economies 1/
(In percent)



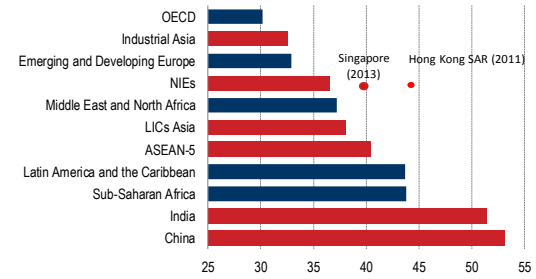
Sources: Adapted from Chetty, Raj. 2015. "Improving Equality of Opportunity in America: New Evidence and Policy Lessons". The Boston Foundation and Budget 2015 Round-Up Speech by Deputy Prime Minister Tharman Shanmugaratnam.
1/ Probability that a child born to parents in the bottom fifth of the income distribution reaches the top fifth of the income distribution.

infrastructure to deal with needs related to population aging.

- The importance assigned to strong high school achievements in the sciences, the *SkillsFuture* program of lifelong learning which continues to be updated and refined, and new initiatives in Budget 2017—acting on the CFE report recommendations—to encourage adoption of new technologies and sectoral and international partnerships, ties in with the growing literature that shows that economic growth is strongly affected by workers' cognitive skills (e.g., Hanushek and Woessmann (2010)) and that better-educated workers will be better able to adapt to new technologies.
- Urban planning focuses on creating integrated neighborhoods where people of different income and ethnic groups live together. The city state's geography along with the high cost of car ownership makes the bulk of Singaporeans use the same public transportation infrastructure which continues to be expanded and upgraded.
- The government is increasingly implementing redistribution measures and programs (e.g., Special Employment Credits, quarterly cash payments ("Silver Support"), subsidies for medical bills for the Pioneer Generation, GST voucher Cash Special Payments, Personal Income Tax Rebates, etc.). And new policy initiatives are typically calibrated to minimize the adverse impact on low income households (e.g., the water tariff increases announced in Budget 2017). As a result, inequality as measured by the Gini coefficient, while higher than in other advanced economies, has been trending down in recent years.

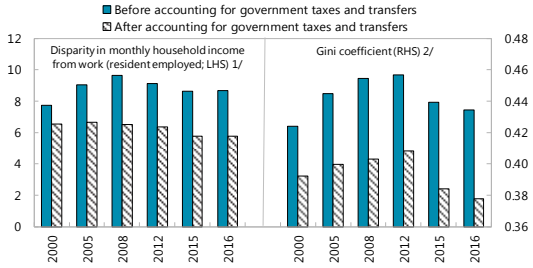
Regional Comparison: Income Inequality Level

(Net Gini Index; in Gini points; year of 2013, or latest, average across regions)



Sources: SWIID Version 5.0; IMF, WEO database; and IMF staff calculations.
Note: ASEAN = Association of Southeast Asian nations; LIC = low-income county; NIE = newly industrialized economy; OECD = Organization for Economic Cooperation and Development

Singapore: Income Inequality



Sources: Singapore Statistics; CEIC Data Co. Ltd.; and IMF staff calculations.
1/ Ratio of monthly household income from work (including employer CPF contributions) per household member at 90th percentile to 10th percentile.
2/ Average of conventional Gini coefficient (including employer CPF contributions) and OECD measures of Gini coefficient that account for household size.

Box 1. At the Forefront of Fintech

Singapore emerged at the top of the league (along with London) in Deloitte's 2016 index capturing how conducive a hub (country or city) is to the growth of Fintech. The high rank reflects Singapore's position as a leading international financial center as well the government support – S$225m committed to the development of fintech ecosystem as well as other initiatives including the regulatory sandbox, cloud computing guidelines, strategic electronic payments, fintech office, the MAS innovation lab, international technology advisory panel and talent development.

Venture capital (VC) investment in fintech has grown in Singapore however remains much lower than in the UK, Germany, and Canada. Many of the larger VC funding in Singapore were concentrated among online payments, remittances or foreign exchange trading platforms. However, activity is shifting from areas such as payments and lending, which have saturated to deep technologies such as blockchain and fast growing areas like insurtech. Singapore offers a distinctive value proposition for fintech development. These include:

- Open banking platform via application programming interfaces (APIs) for faster innovation and integration of new and legacy IT systems within the sector; the MAS has already released several of its data series as APIs to facilitate financial institutions and developers. Open APIS will also increase the efficiency of certain regulatory processes, such as banks' submissions of applications and transactions, which will be key in the promotion of regulatory technology (RegTech);
- The MAS has successfully concluded a proof-of-concept project to conduct domestic interbank payments using distributed ledger technology (DLT) or blockchain. It is aimed to extend the technology to other sectors such as securities trading and settlement and cross border payment using central bank digital currency. As the DLT become scalable, the implications for the conduct of monetary policy and financial stability would need to be properly understood;
- A national KYC (know your customer) utility via expanding Myinfo service to the financial industry, using trusted government collected personal data;
- Financial institutions' cyber resilience through both onsite and offsite supervision. The MAS has revised its Internet Banking and Technology Risk Management Guidelines as well as issued new guidelines on outsourcing risk management including on cloud services;
- Regulatory sandboxes as safe spaces to experiment and roll out innovative products and solutions within controlled boundaries;

While fintech is still at its nascent stage, the regulatory challenges are emerging as the industry grows. For instance, AML/CFT concerns over anonymous cross-border transfers using virtual currencies; framework for governance, supervision and management of algorithms of robo-advisors; regarding APIS, data standards around transaction data, reference data, and more importantly sensitive commercial data; development and coordination on security standards that ensure right level of authentication, authorization and encryption for cyber security. Continued vigilance is warranted as the sector evolves to ensure financial stability and resilience.

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