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ARTICLES IN THIS ISSUE

BOOK REVIEW

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The Philippine Review of Economics

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What next after hyper-globalization and export-oriented industrialization?*

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This paper delves into the evolving landscape of the global economy and its implications for countries like the Philippines. It explores the emerging paradigms that are reshaping economic policies worldwide. Traditionally, economic policies were anchored domestically in export-oriented industrialization models for rapid economic growth. However, the efficacy of this model is waning in the face of technological advancements and changing global dynamics. The hyper-globalization era, marked by financial integration and expanding free trade agreements, prioritized global competition over national interests. But geopolitical tensions, particularly between the US and China, are disrupting the notion of deep economic integration that was once deemed normal. Amidst these shifts, the paper envisions three potential scenarios: a 1930s-style collapse of the world economy (bad), increased weaponization of interdependence and rising geopolitical conflicts (ugly), and a better balance between domestic political autonomy and global integration, fostering a conducive environment for reconstructing national social contracts (good). The paper proposes a shift towards a different economic model focusing on the creation of "good jobs", characterized by productivity levels that enable the creation of a middle class. These are expected to predominantly emanate from the services sector, particularly non-tradable services. This paper offers some insights for policymakers and stakeholders navigating through these transformative times. As the world economy undergoes profound changes, embracing new approaches and an experimental mindset become imperative for charting a sustainable path forward.

JEL classification: F6, F15, O14, O25
Keywords: economic integration, hyper-globalization, good jobs, industrial policy

* Keynote address at the 60th Philippine Economic Society Conference, November 9, 2022. At the time, Prof. Rodrik was President of the International Economic Association.

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1. Introduction

In today's keynote address, I have chosen to delve into the future of the world economy. It's evident that we stand at a critical juncture where fundamental ideas and economic policy narratives are undergoing significant shifts. This transformation will likely impact the Philippine economy as profoundly as it does any other.

My aim is to offer a broad context for our potential trajectory and suggest directions that merit consideration. I will begin by addressing a central theme: the departure from longstanding anchors of our economic policies. These anchors were rooted both domestically and internationally. Internationally, we relied on a specific approach to industrialization to drive rapid economic growth.

We find ourselves at a juncture where the traditional anchors of globalization are faltering. Hyper-globalization faces significant backlash: driven not only by domestic political tensions in advanced nations, but also by escalating geopolitical competition between the US and China. This geopolitical rivalry undermines the deep economic integration once considered normal.

Similarly, export-oriented industrialization, long seen as a path to economic growth, is losing its effectiveness due to technological shifts and reduced labor absorption capacity of globally competitive manufacturing industries. This model, though historically pivotal for some economies, including the Philippines, no longer holds the same promise.

Amidst these challenges, we envision three scenarios: the bad, the ugly, and the good. The bad scenario entails a 1930s-style economic collapse, while the ugly scenario involves increased geopolitical conflicts and trade tensions. However, the good scenario offers hope. It calls for recalibrating globalization, striking a better balance between domestic autonomy and global integration. This entails reconstructing national social contracts, fostering a conducive environment for international trade and investment reminiscent of the Bretton Woods era.

Internally, given the breakdown of the export-oriented industrialization model, we must pivot towards creating "good jobs" in the service sector. These jobs, predominantly non-tradable, require a shift in economic policy orientation towards services, signaling a departure from past approaches. These overarching themes guide our discourse.

2. The post-1990s movement towards hyper-globalization

The transition to hyper-globalization in the 1990s represented a shift away from the trade liberalization model of the Bretton Woods era. While Bretton Woods focused on border restrictions and allowed room for compensating integration's losers, hyper-globalization prioritized deep financial and trade integration with open capital accounts, the World Trade Organization (WTO),

and expanding free trade agreements. This shift emphasized global competition as a vehicle for national growth and development, and anticipated convergence towards a market-oriented model worldwide. However, China's success with its own developmental model contradicted this expectation, revealing the limitations of hyper-globalization.

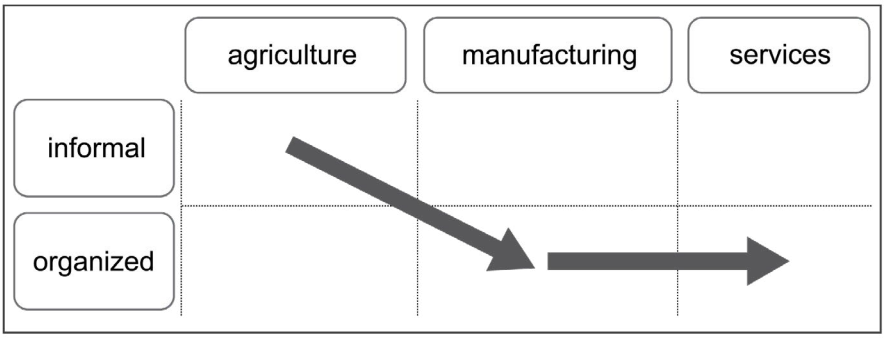
Several contradictions characterized hyper-globalization, spanning from narrow economic concerns to geopolitical tensions. Firstly, there was an overemphasis on the benefits of specialization at the expense of productive diversification, as seen in China's success with diversification policies. Secondly, there arose distributive tensions within countries due to income redistribution issues associated with deep integration. Thirdly, tensions arose between reaping gains from trade and maintaining regulatory diversity, as different countries sought varying regulations. Finally, geopolitical tensions intensified despite the belief that economic integration would foster geopolitical harmony. As China's economic power grew, so did concerns about geopolitical competition. These tensions were mismanaged under hyper-globalization, leading to an overemphasis on trade gains and neglect of other concerns. Looking ahead, I would advocate a shift towards a thinner yet more sustainable model of globalization.

3. A thinner but more sustainable globalization

This entails recognizing that convergence between the Chinese economic model and Western counterparts is unlikely. Instead, peaceful economic coexistence between different development models is key. This implies the need for globally permissive rules on subsidies, intellectual property rights, and industrial policies. Countries should have the flexibility to pursue domestic economic strategies without facing uniform global restrictions. Cooperation on non-economic issues such as climate change, global health, and refugee crises remains crucial. However, in terms of international trade and investment, a more permissive approach would be preferable for the new era. Despite current challenges, there's potential for a positive scenario that maintains globalization while tempering expectations of hyper-globalization.

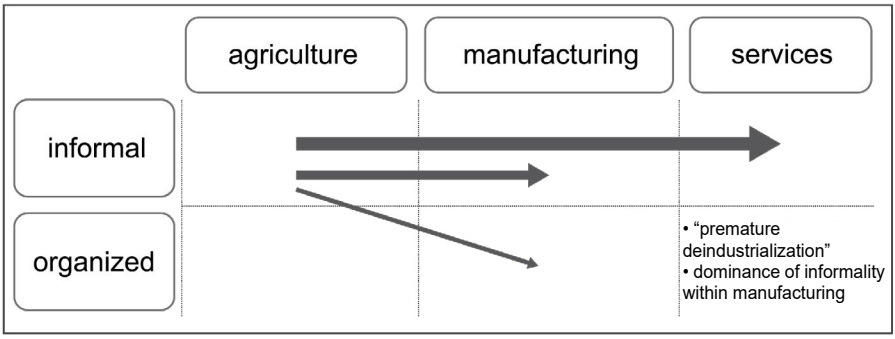
In discussing domestic development models and necessary changes, it's important to examine the traditional development model. This model typically involves a structural transformation illustrated in Figure 1. Initially, economies are primarily agrarian, with production concentrated in traditional agriculture and informal, low-productivity sectors. Successful development entails transitioning labor from informal agriculture to organized manufacturing activities in urban centers. Subsequently, as economies progress, there's a shift towards the tertiary sector, but this typically follows industrialization and attainment of middle-income status.

FIGURE 1. Traditional development model



In much of the developing world today, migration from agriculture to urban areas still continues. However, the main beneficiary is not manufacturing, but services; particularly, low-productivity informal services. Even in instances where manufacturing expands, such as in low-income African countries, it tends to be informal. This phenomenon, termed *premature deindustrialization*, describes situations where countries either struggle to industrialize or undergo deindustrialization at lower income levels than historically observed (Figure 2). Traditionally, industrialization served as a key driver of growth and employment. Now, the central question in development strategy revolves around the source of good, productive jobs, which were historically associated with manufacturing.

FIGURE 2. Premature deindustrialization in most developing countries



4. Key questions facing development strategy: where will the good jobs come from?

In the future, services will play a significantly larger role in job creation. This shift implies that growth and social policies will converge in their goals and strategies. Genuine growth necessitates the creation of productive jobs and the expansion of the middle class. Concurrently, addressing the structural roots of

poverty and inequality demands the generation of quality jobs for low-skilled workers. Therefore, enhancing productivity in the informal service sectors and small to medium-sized enterprises is paramount. This entails not only investing in training and skills but also fostering the development of robust and efficient firms capable of hiring and compensating workers adequately. Ultimately, the pursuit of good jobs entails comprehensive interventions targeting both the supply and demand sides of the labor market.

Investing in education and training is crucial, as it enhances human capital. However, alongside this, there's a need to bolster the capabilities of firms, especially smaller ones in low-productivity service sectors catering mostly to the domestic market, like retail, healthcare, and construction. This investment in firm productivity has traditionally fallen under industrial policy, which typically focuses on manufacturing and large exporters. Yet, looking ahead, the focus may need to shift towards different types of services.

Why services? While productivity improvements in agriculture are possible, the sector's capacity to absorb employment remains a challenge. As productivity increases in non-traditional agriculture, there is a corresponding need to find alternative employment opportunities for rural workers.

The central question remains: where will labor find opportunities, particularly for quality employment? Agriculture alone cannot address this challenge; instead, the focus shifts to the service sector. Broadly, services can be categorized into two types: high-productivity, tradable segments and others. The Philippines has experienced success in areas like business process outsourcing, reflecting productive opportunities akin to manufacturing. However, these services demand high skill levels, posing limitations on labor absorption. Thus, while these segments offer potential, they cannot fully address the need for widespread job creation. It’s essential to tailor job creation to the current workforce’ skill levels while investing in education and human capital for future needs.

To summarize this perspective and highlight its departure from conventional development policy, it’s helpful to conceptualize our strategy within a matrix framework. This framework distinguishes between the stage of the economy where policy interventions occur and the specific economic segments of interest, whether they pertain to lower, middle, or higher productivity. Traditional poverty reduction approaches (Figure 3) emphasize investing in household endowments such as education and training, alongside providing social insurance through transfers and safety nets, whereas the traditional industrial and growth policies tend to focus on the high end of the economy, the high productivity segment of the economy (Figure 4).

FIGURE 3. Traditional poverty reduction and social protection model

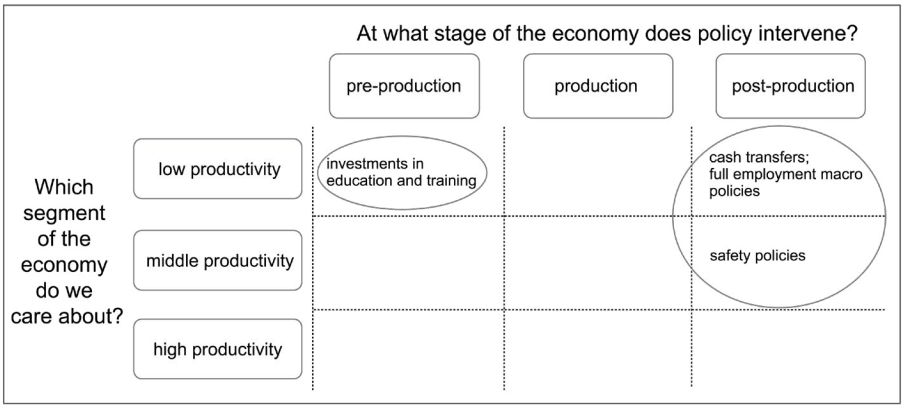
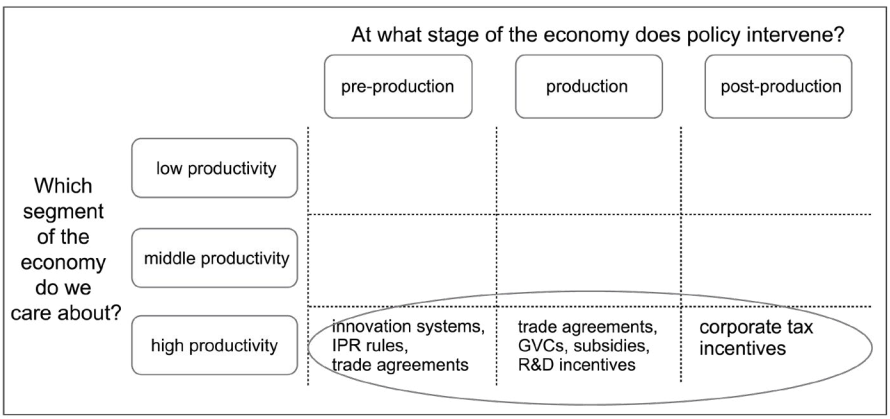
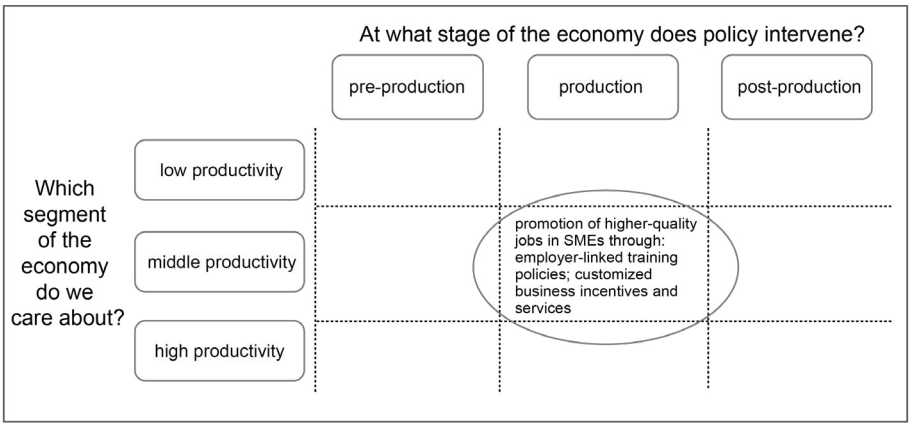


FIGURE 4. Traditional industrial and growth policies



The proposed good-jobs development model focuses on the middle cell of the matrix and emphasizes a shift towards middle productivity segments of the economy that can both enhance productivity and accommodate a larger workforce, particularly comprising lower-skilled workers (Figure 5). This approach necessitates a tailored industrial policy focused on smaller and medium-sized enterprises, addressing their specific needs such as management norms, infrastructure, digital platforms, training programs, and access to technology. Moving away from traditional subsidies, this collaborative approach between firms and policymakers requires innovative solutions tailored to individual enterprise requirements, presenting a significant challenge for future development policies.

FIGURE 5. The good jobs development model



5. New type of "industrial policies"

In conclusion, it is worth considering the potential for novel perspectives on both enhancing globalization and fostering more inclusive development strategies. These approaches will diverge significantly from traditional models, necessitating imagination, creativity, and a willingness to experiment. However, such endeavors must unfold within a global landscape overshadowed by escalating geopolitical tensions between the US and China. This rivalry threatens to detract attention from pressing economic priorities, posing a genuine concern moving forward.

Nevertheless, it remains our duty as economists to illuminate pathways that offer economic opportunities and mutual benefits for all stakeholders. With that said, I extend my gratitude for your attentive audience and express my regret for not being able to participate further in your discussions and deliberations. May your exchanges be fruitful and productive.

Thank you very much.

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Philippine industrial policy journey: transforming the economy in the new digital age

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This paper examines the Philippines' evolving industrial policy in light of the accelerated digital transformation catalyzed by the COVID-19 pandemic. The pandemic laid bare vulnerabilities in supply and value chains, prompting a shift towards adopting Fourth Industrial Revolution or Industry 4.0 technologies.

As the country prepares for the new digital age, implementing a new strategy is imperative to build a more competitive economy. The new science, technology, and innovation (STI)-driven industrial policy leverages Industry 4.0 to support digital transformation and enhance resilience, agility, and productivity. This necessitates integrating the country's production systems across manufacturing, agriculture, and services. The new industrial strategy focuses not only on advancing manufacturing but also on its convergence with services and agriculture, embracing "mindfacturing"—a pathway that integrates intellectual work, creativity, and innovation into modern manufacturing.

To achieve this, it is crucial to accumulate investments and STI capabilities while transforming industries to increase the share of STI-driven sectors in GDP. Aligning the Strategic Investment Priority Plan of the Corporate Recovery and Tax Incentives for Enterprises (CREATE) Act with STI-driven initiatives is essential for driving industrialization and economic recovery. Sustaining the momentum of digital transformation efforts requires a more permanent budget allocation. Additionally, implementing the Philippine Industry Skills Framework is necessary to equip the workforce with future-ready skills.

Nationwide establishment of Regional Inclusive Innovation Centers (RIICs) is also recommended to foster collaboration among stakeholders in innovation and entrepreneurship ecosystems. These centers will address societal issues and industry challenges through market-oriented research, facilitating the translation and commercialization of innovations into products and services.

JEL classification: L5, O2, O14
Keywords: industrial policy, digital age, Philippine industry

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** The views expressed in this article are those of the author and do not represent the official position of the Department of Trade and Industry.

1. New industrial policy: setting the context

Philippine industrial policy started in the 1950s through the adoption of trade and investment policies as the major policy tools of industrialization. To promote the manufacturing industry, the government imposed protective policies, provided generous investment incentives, and implemented government regulations to control prices, domestic supply, and market entry in selected industries. Over time, the protectionist policies came to impose barriers to resource mobility and competition and became associated with the protection of entrenched incumbents and rent-seeking behavior.

In 1979, the government launched eleven major industrial projects across different regions in the country consisting of the following: copper smelting (Isabel and Leyte); phosphate fertilizer (Isabel and Leyte); aluminum smelting (Mindanao); diesel engine, cement expansion, coconut fatty alcohol (Northern Mindanao); integrated pulp and paper mill, petrochemical, and naphtha cracker (Bataan); heavy engineering (foundry to make large castings, huge forge and fabricating equipment), integrated steel, and alcogas. While most of these projects failed to take off, the government-owned Philippine Associated Smelting and Refining Corporation in Leyte, which was established in 1983 and privatized in 1999, was able to survive the internal and external changes in its operating environment. The National Steel Corporation in Iligan was privatized in 1995 but had to shut down after the 1997 Asian financial crisis. Other manufacturing activities that were intended to support the eleven industrial projects and that were already in the pipeline of the Board of Investments (BOI) for implementation were all withdrawn by the private sector following the regime change in 1986.

Assessing the country's protectionism and import substitution in the late seventies, Bautista, Power and Associates [1979] concluded that the policies did not lead to the creation of an efficient mechanism for allocating domestic resources in the economy. The restrictive trade regime created unintended effects that affected competitiveness and prevented the growth of dynamic economic activities. Medalla [2002] characterized this policy regime as import-dependent import substitution, which (i) discouraged backward linkages and encouraged the use of artificially cheap imported inputs; (ii) penalized exports; and (iii) artificially cheapened capital which promoted greater capital intensity among domestic industries.

In the 1980s, the government embarked on a trade liberalization program to reduce tariff and non-tariff barriers. This was followed by policy reforms in the 1990s that liberalized investments particularly in areas previously reserved only for Filipinos, and privatized and deregulated services such as financial, telecommunications, power, water, air transport, and shipping. All these aimed at removing barriers to competition, promoting factor mobility, attracting investments, and attaining sustainable economic growth.

While the trade liberalization programs from the eighties till the early 1990s were pursued on a unilateral basis, the succeeding liberalization episodes were carried out on a bilateral or regional basis through free trade agreements that the Philippines had signed. Towards the mid-1990s, the tariffication and removal of import restrictions were achieved through the General Agreement on Tariffs and Trade-World Trade Organization (GATT-WTO). In the 2000s, further tariff liberalization was implemented as the Philippines signed free trade agreements with the Association of Southeast Asian Nations (ASEAN) Economic Community, ASEAN-Japan, and ASEAN-Korea. Other free trade agreements entered into by the Philippines include the Japan-Philippines Economic Partnership Agreement (JPEPA), Philippines-European Free Trade Association (EFTA) Free Trade Agreement, ASEAN+5 (Japan, South Korea, Australia, New Zealand, China), and more recently, the Regional Comprehensive Economic Partnership (RCEP) Agreement and the Philippines-South Korea Free Trade Agreement.

Amid liberalization and other market-oriented reforms, the government through the Department of Trade and Industry (DTI) tried to revive industrial policy in 1998 through the formulation of the Industrial Development Plan. Focusing on technology and skills upgrading, the Plan focused on developing 16 priority industries: copper products, decorative crafts, electronics, fertilizer, footwear and leather goods, fresh fruits, furniture, garments and textile, industrial tree plantation and rubber products, iron and steel, metal products, marine products, motor vehicles and components, oleochemical, petrochemical, processed food and carrageenan. The Plan was not implemented due to the changes in political administration and the Asian financial crisis.

In 2012, the DTI made another industrial policy attempt by collaborating with industry groups and the Philippine Institute for Development Studies (PIDS) in the formulation of industry roadmaps. The research work centered on the identification of the most binding constraints to industry growth and solutions to address these issues (see Aldaba [2014]). Consultations and focus group discussions with industry players, academe, government agencies, civil society, labor groups, and other stakeholders took place not only in Metro Manila but as well as in the regions. The process yielded long lists of industry issues and recommendations covering measures to enhance firm productivity, strengthen supply chains to enable firms to move up the technology scale, link domestic firms with multinational companies, aggressively court more investments, and establish a coordination mechanism to allow more interaction between government and industry. Based on these recommendations, the Comprehensive National Industrial Strategy (CNIS) provided the framework for the implementation of the sectoral roadmaps to support the growth and development of globally competitive and innovative industries.

Through horizontal and vertical measures to enhance productivity, the CNIS aimed to build a strong and modern industrial base that would enable the real economy to lead the country's high level, inclusive, and sustainable growth.

A coordination mechanism, led by BOI industry champions together with representatives from industries, was designed to allow more interaction between government and industry in identifying obstacles to growth and determining the most appropriate interventions. Auto and auto parts, tool and die, furniture, iron and steel, metal casting, motorcycle and parts, petrochemicals, and shipbuilding were among the priority manufacturing industries identified for development.

Building on the CNIS, the DTI in 2016 finetuned and implemented the country's new industrial policy known as Inclusive Innovation Industrial Strategy (i3S). The strategy placed innovation at its front and center as the country adapted to changing market trends and developments such as the entry of the Fourth Industrial Revolution (Industry 4.0) technologies. Industry 4.0 presented opportunities to improve productivity, and move up the global value chain (GVC).

Amid the implementation of i3S, COVID-19 broke out and triggered a major global economic crisis. As the government reopened the economy, renewing the Philippine industrial policy was crucial not only to overcome the impact of the crisis due to the pandemic but also to set the country back on the economic development path. The current strategy, known as science, technology, and innovation (STI)-based industrial policy focuses on the adoption of digital technologies and policies to accelerate a transformative recovery and facilitate the investments to achieve structural change and industrialization.

This paper aims to revisit the new industrial policy experience of the Philippines, identify the challenges and opportunities arising from the entry of the Industry 4.0 technologies, and articulate the next steps and way forward especially amid the new digital age. The next section presents the structure and performance of industries, the impact of the pandemic on industries, and how industrial policy was used in helping industries survive the health and economic crises. Section 3 analyzes the current state of technology utilization in the manufacturing industry and the implications of Industry 4.0 on the country's economic development. Section 4 discusses the underlying industrial policy framework and its elements along with the major strategies in the implementation of the STI-driven industrial policy. Section 5 proposes some ways forward to support the country's industrial transformation in the digital era and outlines the role of a new industrial policy.

2. Economic recovery towards accelerating industrialization

2.1. Impact of COVID-19 and the need for economic restructuring

Prior to the pandemic, the Philippines was growing at an average of 6.6 percent during the period 2016 to 2019 (Table 1). Manufacturing and services contributed substantially to this strong growth with average manufacturing growth at six percent while services posted 7.4 percent. Within the services sector; wholesale and retail trade, financial and insurance and professional and business services

were the major sources of growth. In the case of agriculture, forestry and fishing, however, growth had been declining and registered an average of only 1.4 percent during the same period.

TABLE 1. GDP growth performance (2001-2023, in percent)

Major economic sector	2001-2005	2006-2010	2011-2015	2016-2019	2020	2021-2023
Agriculture, forestry, and fishing	4.1	2.9	2.4	1.4	-0.2	0.5
Industry	3.9	4.5	6.0	7.0	-13.1	6.2
Mining and quarrying	13.5	6.4	2.4	3.3	-18.6	4.1
Manufacturing	4.2	2.8	5.4	6.0	-9.8	5.0
Electricity, steam, water, and waste management	4.6	5.0	4.9	6.6	-0.4	5.1
Construction	0.5	11.1	9.6	10.5	-25.5	10.3
Services	5.3	5.8	6.9	7.4	-9.1	7.2
Wholesale and retail trade; repair of motor vehicles and motorcycles	4.9	4.9	5.6	6.9	-6.1	6.1
Transportation and storage	2.6	2.8	9.4	7.9	-30.6	14.4
Accommodation and food service	4.2	4.3	6.9	9.4	-45.5	20.9
Information and communication	19.1	6.3	6.0	6.3	5.1	7.2
Financial and insurance activities	7.5	9.2	9.1	9.4	5.6	6.9
Real estate and ownership of dwellings	2.8	4.7	7.8	4.9	-16.7	3.8
Professional and business services	13.2	14.3	11.0	7.9	-9.6	7.4
Public administration and defense; compulsory social activities	3.3	4.2	3.6	11.4	4.5	4.0
Education	3.1	4.1	3.1	6.8	-10.2	7.4
Human health and social work activities	6.8	2.7	7.4	4.6	-5.1	8.5
Other services	3.6	9.1	7.3	5.1	-41.0	17.1
GDP	4.7	5.0	6.0	6.6	-9.5	6.3

Source: Philippine Statistics Authority [n.d.].

The COVID-19 crisis in 2020 interrupted the robust growth performance of the country and led to a severe contraction of the economy. With the quarantines and lockdowns which halted business operations, manufacturing and services registered negative growth rates. The gradual reopening of the economy in the third quarter of 2020 and the arrival of vaccines started to restore business and consumer confidence. Table 1 shows recovery as the economy grew by 6.3 percent in 2021-2023. Manufacturing expanded by five percent while services posted a 7.2 percent growth; however, agriculture, fishing and forestry remained

weak at -0.5 percent due to the onslaught of the African Swine Disease and series of typhoons that adversely affected the sector's recovery.

Table 2 presents the structure and changes in contribution of the major economic sectors covering the same period. The average share of agriculture, fishing and forestry continued to decline from 15 percent during the years 2001-2005 to 9.9 percent for the years 2016-2019 and to nine percent in the more recent 2021-2023 period. The average contribution of manufacturing also dropped from 22 percent to 19 percent and 18.6 percent during the same years under study. With an average share of 53 percent for the period 2001-2005, services' share went up steadily to almost 60 percent for the period 2016 to 2019 driven by wholesale and retail, financial, and professional and business services. This increased further to 61.4 percent in the years covering 2021-2023.

TABLE 2. Economic structure (2001-2023, in percent)

Major economic sector	2001-2005	2006-2010	2011-2015	2016-2019	2020	2021-2023
Agriculture, forestry, and fishing	15.2	14.3	12.4	9.9	10.2	9.0
Industry	31.4	30.0	29.7	30.4	29.2	29.6
Mining and quarrying	1.0	1.1	1.0	0.9	0.8	0.8
Manufacturing	22.3	20.6	19.4	19.1	18.6	18.6
Electricity, steam, water, and waste management	3.3	3.2	3.1	3.1	3.4	3.3
Construction	4.9	5.1	6.2	7.3	6.4	6.9
Services	53.4	55.8	57.9	59.8	60.7	61.4
Wholesale and retail trade; repair of motor vehicles and motorcycles	18.2	18.3	17.9	17.8	18.7	18.5
Transportation and storage	3.8	3.3	3.4	3.8	2.9	3.3
Accommodation and food service	2.0	1.9	1.9	2.2	1.3	1.6
Information and communication	2.0	2.9	2.9	2.8	3.3	3.4
Financial and insurance activities	5.1	6.4	7.4	8.2	10.1	10.1
Real estate and ownership of dwellings	6.6	6.4	6.7	6.5	5.9	5.6
Professional and business services	2.3	4.0	5.3	6.3	6.1	6.2
Public administration and defense; compulsory social activities	4.6	4.2	4.0	4.1	5.2	5.0
Education	5.0	4.6	4.2	3.9	3.9	4.0
Human health and social work activities	1.8	1.8	1.7	1.7	1.7	1.9
Other services	1.9	2.0	2.4	2.3	1.5	1.7
GDP	100.0	100.0	100.0	100.0	100.0	100.0

Source: Philippine Statistics Authority [n.d.].

Table 3 looks at the employment contribution of industries during the same years under study. With the failure of manufacturing to create sufficient employment for new entrants to the labor force as well as those who move out of the agricultural sector, the services sector has emerged as the most important employment provider as it continued to absorb the unemployed workers especially in wholesale, retail, and repair of vehicles and appliances which constituted the bulk of services employment. Services average employment share rose steadily from 51 percent during the period 2008-2010 to 57 percent in 2016-2019 and to 57.9 percent in 2021-2023. Amid the lockdowns and supply chain disruptions arising from the pandemic, the average contribution of manufacturing declined from 8.6 percent in 2016-2019 to 7.8 percent in 2021-2023. Meanwhile, agriculture continued to account for a substantial share of total employment although its contribution had fallen from 34.3 percent in 2008-2010 to 24.7 percent in 2016-2019 and to 24 percent during the years 2021-2023.

TABLE 3. Employment structure (2008-2023, in percent)

Major economic sector	2008 - 2010	2011 - 2015	2016 - 2019	2020	2021-2023
Agriculture, forestry, and fishing	34.3	31.2	24.7	24.8	24.0
Industry	14.8	15.6	18.6	18.3	18.0
Manufacturing	8.4	8.3	8.6	8.1	7.8
Services	50.9	53.3	56.7	56.9	57.9

Source: Philippine Statistics Authority [n.d.].

Comparing the country's manufacturing performance against its neighbors in the region for the period 2000-2022, Figures 1 and 2 indicate that the Philippines lags behind Korea, Thailand, Malaysia, Vietnam and Indonesia in terms of contribution to GDP. In terms of the contribution of manufacturing to employment, the Philippines is also at the bottom. Thailand, Indonesia, and Malaysia are experiencing declining manufacturing shares to GDP after reaching a peak of around 30 percent share in 2007-2008 in Thailand, 28 percent in 2003-2005 in Indonesia, and 30 percent in Malaysia in 2000-2004. Korea was able to manage and sustain its manufacturing share; the same holds for Vietnam particularly in the more recent period. Vietnam is the only country with an increasing manufacturing employment contribution for the entire period.

In terms of the country's trade integration with the world, the trade to GDP ratio was rising but after reaching a peak of almost 95 percent in 2000, it started to fall (Figure 3). A declining trade to GDP ratio indicates a less open and more inward-oriented economy. In the more recent years, some recovery was observed as the ratio rose from 46 percent in 2015 to 56 percent in 2022.

FIGURE 1. Manufacturing contribution to GDP: 2020-2022

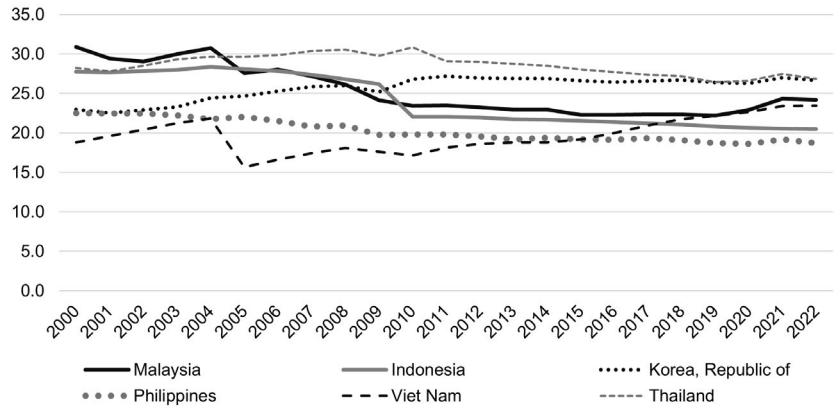
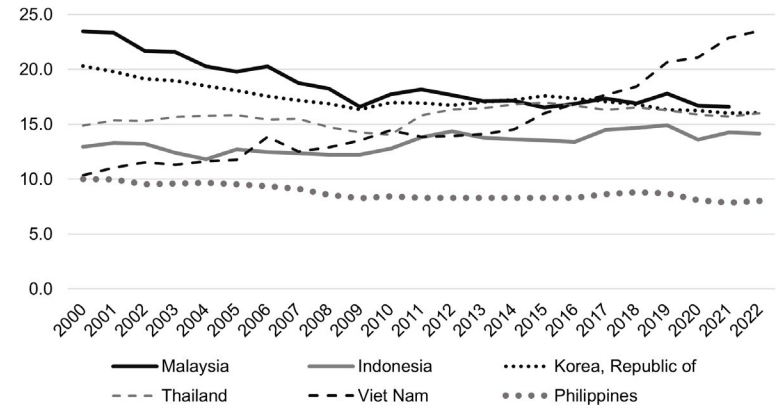
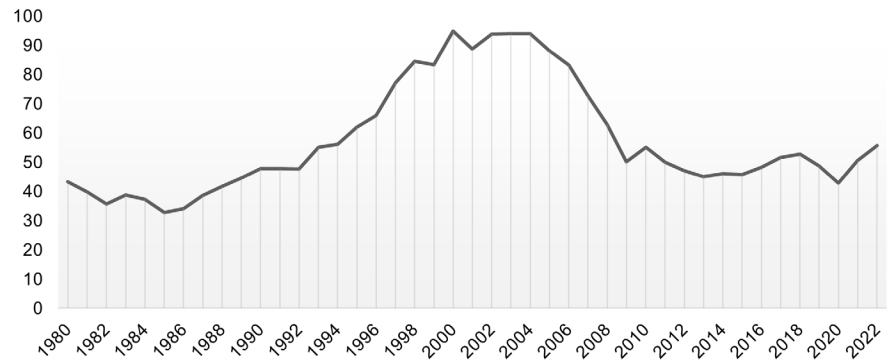


FIGURE 2. Manufacturing contribution to employment: 2000-2022



Source of basic data: ADB Key Economic Indicators

FIGURE 3. Trade as percentage of GDP



Source: UNCTAD Statistical Portal. [n.d.].

The country's export structure in Table 4 indicates that the country's exports have become less diversified. In the 1980s, Philippine exports were composed of light manufactures such as metalliferous ores and metal scrap with an average share of 8.4 percent of total exports, vegetable oils and fats (8.3 percent), fruits and vegetables (6.9 percent), clothing (six percent), electrical machinery (5.7 percent), sugar and sugar preparations (4.6 percent), wood lumber and cork (3.6 percent), fish and fish preparations (3.5 percent), and special transactions which accounted for 26.9 percent of the total. In the 1990s, a huge shift towards electrical machinery (30 percent) and machinery other than electric (eight percent) was evident. This continued in the next period (2000-2009) as the electronics sector now dominated the country's exports with electrical machinery accounting for an average of 48 percent of total exports while machinery other than electric accounted for an average share of 21 percent. During this period, emerging sectors such as transport equipment and scientific and control instruments registered average shares of four percent and 2.3 percent, respectively.

TABLE 4. Structure of exports: average shares (in percent)

SITC Code	Product Description	1980-1989	1990-1999	2000-2009	2010-2019	2020-2023
1	Meat and meat preparations	0.0	0.0	0.0	0.1	0.0
2	Dairy products and eggs	0.0	0.0	0.2	0.1	0.1
3	Fish and fish preparations	3.5	3.2	1.1	1.4	1.2
4	Cereals and cereal preparations	0.4	0.2	0.2	0.2	0.3
5	Fruit and vegetables	6.9	3.8	2.1	3.3	3.9
6	Sugar, sugar preparations and honey	4.6	0.9	0.3	0.4	0.1
7	Coffee, tea, cocoa, spices, and manufactures	1.5	0.2	0.0	0.0	0.0
8	Feedstuff for animals, excluding unmilled cereals	1.3	0.4	0.1	0.2	0.1
9	Miscellaneous food preparations	0.1	0.2	0.2	0.4	0.4
11	Beverages	0.1	0.1	0.1	0.1	0.0
12	Tobacco and tobacco manufactures	0.6	0.3	0.3	0.6	0.7
22	Oil seeds, oil nuts and oil kernels	0.5	0.1	0.0	0.0	0.0
23	Crude rubber including synthetic and reclaimed	0.1	0.1	0.1	0.1	0.2
24	Wood, lumber and cork	3.6	0.2	0.1	0.2	0.4
25	Pulp and paper	0.2	0.2	0.1	0.2	0.2
26	Textile fibers, not manufactured	0.6	0.2	0.1	0.1	0.1
27	Crude fertilizers and crude mineral	0.1	0.1	0.0	0.0	0.0
28	Metalliferous ores and metal scrap	8.4	2.1	1.2	3.1	4.0
29	Crude animal and vegetable material	0.5	0.5	0.2	0.4	0.4
32	Coal, coke, and briquettes	0.0	0.0	0.0	0.4	0.8
33	Petroleum and petroleum products	1.1	1.2	1.6	1.6	0.4

TABLE 4. Structure of exports: average shares (continued)

SITC Code	Product Description	1980-1989	1990-1999	2000-2009	2010-2019	2020-2023
34	Gas, natural and manufactured	0.2	0.5	0.1	0.1	0.0
42	Fixed vegetable oils and fats	8.3	3.3	1.4	2.1	1.9
43	Animal and vegetable oils and fats	0.2	0.1	0.1	0.1	0.2
51	Chemical elements and compounds	1.3	0.5	0.5	0.8	0.5
52	Crude chemicals from coal, petroleum	0.1	0.0	0.0	0.5	0.2
53	Dyeing, tanning, and coloring materials	0.0	0.0	0.0	0.0	0.1
54	Medicinal and pharmaceutical produce	0.1	0.1	0.1	0.1	0.1
55	Perfume materials, toilet and cleansing preparations	0.1	0.2	0.2	0.5	0.3
56	Fertilizers, manufactured	0.7	0.7	0.2	0.1	0.0
57	Explosives and pyrotechnic products	0.1	0.0	0.0	0.4	0.4
58	Plastic materials, etc.	0.3	0.3	0.3	0.2	0.4
59	Chemical materials and products, n.e.s.	0.3	0.2	0.1	0.4	0.3
61	Leather, leather manufactures, n.e.s.	0.0	0.1	0.0	0.0	0.0
62	Rubber manufactures, n.e.s.	0.0	0.2	0.3	0.4	0.5
63	Wood and cork manufactures	2.7	1.2	1.0	3.2	0.4
64	Paper, paperboard, and manufactures	0.1	0.3	0.3	0.2	0.2
65	Textile yarn, fabrics, made-up articles, n.e.s., and related products	1.0	1.2	0.6	0.3	0.4
66	Non-metallic mineral manufactures, n.e.s.	0.6	0.7	0.6	0.3	0.4
67	Iron and steel	0.7	0.4	0.3	0.2	0.1
68	Nonferrous metals	3.0	2.1	1.8	2.1	3.2
69	Manufactures of metal, n.e.s.	0.3	0.5	0.4	1.1	0.9
71	Machinery, other than electric	0.3	8.3	20.8	11.3	9.0
72	Electrical machinery, apparatus and	5.7	29.6	47.9	38.1	49.2
73	Transport equipment	0.6	1.3	4.0	5.1	2.7
81	Sanitary, plumbing, heating and lighting fixtures and fittings, n.e.s.	0.1	0.1	0.1	0.1	0.1
82	Furniture	1.8	1.6	0.7	0.5	0.5
83	Travel goods, handbags and similar containers	0.2	0.7	0.4	0.5	0.8
84	Clothing	6.0	9.6	5.8	2.2	1.0
85	Footwear	0.9	1.0	0.1	0.1	0.1
86	Scientific and control instruments	0.2	0.9	2.3	3.2	3.1
89	Miscellaneous manufactured articles	2.9	3.4	1.5	1.9	1.9
93	Special transactions and commodities not classified according to kind	26.9	17.0	0.1	4.6	0.0

Source: World Bank [n.d.].

In the more recent periods covering 2010-2019 and 2020-2023, the overall export structure remained unchanged and characterized by the high concentration in electronics with its average share rising from 38 percent to 49 percent. Except for fruits and vegetables, metalliferous ores, and nonferrous metals, most of the sectors experienced reductions in their average shares. Machinery other than electric dropped from 11 percent to nine percent, transport equipment from five percent to three percent, wood and cork from three percent to 0.4 percent, and clothing from two percent to one percent. Scientific and control instruments' average share was maintained at three percent during the same periods under review.

Based on the research and analysis of the Harvard Growth Lab [n.d.], the Philippines diversified into a sufficient number of products starting in 2006 and added 30 new export products in the next 15 years with a total value of USD 4.68 billion. The volume, however, has been too small to contribute substantially to growth. In the same period from 2006 to 2021, Vietnam was able to introduce 41 new products valued at USD 145 billion while China had 20 products with a total value of USD 45.2 billion. The Growth Lab recommended the following products to support the country's diversification path and enter into more complex production: apparatus and equipment for photographic laboratories n.e.c.,[1] chemical elements for electronics, machines n.e.c., instruments for physical or chemical analysis, appliances for thermostatically controlled valves, ball or roller bearings, equipment for temperature change of materials, telephones, batteries, primary cells and primary batteries, computers, parts for electrical apparatus, parts of motorcycles or wheelchairs, electrical lighting equipment used for motor vehicles, games, and insulating fittings for electrical machines.

2.2. Coping through innovation and adoption of new technologies[2]

The pandemic highlighted the critical role that new technologies and innovation have played in keeping societies functional in times of quarantines or lockdowns and in responding to the global crisis, recovery and protecting the workers. One important realization is the need for countries to adopt new technologies, pursue digital transformation, and focus on innovation, sustainability, and resilience. While the use of artificial intelligence or AI, for example, could displace some workers, at the same time, these new technologies could lead to innovation effects where new jobs arising from new tasks and new products could emerge.

Ionics is a Filipino electronics manufacturing services company that invested in a smart factory prior to the pandemic. It reduced its workers by 90 percent in one production line but its output increased by 100 percent. At the same time, it increased its engineering and computer science staff by 200 percent while its profitability went up between ten to 20 percent. Ionics indicated that while the

[1] N.e.c. stands for not elsewhere classified.
[2] This draws from Aldaba [forthcoming].

COVID-19 crisis has affected them significantly, the impact of the pandemic on their business would have been far much worse had it not been for their smart factory which enabled them to operate.

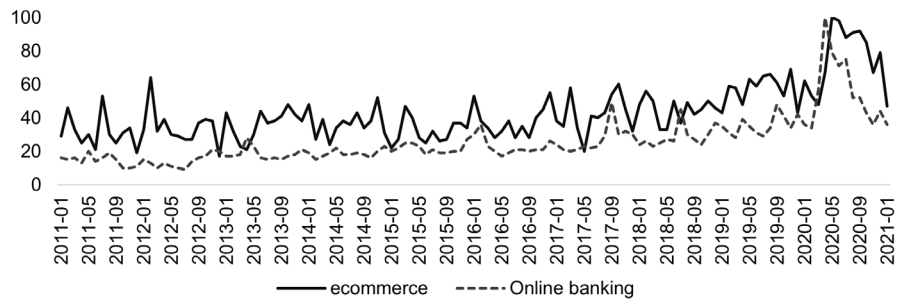
Another example is Union Bank (UB) which is the first 5G-powered bank in the country. Applying digital initiatives to promote financial inclusion, UB implemented i2i, an open finance platform to bring digital financial services to unbanked and underbanked individuals in financially underserved communities. i2i connects financial institutions and community-based financial services nationwide including remittance centers. During the pandemic, usage volumes of i2i rose by over 3,000 percent in the last six months of 2020. i2i's network also helped expedite the disbursement of the Department of Social Welfare and Development's Social Amelioration Program to beneficiaries. UB's digital branch called The ARK has no bank tellers, no long lines, and has completely paperless banking transactions. UB indicated that it did not close any of its branches; the tellers were not replaced but were reskilled to become marketing ambassadors. At the same time, they hired new people with various backgrounds, specifically on telecommunications, technology, and data analytics.

Along with micro and small enterprises, the pandemic affected startups' financial stability, market dynamism, and talent productivity. Despite the crisis, startups responded to the issues arising from the public health emergency by offering solutions through the creation of new products, services, and processes. Based on a survey done by PricewaterhouseCoopers [2020], 49 percent of Filipino startups explored new product/services and more than 20 percent of the startups said that they experienced an increasing demand for their services and products particularly in logistics, education technology, enterprise services, financial technology, and healthcare by a startup company, DWARM Technologies.

Using new technologies, startups provided support to government through contact tracing apps, personal and community health monitoring, chatbots, along with social distancing and online marketplaces. For instance, RC143, a contact tracing app was developed for the Red Cross; DWARM Technologies built AI thermal scan solutions mounted on drones which were used as non-contact thermal scanners at expressway checkpoints; while the Remote Sensing and Data Science (DATOS) Project of the Advanced Science and Technology Institute used geographic information systems, remote sensing, AI and data science to provide maps and other information for disaster risk reduction applications. The University of the Philippines National Institute for Health created GenAmplify COVID-19 test kit which was manufactured by Manila HealthTek. Other innovative startups emerged to provide tech solutions to address issues in health, agriculture, education, finance, multimedia, supply chain and logistics. In 2021, the Philippines saw its first unicorn, fintech company Mynt with a value of over USD two billion. In 2022, Voyager Innovation, owner of e-wallet PayMaya and digital bank Maya Bank, became the second unicorn.

The increasing use of technology to work, buy, and stay connected during the pandemic shaped new digital habits among consumers in the country. This forced traditional enterprises and startups to create new digital business models to diversify revenue streams. As Figure 4 shows, searches for "e-commerce" and "online banking" from 2011 to 2021 skyrocketed to its maximum index of 100 beginning January 2020. At the height of the lockdown, the number of online business registrations went up significantly from 1,753 during the months January to March 2020 to 82,100 in October 2020.

FIGURE 4. Google searches for e-commerce and online banking



Source: Google Trends [n.d.].

The crisis also expedited the adoption of fintech solutions in many economies, including the Philippines. It led to the shift from cash payments to digital payments. For the first eight months of 2020, the value of InstaPay rose almost 400 percent, while that of PESONet jumped 100 percent year-on-year. It also accelerated the demand for education technologies and online learning solutions as the world shifted to distance learning amidst the ongoing threat of the virus. Nielsen [2020] indicated a 60 percent increase in the amount of video content watched globally as people stayed at home due to lockdowns and quarantine restrictions. The same shift in consumer behavior was observed in the country as demand increased for online sources of entertainment such as online games, online movies, and other online entertainment applications.

At the same time, the pandemic sparked a boom in the country's digital economy. Based on the digital economy report by Google et al. [2021], the Philippines was seen as the fastest growing market in Southeast Asia with gross value of USD 17 billion in 2021. The same report showed that Southeast Asia's small and medium enterprises adopted technology with focus on digital platforms, financial services, and digital tools.

Like other countries, the pandemic exposed weaknesses in the Philippine supply and value chains, particularly the lack of medical devices that were urgently needed by the healthcare system. The surge in demand for personal protective

equipment (PPE) led to a huge shortage in its supply. The DTI implemented a manufacturing repurposing program and called on manufacturers to repurpose their facilities for the production of COVID critical products. In response, a group of companies[3] from the garments and electronics bonded themselves together and repurposed their manufacturing plants for the production of medical masks and coveralls. They invested USD 35 million to bring in medical grade raw materials and equipment and built clean rooms for the production of PPEs. At the same time, they were also able to create 7,450 new jobs.

The pandemic moreover provided an impetus to fast track the adoption of the Fourth Industrial Revolution or Industry 4.0 technologies and innovation with greater focus on resilience and sustainability. The crisis presented new Industry 4.0 opportunities that could be leveraged to discover new, better, and more resilient ways of doing things. Enterprises with greater innovation emerged resilient and even recorded gains amidst the economic slowdown. New and powerful technologies such as AI, Internet of Things (IoT), blockchain, robotics, e-commerce, and digital trade were expected to play an important role in shaping the post-crisis landscape especially in ensuring the survival of more companies and organizations.

Furthermore, the pandemic emphasized major lessons learned such as customizing production and supply systems to accommodate shifting consumer behaviors and leveraging advanced technologies to enhance production agility. It also brought to light the need for new approaches to enhance workforce adaptability and resilience. To address these challenges, initiatives focused on workforce development, including reskilling and upskilling programs, are essential to prepare employees for the demands of Industry 4.0. In terms of industry development priorities, the pandemic underscored the urgency of strengthening domestic supply chains, particularly in addressing deficiencies related to the manufacturing and distribution of essential goods such as food, PPEs, medical supplies, and online healthcare and educational services.

3. Embracing Industry 4.0 technologies[4]

There have been various waves of technological advancement that have affected economic and industrial development of countries. In the First Industrial Revolution, mechanization emerged from the discovery of steam power and water. The Second Industrial Revolution was characterized by mass production through assembly lines made possible by the discovery of electricity. During the Third Industrial Revolution or Industry 3.0, automation through electronics and

[3] The Confederation of Philippine Manufacturers of PPEs (CPMP) consisted of Reliance Producers Cooperative, Medtecs International Corporation, EMS Components Assembly, L&T International Group, Tacca Philippines, and Integrated Micro Electronics.

[4] See Aldaba [forthcoming].

information technology was introduced. Industry 4.0 evolved from Industry 3.0 technologies, but what differentiates it is the machines' connectivity, flexibility, and functionality in executing tasks. These machines can collect and transmit data through the Industrial IoT. With big data analytics, the processing of vast quantities of data in near real-time becomes possible. Industry 4.0 is based on cyber-physical systems, merging the physical and virtual worlds. This becomes possible through smart, networked systems using embedded sensors, processors, and actuators designed to sense and interact with the physical world and provide real-time support.

Traditional manufacturing is being disrupted as operations are undergoing digital transformation using AI, machine learning (ML), big data analytics, cloud computing, 3D printing, and other technologies towards smart manufacturing. The new digital production technologies consist of the following elements which combine both old and new generations of digital technologies:

- Hardware: tools, tooling and complementary equipment of modern industrial robots and intelligent automated systems, robotic arms, cobots (robots cooperating with workers in the execution of tasks), 3D printers for additive manufacturing, others
- Software: active design and manufacturing software, computer-aided manufacturing (CAM), computer-integrated manufacturing (CIM), and computer-aided design (CAD); information and communications technologies, and cyber-physical systems (CPS), machine-to-machine radio frequency identification (M2M RFID), CPS with data analysis
- Connectivity: Industrial IoT

The different generations of digital production applied to manufacturing production from analog to digital are described in Table 5. Analog production does not make use of digital production technologies (DPT) in any area of the company. Rigid production applies digital technologies for specific purposes and in isolation from each other. Smart production is characterized by the use of digital technologies with information feedback to support decision making and implies the use of advanced communications devices, robotization, sensorization, big data, and artificial intelligence. UNIDO [2019] indicated that evolving from generation 1.0 to 2.0 does not require major organizational changes but evolving from generation 2.0 to 3.0 requires substantial changes. To successfully move up the innovation ladder, latecomer countries should take into account factors such as capabilities, endowments, organizational characteristics, technological efforts, and infrastructural and institutional conditions. One important historical insight is that latecomers need not invent new technologies; instead, their main entry point could be to rapidly adopt emerging technologies or adapt them to local conditions through innovation.

TABLE 5. Digital production technology characteristics

Generation	Characteristics
4.0 Smart Production	DPTs allow for fully integrated, connected, and smart production processes, where information flows across operations and generates real-time feedback to support decision-making (such as use of smart sensors and machine-to-machine communication, cobots, big data analytics, cloud computing, artificial intelligence and 3D printing)
3.0 Integrated Production	DPTs integrated across different activities and functions, allowing for the interconnection of the whole production process (such as use of enterprise resource planning systems, fully "paperless" electronic production control system, industrial robots)
2.0 Lean Production	DPTs involve and connect different functions and activities within the firm (such as use of CAD-CAM linking up product development and production processes; basic automation)
1.0 Rigid Production	DPTs limited to a specific purpose in a specific function (such as use of CAD only in product development; use of machines operating in isolation)
0.0 Analog Production	No DPTs used throughout the whole production process (such as personal or phone contact with suppliers; use of machinery that is not microelectronic based)

Source: UNIDO [2019].

These new technologies could serve as drivers to achieve an inclusive, resilient, and sustainable industrial development. Through the use of AI, for example, new products and services can be created leading to jobs and income opportunities, as well as new activities. Adopting smart manufacturing could increase productivity; new technologies could reduce material and energy use. The use of IoT for asset management could generate the following benefits: increased operational efficiency and productivity, more efficient safety and compliance checks, automation of maintenance and repair operations, more efficient use of resources, better control over the sales lifecycle, easy identification of growth opportunities, and a responsive smart ecosystem [Siemens 2021].

The McKinsey Global Institute [2018] highlighted that AI techniques and solutions have the potential to create from USD 3.5 trillion to USD 5.8 trillion in value in 19 industries led by retail especially e-commerce, transport and logistics, travel, healthcare, consumer packaged goods, auto and assembly, and other activities. In assessing the readiness of countries for future production, the World Economic Forum [2018] indicated that the Philippines is among the legacy countries characterized by a strong production base but with unfavorable drivers of production that are at risk for the future. The report recommended legacy countries like the Philippines to focus their policies on reskilling and upskilling the work force, upgrading technology platform, and fostering innovation.

In terms of the potential impact on jobs, the McKinsey Global Institute [2017] estimated that 48 percent of activities in the Philippines could be automated. This is equivalent to 18.2 million jobs with six million in agriculture, 3.4 million in retail, and 2.4 million in manufacturing. Similarly, Francisco et al. [2019] showed that the agriculture, forestry, and fishing sector has the highest probability of jobs

being automated; financial insurance has a probability of 79 percent; mining and quarrying, 78 percent; construction, 76 percent; accommodation and food service, 72 percent; manufacturing, 65 percent; public administration, 40 percent; human health, 33 percent; and education, 15 percent. Most reports indicated that low-skilled, low-educated, and routinized jobs are the most vulnerable to the adverse effect of technological change.

AI and robots could lead to both the destruction and creation of jobs through the following: displacement and income effects. The displacement effect is due to humans losing their jobs to robots. However, there are cost savings from the use of AI and robots which allow firms to lower their prices and in turn increase the consumers' real income and spending. This income effect increases demand for goods and services which then forces firms to hire more workers as they expand their capacity. The adoption of new technologies could lead to the creation of new jobs arising from new tasks that emerge from these new technologies. The future of work will depend on the balance between labor replacing technologies and labor augmenting technologies particularly the emergence of new tasks at which humans have a comparative advantage.

Based on a 2019 survey[5] of manufacturing companies across the country, the Philippine manufacturing industry is still at a very low level of technology utilization with most companies still using manual and spreadsheet management or a standalone database management system with legacy applications. Technology utilization is measured in eight major manufacturing dimensions characterized by the following:

- Equipment maintenance: 44 percent have no maintenance system and repairs are carried out reactively
- Shopfloor visibility: 31 percent have shopfloor status pushed via scheduled report
- Quality: 35 percent control documents, connective and preventive action (CAPA) and data collection using paper-based approach; 35 percent use excel sheets but not integrated with manufacturing systems
- Cybersecurity: 46 percent have no established cybersecurity procedures and programs
- Manufacturing activity management: 53 percent control and track manufacturing activities manually through a paper-based system

[5] The survey of manufacturing companies' technology utilization was based on the Manufacturing Enterprise Solutions Associations (MESA) Smart Manufacturing Maturity Index focusing on eight dimensions covering the manufacturing process: 1) planning and scheduling; 2) manufacturing activity management; 3) equipment connectivity and data management; 4) material management and handling; 5) equipment maintenance; 6) shopfloor visibility; 7) quality; and 8) cyber security. Of 1,276 survey questionnaires sent out through email, 144 companies responded.

- Planning and scheduling: 31 percent start work orders based on demand and only 6 percent start work orders via an advanced planning and scheduling system interfaced with Manufacturing Execution System/predictive analytics
- Equipment connectivity and data management: 58 percent have no manufacturing equipment connected to the network
- Material management and handling: 44 percent have their raw materials pulled into the shopfloor via an unstructured request system (paper, email, verbal)

The highest technology utilization is in the areas of cybersecurity, quality, and manufacturing activity management. The lowest scores are in equipment maintenance and equipment connectivity and data management. Across the different manufacturing sectors, the highest technology utilization is in other non-metallic products, paper and paper products, computer, electronic and optical products, motor vehicles, and pharmaceutical products. The lowest technology utilization is in textile, leather, beverages, wearing apparel, repair and installation of machinery and equipment, and food products.

TABLE 6. Technology utilization in the Philippine manufacturing industry by firm size

	No Tech	Very Low	Low	High	Very High	Total
Micro	4	14	4	0	0	22
Small	2	28	18	3	2	53
Medium	0	8	8	1	0	17
Large	0	8	21	14	5	48
Total	6	58	51	18	7	140

Note: Levels: 0: purely manual; 1: with widespread management; 2: Stand-alone DB Management System with Legacy Applications; 3: Manufacturing Execution System (MES), and 4: MES + Industry 4.0 technologies like Industrial IoT, Big Data, Machine Learning, Robotics, and others

In terms of characteristics, firms that are large, with foreign equity, operate inside ecozones, and that are exporting have the highest technology utilization scores. Micro and small enterprises have the lowest technology utilization scores. In terms of geographic distribution, the highest technology utilization is still in the National Capital Region, Central Luzon, and CALABARZON which are the country's key economic centers contributing over 60 percent of the GDP. It is important to provide the necessary digital infrastructure and support to industries located in areas outside of these regions especially to micro, small and medium enterprises to ensure that the adoption of new technologies would not widen the digital divide in the country.

The results showed that the surveyed firms are open to adopting Industry 4.0 technologies. Seven out of ten micro enterprises and six out of ten small and medium enterprises are familiar with Industry 4.0. Their primary considerations for Industry 4.0 transformation are improvement in productivity and competitiveness, cost of investment and funding, innovation, and technological advancement. The firms perceive the following as barriers to adopting new technologies: financial capability, market conditions, and poor digital infrastructure. To overcome these barriers, firms are formulating their internal corporate strategies, studying prospective loan applications; and investing in research and development (R&D).

4. Transforming Philippine industries and enterprises

4.1. Major empirical findings: trade, productivity, innovation, and firm survival

Given the substantial trade liberalization that the Philippines carried out from the early 1980s till the 2000s, assessing the impact of trade on productivity is crucial in crafting the country's industrial policy. The theoretical literature on trade and productivity provides conflicting results on the impact of trade liberalization on productivity [Aldaba 2012a]. Trade liberalization can lead to productivity gains through increased competition, exit of inefficient firms and reallocation of market shares in favor of more efficient firms, increasing scale efficiency, or through learning by exporting effects. However, as Rodrik [1988,1992] argued, there are no reasons to believe that protection discourages productivity improvement. It is import liberalization that retards productivity growth by shrinking domestic sales and reducing incentives to invest in technological effort. Thus, whether liberalization really improves efficiency in less developed countries is ambiguous and has remained an empirical question.

Using Philippine micro data from 1996 to 2006, Aldaba [2012a] examined the impact of trade on productivity growth. In the presence of firm heterogeneity, the results provide some evidence that trade liberalization leads to productivity gains. Trade liberalization allows more productive firms to expand while less efficient firms either exit or shrink. Tariff reduction drives the process of restructuring and reshuffling of resources within and across sectors of the economy such that unprofitable activities contract while profitable ones expand. Epifani [2003] indicated that, in general, the productivity of firms exposed to international trade, i.e., exporters and import-competing firms, grows much more than that of firms in the non-traded sectors.

In a separate paper, Aldaba [2012b] assessed the impact of firm entry and exit in spurring a reallocation of resources across firms. Controlling for firm characteristics, the results showed that tariffs have a highly significant negative effect on firm exit suggesting that trade liberalization increases the probability of exit of a given firm. Moreover, firms with high productivity are more likely to survive as tariffs are reduced. This is consistent with the findings of Melitz [2003]

that trade liberalization induces the exit of less productive firms. Aldaba [2012b] also found that apart from high productivity, firm characteristics matter with larger, older, foreign-affiliated and export-oriented firms having a lower probability of exit.

Utilizing the same panel dataset, Aldaba [2020] examined the relationship between trade and innovation applying a two-stage approach where trade and innovation are linked via competition. The results show that trade liberalization has a significant positive impact on innovation through competition. A reduction in tariffs leads to an increase in competition due to the increase in the number of players in the domestic market. As competition increases, profits fall while the productivity threshold above which firms can profitably operate increases. This forces inefficient firms out of the market and resources are reallocated from exiting firms to the higher productivity surviving firms which innovate at a faster pace.

Aldaba [2020] indicated that despite the more than two decades of implementing liberalization policy, competition and productivity growth remained weak not only due to the presence of structural and behavioral barriers to entry, but also to the country's inadequate physical and institutional infrastructure. Due to the fundamental weakness of competition in many of the major economic sectors, the gains from liberalization remained limited which slowed down the growth of manufacturing.

Weak competition reduces the pressure on firms to adopt new technology or innovate, resulting in low growth of productivity and a loss of competitiveness. In an open market environment, the government should focus on designing an overall industrial policy and strategy that would ensure competition, innovation, and productivity growth of firms. At the same time, the strategy must implement programs to enable industries to face increased competition from imports and take advantage of opportunities such as bigger export markets and increased foreign direct investment flows. Other important determinants of innovation including human capital, infrastructure, institutional factors and other elements comprising the innovation ecosystem must be taken into consideration along with their interaction with trade policy reform indicators.

To increase the probability of survival in an open trade regime, government's industrial policy should be designed towards measures that would enhance firm productivity, link domestic parts manufacturers with multinational companies (MNCs) and attract more foreign direct investment [Aldaba 2020]. MNCs are an important source of international capital and technology, their entry can facilitate the transfer of technical and business know-how resulting in productivity gains and competitiveness among local firms. Furthermore, deepening linkages with MNCs' international production networks and global value chains would be important in increasing gains from trade.

Policies geared towards providing export assistance would also be necessary along with measures crafted to boost the survival of new entrants particularly small and medium enterprises (SMEs). Making small and medium manufacturers internationally competitive is a major challenge that would require government

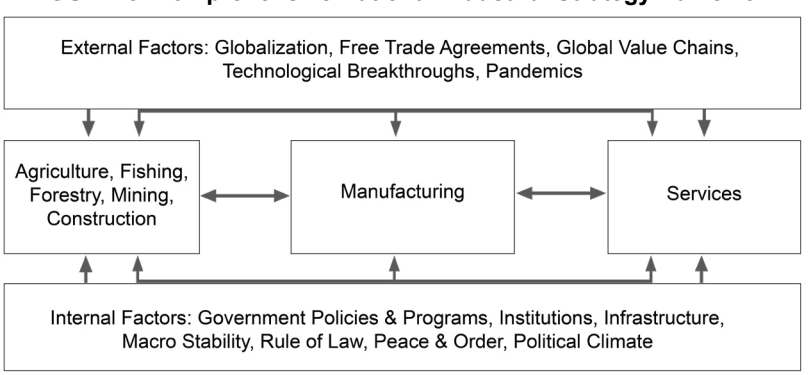
support and close coordination between government and industry. Addressing constraints preventing the growth of SMEs would also be crucial. These include financing issues like inadequate working capital, insufficient equity, difficulties of credit financing and prohibitively expensive credit cost.

Improving the technological capabilities and strengthening domestic supply chains are necessary to enable SMEs to move up the technology scale as well as to create and enhance existing linkages with global value chains (GVCs). Participation in regional/global value chains provides domestic firms not only access to export markets but to newer technologies as well. Leading MNCs provide their local affiliates and local suppliers with more rapid technological upgrading and greater attention to quality control, cost control and human resource development. Aldaba [2020] also highlighted the potential for SMEs, in light of rising globalization and increasing economic integration in East Asia, to be suppliers of outsourced parts and services and to provide the link to the export sector and/or GVCs, particularly in manufacturing sectors such as automotive, machinery, electronics, food and garments.

4.2. Comprehensive National Industrial Strategy (CNIS)

Overall, Philippine experience shows some evidence that increasing competition from trade liberalization could enhance both innovation and productivity. In light of the above empirical findings, the country's CNIS is underscored by the relationship between competition, innovation, and productivity. As Figure 5 shows, firms and industries operate in a market environment affected by external and internal factors. Meanwhile, firms and industries are connected through supply and production chains. The interplay of internal and external factors could affect firm or industry growth through the competition, innovation, and productivity channels. Any changes in these internal and external factors would affect the process of competition, innovation, and productivity which in turn determines the growth of industries.

FIGURE 5. Comprehensive National Industrial Strategy framework



Source: Aldaba [2014].

External factors include multilateral, bilateral, and regional trade agreements that bring about trade and investment liberalization. The international environment also encompasses globalization and GVCs which are forms of industrial organization particularly in industries like automotive, electronics, machinery, food and garments. New technologies such as AI, automation, robotics, machine learning, or IoT and pandemics can pose both risks and opportunities to firms and industries. The removal of trade and investment barriers through free trade agreements can provide opportunities such as bigger export markets and increased foreign direct investment flows. At the same time, the entry of competing imports or more competitive global players in the domestic market would increase competition which might pose risks to the survival of relatively smaller, less competitive and what used to be highly protected firms in the domestic economy.

Internal or domestic factors include macroeconomic conditions, political situation, peace and order, infrastructure, and government policies, regulations, and industry development programs. Within the domestic environment, there are industry-specific or internal factors affecting the growth and development of firms and industries. These include trade and investment policies such as tariffs and import restrictions, investment incentive measures like income tax holidays, tax and duty exemptions on imports, subsidies, grants, and soft loans along with human resource development, capability building and training support programs along with government regulations affecting the operations of firms and industries.

4.3. Key impediments preventing industry growth and development

Table 7 summarizes the most binding constraints preventing industry growth and entry of new activities. Firms continue to face major challenges such as poor infrastructure and logistics; lack of domestic raw material suppliers, parts and components; bureaucracy, red tape, policy inconsistency; and lack of highly skilled workers. Furthermore, manufacturers have continued to suffer from the unabated entry of smuggled and substandard products.

Broken linkages in the supply/value chain characterize Philippine industries. The lack of materials processing has severely affected the competitiveness of parts and supplies industries and hampered the ability of high-technology industries to move up the value chain. Due to weak backward linkages within the manufacturing industry, automotive and electronics have continued to rely on imported parts and remained at the assembly stage of the supply chain. The development of the domestic parts and suppliers would be crucial to deepen the firm and industry linkages within the economy.

TABLE 7. Summary of most binding constraints

Major area	Main bottlenecks
Infrastructure and logistics	High cost and unpredictability of power High cost of domestic shipping
Governance and regulation	Smuggling, corruption, bureaucracy and red tape Lack of streamlining/automation of interrelated business procedures
Small and medium enterprise development	Access to finance, weak absorptive capacity to technology and knowledge transfers, inability to comply with product standard regulations
Human resource development	Lack of skilled workers, skills-jobs mismatch
Low level of technology utilization	Most companies, MSMEs in particular, are still utilizing purely manual operations, spreadsheet management system or stand-alone data management system with legacy applications
Innovation and entrepreneurship	Fragmented innovation and entrepreneurship ecosystem, growing but still limited industry-academe linkages, low R&D expenditures
Supply/value chain gaps	Absence of raw materials (upstream); weak parts and components sector (mid-stream)
Weak domestic market expansion	Weak economies of scale due to limited domestic production and heavy dependence on imports

Source: Aldaba [2014].

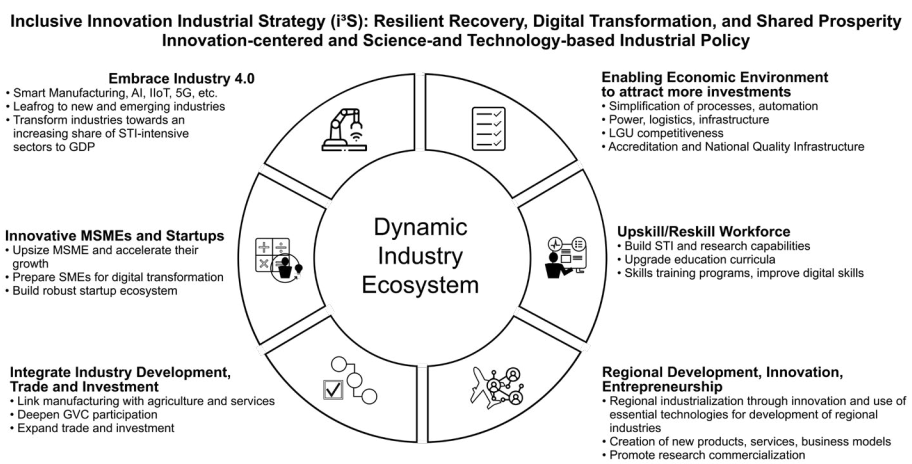
In the iron and steel industry, which is critical for the manufacture of parts and equipment, competitiveness issues have remained due to the high cost of raw materials apart from the high costs of power and logistics, smuggling and entry of sub-standard products. The local tool and die industry has to compete heavily against imported dies and molds while its backward linkages are weak due to the unavailability of most raw materials, equipment, and software. Special steels and castings, general and specialized metal machining equipment, and software are all imported. Though the country has natural resources that would provide important metals like iron and copper, there are no processing plants (capital-intensive blast furnace, steel making facility) to produce the form of metal that the industry requires. There is no reliable aluminum casting facility for molds used in molding large plastic components like refrigerator liners.

In the export-oriented copper industry, firms have hardly any linkage with the domestic economy. Copper ores are all exported and although the country has a copper smelting facility, it imports 100 percent of its copper ore requirements and exports 100 percent of its output due to the absence of a copper rod facility. Manufacturers of wiring harness, a major export product and user of copper rods, import all of their copper rod requirements.

4.4. Science, technology, and innovation (STI)-driven industrial strategy

To strengthen the competitiveness of Philippine industries and address the most binding constraints preventing their growth and development, the DTI has implemented an innovation-centered industrial policy through the i3S. This is a growth model where a modern industrial sector will play a key role in generating investment and employment. i3S has evolved into its current form known as science, technology, and innovation (STI)-driven strategy. Science and technology-driven innovation is at the heart of the new industrial policy. The vision is to grow globally competitive and innovative industries by transforming industries into a more dynamic industry ecosystem characterized by continuous innovation, collaboration, agility, and resilience. This would provide the foundation for industrial transformation that would generate quality jobs and investments, create new products and services, and drive sustainable and inclusive growth. With science and technology-driven innovation at the front and center of the country's strategic policies and programs, industries would be in a better position to face competition in both domestic and export markets. Innovation is crucial as the Philippines embraces automation, robotics, AI and other new technologies arising from Industry 4.0.

FIGURE 6. STI-driven industrial strategy pillars



Source: Pascual [2022].

The government and the private sector would collaborate towards the implementation of industry activities and programs to enhance the productivity of local firms and industries through innovation. While the private sector is seen as the major driver of growth, the government plays an important role in coordinating policies and necessary support measures to address the obstacles to the entry and growth of domestic firms. The government must create the right policy framework to encourage the development of the private sector along the

lines of the country's comparative advantage and industry priorities. These entail programs and policies to address the high cost of power, high cost of domestic shipping and logistics, inadequate infrastructure, and complex government rules and regulations affecting business operations. Equally important are more specific strategies for the development of human resources and skills training as well as creation of innovative startups and micro, small, and medium enterprises (MSMEs).

To achieve industrial transformation, the country's new STI-driven industrial policy focuses on embracing Industry 4.0, supporting digital transformation, and ensuring resilience and agility in production through advanced technologies. It integrates industrial policy with trade, investment, and innovation policies to address supply chain gaps and support new and emerging industries. The strategy emphasizes investing in human capital development, reskilling, and upskilling the workforce to meet future job demands. It fosters the growth of innovative startups and MSMEs by enhancing their access to finance, technology, and skilled workers and promoting collaboration and digitalization. Regional industrialization is encouraged through innovation and entrepreneurship, bridging gaps between academia and industry, and accelerating research commercialization. Finally, the strategy seeks to create a more enabling business environment by strengthening regulatory frameworks, improving infrastructure, attracting foreign investments, and providing targeted fiscal incentives (Annex A contains descriptions of more specific measures).

The major priorities for industry development focus on four major clusters. First, the industrial manufacturing and transportation (IMT) priorities include the auto industry, semiconductor manufacturing, electronic manufacturing services, and aerospace parts and aircraft maintenance. Second, the telecommunications, media, and technology (TMT) sector emphasizes the transformation of information technology and business process management (IT-BPM), creative industries, innovation and R&D, and the digital economy, with applications in smart and resilient technologies and vehicle tech. Third, the health and life sciences (HLF) priorities cover pharmaceuticals, biotechnology, medical devices, and digital health. Lastly, modern basic needs and resilient economy (MBNRE) activities target chemicals, integrated iron and steel, textile and garments, agriculture and agribusiness, infrastructure and logistics, and climate change and environment-friendly products and services. These clusters aim to drive sustainable growth, innovation, and resilience across the economy (see Annex B for the detailed list of activities).

5. Current initiatives, plans, and ways forward

The industrial policy debate in the country has gradually shifted from whether this is the correct development strategy to achieve the country's industrialization goal to discourses on the appropriate level of intervention and design of industrial policy programs. On the whole, there is an acceptance in government of the need for industrial policy for inclusive and sustainable industrialization and to achieve

this, a whole-of-government-and-society approach is crucial. To successfully develop an industry, government needs to play a facilitative role. As Lin [2011] pointed out, in starting a new industry, the government has a crucial role to play in providing or coordinating investments particularly in addressing the lack of necessary infrastructure and complementary inputs for attracting new industries.

The pandemic has accelerated the use of digital technologies and highlighted the crucial role of innovation in ensuring quick responses to the crisis along with business continuity, economic recovery, and worker protection. As the country prepares for the post pandemic future, implementing a new industrial policy is an imperative to build a more competitive economy. The country's post-pandemic industrial policy (a STI-driven strategy) focuses on building capacity, addressing the huge gaps in the supply and value chains, integrating production systems, and ensuring that the industrial recovery will not leave anyone behind. Through innovation and use of essential digital technologies, the country's strategy identified priority industries to foster industrial development. It also prioritizes improving support for MSMEs and startups, human resource development and capacity building, regional industrialization, and creating an enabling environment for business, especially investments in digital and health infrastructure.

The integration of the country's production systems requires efficient supply and value chains that interconnect manufacturing, agriculture, and services to drive structural change and enhance industrial competitiveness. Agricultural development is necessary in order to transform regional economies from traditional agriculture to more modern agribusiness. Meanwhile, the services sector, which provides direct inputs to economic activities, plays a vital role in linking value chain activities together. Manufacturing, agriculture, and services must be integrated, strengthened, and developed to enable the country to pursue a more advanced and balanced industrial structure. To achieve this, the country's STI-driven industrial policy should focus on the following imperatives:

- Accumulation of investments and STI capabilities through the adoption of new technologies and advanced digital production; investment in innovation infrastructure and R&D; and building new and future skills along with research capacity of the workforce to increase productivity and production efficiency.
- Transformation of industries towards an increasing share of STI-intensive sectors to GDP through the adoption of Industry 4.0 technologies, clean and efficient production, and integration of production systems that would lead to new jobs, new economic activities, income opportunities, and higher GDP.

Drawing from the insights and empirical findings on the relationship of trade, competition, innovation and productivity, the following measures are proposed to be integrated into the new industrial policy to bring the Philippines closer to a better future through inclusive and sustainable industrial transformation.

5.1. Transformation from manufacturing to "mindfacturing:"[6] a new pathway

The STI-driven industrial policy should consider the current metamorphosis of the manufacturing industry which is being fueled by three major factors. First, today's manufacturing industry is no longer powered by gears and machines alone, but rather by new production techniques using new technologies which change the industry's long-standing traditional processes and business models. Second, it is increasingly becoming evident that industrial development is not centered on the growth of manufacturing industry alone, but rather on its convergence not only with services but also with other industries, amplifying the importance of strengthening collaboration and linkages across sectors and tapping new sources of value, growth, and employment. Lastly, the world is entering an age where the significance of creativity, innovation, and the human intellect is ever-expanding in a modern manufacturing ecosystem. Hence, manufacturing is expected to evolve towards integrating more intellectual work which highlights physical goods that increasingly rely on knowledge and creative outputs like biotechnology, renewable energy, and R&D outputs like patents and hybrids that combine physical goods and services such as tech companies producing both hardware and software. As the new industrial policy focuses on harnessing Filipino ingenuity, creativity, and innovativeness to drive industrial development and economic growth, articulating mindfacturing in the country's strategy and priorities would be an important pathway to pursue.

5.2. Alignment of the Strategic Investment Priority Plan of the Corporate Recovery and Tax Incentives for Enterprises (CREATE) Act with the STI-driven industrial policy and making CREATE a driver for Philippine industrialization and recovery

The CREATE Act reduced the corporate income tax rate from 30 percent to 25 percent for large companies and to 20 percent for small and medium enterprises. Incentives were harmonized across the different investment promotion regimes granting income tax holidays from four to seven years, five percent special corporate income tax rate based on gross income earned from five to ten years, and enhanced deductions such as depreciation allowance, labor expense, R&D expenditures, training expenses and domestic input expenses, among others. The CREATE Act also empowers the President to modify the mix, period or manner

[6] Mindfacturing refers to the seamlesss integration of intellectual capabilities and advanced technologies to transform the manufacturing landscape towards more agile and adaptive processes to drive innovation, efficiency, and customization across various industries. Examples include the use of 3D printing technology to create tissues and organ prototypes for medical research and potential future transplants; use of AI to analyze genetic data and develop personalized treatment plans; use of digital twins and IoT to create a virtual replica of a company's manufacturing process; and use of robotic systems and AI to produce custom footwear on demand with customers designing and sending design specifications directly to automated factories for production.

of availing incentives and to craft financial support package for highly desirable projects based on a sustainable development plan, inclusive business approach, high level of sophistication, and innovation.

With close coordination among government agencies and alignment of priority industries with the new industrial policy, CREATE could serve as tool to drive the country's recovery and industrialization. CREATE incentives could help develop industries with existing, emerging and latent comparative advantage; integrate production systems and link manufacturing, agriculture, and services; deepen and upgrade GVC participation, and enable digital transformation. Through time-bound, performance-based, and transparent incentives, CREATE could address market failures, prepare industries as they adopt Industry 4.0 technologies, create more innovative industries, generate spillover effects, support innovative MSMEs and integrate them in GVCs, and foster competitive industries particularly in the regions.

5.3. Acceleration of digital industrial transformation

Digital transformation is a journey towards embracing a culture of innovation in all facets of production involving people, technology, and organization. The drive towards digital transformation would lead to more innovation and application of new technologies in addressing social, economic, environment, and health problems. Smart technologies applied to agriculture or manufacturing could result in more efficient, productive, and resilient production. The adoption of Industry 4.0 technologies can make industries more efficient and scalable and leapfrog to inclusive, resilient, and sustainable industrialization.

New technologies like AI are here to create new jobs and change what work looks like, augment human intelligence and skills and make workplaces safer. The wide use of AI represents a big window of opportunity for the Philippines to leverage on existing comparative advantage especially in the global IT-BPM sector and expand to key international AI markets in the future. AI can address development issues leading to the creation of innovative goods and services to finally eradicate poverty. AI can provide solutions to problems and challenges faced by MSMEs, large enterprises, including government agencies.

One of the most recent initiatives of the DTI is the Artificial Intelligence Roadmap which focuses on uplifting the lives of the Filipino people, industries and the economy, and making the Philippines an AI center of excellence. AI adoption can enable the country to tap vast opportunities to help maintain the regional and global competitiveness of industries, prepare the future workforce for the jobs of the future, and attract the AI R&D of multinational and big tech companies to locate in the Philippines.

To accelerate innovation and MSME digitalization, one of the major recommendations of the roadmap is the establishment of a Center for AI Research. The plan is to make the AI Center a public-private partnership that would serve as hub for data scientists and researchers to perform collaborative AI R&D,

consultancy services, create AI tech products, conduct data literacy programs, and attract leading global firms to set up their R&D activities in the country. The Center would focus on key areas utilizing AI such as precision farming to improve the productivity of the agriculture sector, smart manufacturing, healthcare services, AI-powered business process outsourcing, cybersecurity, and resilient technology.

Other Industry 4.0 initiatives are geared towards supporting firms and industries shift to industry transformation. The DTI is also planning to build an Industry 4.0 pilot factory to serve as platform for a collaborative learning environment to teach and demonstrate Industry 4.0 management and production technology (robots, automation, IoT, smart factory), R&D and prototyping for companies especially MSMEs, universities and researchers and co-maker and co-working space.

To implement these Industry 4.0 plans, a more permanent budget is necessary to sustain government digital transformation efforts for industrial change and development. The recently legislated Tatak Pinoy Act which institutionalized the country's industrial policy along with the Philippine Creative Industry Development Act provide the legal framework, including sustainable financing, for the development of priority industries that could pave the way for industrial development.

5.4. Implementation of the Philippine Industry Skills Framework to prepare the workforce for the jobs of the future

While many jobs will be lost as a result of automation, new jobs will emerge through the adoption of technologies that will increase worker productivity. Tapping these benefits will require increasing investments in skills development along with greater efforts by companies to upskill their workforce to perform new and higher order roles complementary with machines. Current systems of learning and signaling job-fit do not provide the agility that lifelong learners will require. Shifting to a skills-based system can not only provide more efficient mechanisms by which employers can identify the talent they need for business to flourish but can also create fairer labor markets where individuals are able to rapidly transition between roles, have greater access to learning opportunities, and be matched to employment through unbiased and skills-based evaluation.

In 2021, the DTI launched the Philippine Skills Framework, a new initiative which serves as a common reference or language that employers and workers share in order to ensure the match between jobs and skills. The skills framework describes the skills, knowledge and competencies required in different jobs. It also provides sectoral information, occupations/jobs and roles, skills description, career pathways, and training programs needed. Using the skills framework, employers can identify the necessary skills and competencies while job seekers are able to define ways forward or upward in a particular industry. For educational institutions, the framework is used to revise existing curricula and design new

courses to bridge the skills and competencies of the workers as they upgrade to desired occupations. Among the priority sectors for the development of the skills frameworks are manufacturing, construction, logistics and supply chain, health and wellness, food and agriculture, creatives, tourism, and IT-BPM.

5.5. Support for the development and scale-up of innovative startups and MSMEs

Start-ups have emerged as key drivers of economic recovery, inclusive and sustainable growth, and job creation. Startups are also seen as catalysts for disruptive innovation. To accelerate the growth of the Philippine tech startup ecosystem, the DTI is implementing four major strategies: (i) growing the number of startups through a larger, more coordinated ecosystem and promotion of technology entrepreneurship; (ii) increasing early stage funding by attracting more private angels and angel investors[7] in the Philippines and the implementation of a fund of funds program to support early stage financing; (iii) building startup quality by strengthening founder know-how, deepening market reach, and increasing talent quality; and (iv) expanding global connectedness by engaging with foreign partners by connecting the Philippine startup ecosystem with other global ecosystems through investment and knowledge exchange programs among angel investors, venture capitalists, startup founders and enablers from other countries.

To help startups grow and scale up their business operations, the DTI is implementing three major startup programs: the Incubation, Development and Entrepreneurship (IDEA) Program for startups with minimum viable products and Acceleration, Valuation, and Corporate Entrepreneurship (ADVANCE) Program for startups that are in their commercialization stages, and a Global Acceleration Program (GAP) to immerse and expose Philippine startups to the global ecosystem and enable them to pursue global business development and raise funds.

5.6. Building Regional Inclusive Innovation Centers (RIICs) all over the country

With the innovation focus of the new industrial policy, the DTI, in collaboration with other government agencies, is building RIICs which serve as innovation networks or platforms linking together the different stakeholders in the innovation and entrepreneurship ecosystems towards market-oriented research that addresses societal issues and industry problems. The stakeholders include startups, spinoffs, and MSMEs with other stakeholders such as universities, funders, R&D and S&T parks, accelerators and incubators, government, and other services providers. They will be nurtured by the collaboration of government, industry, and education/academia through policies, programs and projects that continuously develop human capital, ensure access to funding and other sources of financing, and provide the needed support mechanisms and services to accelerate the commercialization of research.

[7] Angel investors are private investors that provide initial financing for small business ventures using their own funds in exchange for an equity stake.

Pilot RIICs were established in 2019 in Cebu, Davao, Legaspi, and Cagayan de Oro. Four more RIICs were added in 2021 covering Zamboanga, Batangas, Tuguegarao, Cagayan, and Central Luzon. There are currently 13 RIICs located across different regions in the country. In the near future, the RIICs which are seen as the linchpin of the country's new industrial policy, will drive regional development and economic transformation leading to new investments, job generation, higher incomes, improved quality of life, and shared prosperity for the Filipino people.

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Annex A: Strategic pillars of the Philippine STI-driven industrial policy[8]

Embrace Industry 4.0 to enable industrial transformation and leapfrog to inclusive and sustainable industrial development

- Support industries' shift towards digital transformation and craft and implement people-centered digital transformation plans and programs with focus on inclusive growth.
- Design support measures and programs to help firms increase resilience and become more agile in production and supply systems enabled by advanced technology and automated processes.
- Ensure that the digital and future skills demanded by companies and industries would be sufficiently provided and would enable all people at every level of society to participate in building an innovative and creative future.

Integrate industrial policy with trade, investment, and innovation policies

- Craft industry programs to address gaps and linkages in domestic supply and value chains by linking services activities such as design, R&D, engineering, IT and digital services, marketing, financing, and after-sales with manufacturing, agriculture, and other sectors.
- Support the growth of new industries and activities to bridge gaps in the supply and value chains of industries like copper, nickel, iron and steel, electronics, automotive, manufactured parts and components, textile, agricultural crops, and processed food.
- Expand government support to new and emerging industries to increase their domestic market base; help them attain economies of scale and realize their export potential and deepen participation in global value chains.

Increase investment in human capital development and workers' reskilling and upskilling

- Design human resource development and training programs to improve skills and establish tie-ups with universities and training institutions.
- Develop skills framework to identify the skills and competencies needed to address jobs-skills mismatch, prepare the workforce for the jobs of the future, and ensure that the skills demanded by companies would be sufficiently provided

Foster the growth and development of innovative startups and MSMEs

- Support the expansion of production capacities and digitalization of MSMEs.
- Enhance MSME programs to improve their access to finance, technology, and skilled workers.

[8] See Pascual [2022].

- Accelerate innovation and MSME digital transformation, link MSMEs with startups especially those that could help address their digital challenges, and connect MSMEs as well as with large domestic enterprises and multinationals; promote inter-firm and academe collaboration.
- Establish common service facilities and support for efficient storage and logistics services.
- Support startup growth and development by crafting and implementing programs to build the startup ecosystem, create common understanding on the startup journey and ecosystem development among government agencies towards the alignment and harmonization of startup policies and programs, provide strong focus on promoting innovation and entrepreneurship, and create a more enabling business environment for startups and allow more foreign participation.

Promote regional industrialization through innovation and entrepreneurship

- Establish inclusive innovation centers to bridge the gaps between academe and industry.
- Accelerate commercialization of market-oriented research, equip universities to carry out research relevant to industries, promote intellectual property protection.
- Provide R&D incentives like tax credit, accelerated depreciation, and innovation spaces to serve as networking hubs and R&D shared facilities for rapid prototyping and demonstration.

Create a more enabling business environment

- Continue to strengthen the institutional and regulatory framework by addressing smuggling and eliminate bureaucratic red tape by streamlining and automation of government procedures and regulations.
- Strengthen mechanism for coordinating business registration, application for permits and licenses, and investment promotion with local government units and other national government agencies.
- Scale up investments in digital infrastructure and improve investments in building other physical infrastructure like roads, power, logistics, modern and efficient air and sea infrastructure, including education and heath infrastructure.
- Implement aggressive promotion and marketing programs to attract more foreign direct investments especially those that would bring in new technologies.
- Address market failures by providing fiscal incentives that are well-targeted, performance-based, transparent, and time bound.
- Promote the establishment of domestic ecozones that would allow activities catering to both domestic and export markets.

Annex B: Priority clusters for industrial transformation

In terms of the priority sectors, the following industry clusters have been identified for development:

Industry clusters identified for development

Cluster	Priorities
Industrial Manufacturing and Transportation	• Auto and auto parts: auto electronics, advanced driver assistance systems (ADAS) components, engineering services outsourcing, electric motor powertrains like battery, public utility vehicles, electric vehicles • Semiconductor manufacturing service: integrated circuit (IC) design, R&D, wafer fabrication • Electronic manufacturing services: auto electronics, aerospace electronics, consumer electronics, medical devices, telecommunications equipment, power storage • Aerospace parts and aircraft maintenance, repair and overhaul (MRO): flight control actuation systems, servo actuators, servo valves, galley inserts, structures and equipment, seat parts, lavatories, interior fit-out, panel assembly, electronics, airframes and sub-assemblies; MRO base and line maintenance
Telecommunications, Media, and Technology	• IT-BPM: activities to support the Philippine IT-BPM's transformation from voice-enabled and linear customer support services to complex, digitized, end-to-end customer experience (CX) services consisting of complex services business process outsourcing (BPO), knowledge process outsourcing in health, medical, financial, and legal services; animation, game development; engineering services outsourcing (ESO), software development, shared services, data analytics, legal process outsourcing, health information management (preventive health, remote), IT services, global-in-house, services embedded in manufacturing • Creative industries: traditional and cultural expressions (arts, crafts, festivals, celebrations), cultural sites, visual arts, performing arts, publishing and printed media, audiovisuals, design, new media (digital animation, game development, software development) and other creative services • Innovation and R&D activities: commercialization of registered intellectual property products, R&D centers, adoption of innovative processes such as smart manufacturing or predictive agriculture • Digital economy: new products or solutions using digital technologies like artificial intelligence, robotics, augmented reality, virtual reality, mixed reality, 5G connectivity, Internet of Things (IoT) ◦ Smart technology: applications in buildings, homes, factories, agriculture, cities, interconnected products and services, voice assistants embedded in TV sets, cars home appliances, smart home devices, home robots ◦ Resilient technology: disaster preparedness/mitigation, cyber security, renewable energy ◦ Vehicle technology: flying cars, self-driving cars, multimodal transportation, electric vehicles (EV) ◦ Audio, video, education technology ◦ E-gaming: console and pc gaming software, mobile gaming; immersive audio and advanced communication capabilities; cloud gaming platforms; gaming accessories

Industry clusters identified for development (continued)

Cluster	Priorities
Health and Life Sciences	• Pharmaceuticals, life sciences, and biotechnology • Medical devices and digital health: personal health wellness technology products, smart watches, lighter health wearables, more precise sensors, therapeutic systems addressing chronic diseases, telemedicine solutions and AI-assisted diagnoses
Modern Basic Needs and Activities to Promote a More Resilient Economy	• Chemicals: petrochemicals, acyclic alcohols and derivatives, metallic salts and peroxyl salts of inorganic acids, cyclic hydrocarbons, oleo chemicals • Iron and steel, tool and die: integrated iron and steel • Integrated textile and garments: design, textiles using natural fibers and locally available materials • Agriculture and agribusiness: coffee, cacao, coconut, fruits and nuts, tropical fibers, rubber and other high value crops • Infrastructure and logistics: roads, railways, bridges, ports, airports, land, air, and water transport construction and services, warehousing and support facilities for logistics; energy, hospitals and other health facilities, education, testing laboratories, low-cost housing, digital infrastructure • Climate change and environment-friendly products and services: goods and services that improve the quality of life while minimizing the use of resources and inputs including energy and the emissions of pollutants and wastes

Source: Pascual [2022].

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Nexus between payments digitalization and cash usage in the Philippines

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Innovative contactless payment technologies are transforming retail payments, suggesting a gradual decline in cash use, particularly in advanced economies with an early start on digitalization. In the Philippines, preliminary analysis indicates some substitution from cash to digital payments, albeit not on a large scale yet. While the remarkable inroads in retail payments digitalization and demographics are expected to bring about a behavioral shift in cash usage, the pace and extent of substitution are contingent on policy reforms aimed at widening access to affordable digital payment services, secure digital infrastructure, and privacy protection, among others. More granular data would help inform strategies for equitable and safe payment choices, enabling consumers to securely access and freely choose from diverse and affordable payment options that suit their needs. Thus, it is vital for cash and digital payment infrastructures to adapt and uphold consumer payment choice.

JEL classification: C20, E42, E58, O33
Keywords: central banking, payments digitalization, cash demand, ordinary least squares

1. Introduction

Money, regardless of form, primarily functions as a unit of account, a medium of exchange, and store of value. These fundamental functions of money require a well-functioning, safe, efficient, and inclusive payments and settlements system that is recognized, trusted, and conventionally used by government, businesses, and individuals.

Existing monetary systems are anchored on public money issued by a central bank in the form of banknotes and coins, and central bank reserves, while private

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money is issued by commercial banks in the form of deposits and by non-bank financial institutions in the form of digital money. Banknotes and coins are the only form of public money available to the general public. Banks, in contrast, also have access to public money in electronic form, via central bank reserves.

As innovative contactless payment technology radically transforms the retail payment markets, cash usage is expected to moderate over time. The COVID-19 pandemic buoyed up e-commerce and concomitantly sped up the uptake of more convenient digital payment platforms. Digital payments can also potentially open new business opportunities, particularly for small businesses [Tanaka 2016] by enhancing transparency and security in transactions and promoting financial inclusion and inclusive growth ["Why digital payments" n.d.].

The usage of digital forms of payment has notably risen over the years, especially in the advanced economies. The steady increase in electronic transactions through various payment platforms suggests that going cash-lite aligns with overall growth in the digital economy. This trend underscores broader changes in consumer preference for more efficient payment solutions [Henry et al. 2024]. Aside from the benefits of convenience and speed, digital payments are traceable, thus adding a layer of security in financial transactions. By facilitating easier, safer, and more accessible financial transactions, digital payments can bring unbanked and underbanked populations into the financial system, potentially reducing poverty, and adding to economic dynamism and opportunities [Resendiz 2017].

In the Philippines, digital payment platforms are gaining an increasing foothold in terms of public acceptance and usage, with exponential growth in the use of PESONet and InstaPay observed during the pandemic. Payment digitalization is a potent force that can help foster a financially inclusive and cash-lite society.

A cash-lite economy is characterized by substantial reduction in the usage and volume of cash in circulation due to massive use of electronic payment channels. Such shift in consumers' payment preference is seen to bring about ancillary efficiency gains in cash cycle management as costs of cash production and transportation are reduced in the process. Recognizably, the digital transformation of money and the substitution of physical cash are processes that evolve gradually over a longer period of time. Boundless growth is improbable given the upper limits imposed by external factors. Nonetheless, a significant growth spurt can be anticipated when a new and major transformative shock sends growth to new heights.

The realization of the vision of a cash-lite economy also depends on a number of factors outside the full control of the central bank. Several factors affect the posited substitution between physical and digital cash such as (i) preferences and habits, (ii) pace of development in digital infrastructure, (iii) fee structure, (iv) cultural factors, (v) demographics, (vi) policy frameworks, including those on privacy safeguards and consumer protection, and (vii) adoption of central bank digital currency (CBDC) at the retail level, among others. Currently, these constitute a large set of unknowns. Hence, it is important to carefully balance

rationalized currency issuance that is reliant on efficient and cost-effective production vis-à-vis the pace of digital retail payments adoption and change in the payment habits of Filipino consumers.

1.1. Significance of the study

Available reports and studies delve into the remarkable inroads in retail payments digitalization. The current measurement model by the Bangko Sentral ng Pilipinas (BSP) measures and analyzes the volume and value of digital payments in the country made to and by the government, businesses, and individuals to facilitate the identification of payments use-cases that may be prioritized for digitalization [Mesina-Romero et al. 2022]. Reproduced below is the 3 x 3 payment grid, which illustrates nine possible payment combinations and 24 payments use-cases among the government, businesses, and individuals.

FIGURE 1. Payment grid with focus use-cases

		PAYEE		
		GOVT	**BUSINESS**	**PERSONS**
PAYER	**GOVT (0.92 percent)**	• Transfers from center to LGUs • Social welfare contributions • Procurements for common use item **0.12 percent**	• Procurement and supplier payments • Utilities **0.13 percent**	• Social welfare contributions • Salaries and payroll **0.85 percent**
	BUSINESS (24.05 percent)	• National taxes and fees • State taxes and fees • Social welfare contributions **0.07 percent**	• Supplier payments • Business lending • Interest payments **27.92 percent**	• Salaries and payroll • Social welfare contributions • Consumer lending **2.35 percent**
	PERSONS (75.03 percent)	• Tax collections • Government fees levied for services • Social welfare contributions **0.07 percent**	• Merchant payments • Utility payments • Interest and loans **60.22 percent**	• Remittances • P2P lending **8.27 percent**

Source: Mesina-Romero et al. [2022].

However, there is no known empirical study that looks into the extent of substitution between cash usage and digital payments in the Philippines; one that considers the possibility that the digital payment chain, particularly at the retail level, is not yet digitalized end-to-end. Measuring the magnitude of substitution would provide important insights on the pace and depth of changes in the cash

demand landscape and their implications on cash cycle management and payment digitalization efforts.

This study fills the gap by providing preliminary baseline empirical analysis of the interplay between retail payment digitalization and cash demand. It utilizes unique monthly data on aggregate bank currency withdrawals from the BSP and payment digitalization from the Electronic Payments and Financial Transactions (EPFS) of Philippine banks. Despite limitations in available payment digitalization data, this study offers some perspectives on the balance between the BSP's exclusive currency issue power and payment digitalization thrust, in support of its vision of a cash-lite and financially inclusive society.

This paper is organized as follows: Section 2 examines the literature on cash usage and digitalization. Section 3 discusses stylized facts on cross-country trends and the Philippine experience. Section 4 describes the data and empirical methodology. Section 5 offers insights into preliminary empirical estimates, and Section 6 concludes.

2. Review of related literature

With the exception of a few jurisdictions, cash remains widely used in both leading and emerging economies around the world despite considerable strides in payment digitalization. However, the future of money is also rapidly changing with sustained advances in technology and adaptation by both issuers and users.

In the 2022 Central Banking benchmarking study by Margulies and Asaju, a majority of the surveyed central banks expected increases of between zero to 20 percent in demand for cash, suggesting that the demise of cash is nowhere imminent. In similar vein, Central Banking [2023] reports that almost two-thirds of the central bank respondents institute access-to-cash policies while nearly half of the respondents maintain minimum cash service levels for commercial banks. The report further notes that the European Commission has drafted regulation that would require Eurozone countries to safeguard sufficient and effective access to cash.

The experience of Sweden, which is considered as a country that will fast transition toward an almost cashless society, provides valuable insights on the payments digitalization drive as well as an admonition on the need for policy balance to ensure that no segment in society is marginalized in access to payment.

In a conversation with Knowledge at Wharton, Associate Professor Jonas Hedman of the Copenhagen Business School emphasized the multifaceted drivers of this trend [Knowledge at Wharton Staff 2018]. Use of payment cards and digitalization of bank accounts began in the 1950s-1960s. Internet infrastructure and internet banking were already set up in the 1990s with strong government support such that by the 2000s, the central bank started to outsource its printing and distribution of cash. He also underscored the legal framework that enshrines precedence of contract laws over banking and payment laws. These factors

provided the fodder for a behavioral shift among the consumers. But even with the sizeable reduction in cash usage, he cautioned about the implications of the payment digitalization trend on anonymity and on the less-technology savvy segments of the population, including elderly people afflicted with dementia. Benedictus [2021] reported that contrary to news brandished in social media platforms, the Swedish government has not made any policy pronouncement on going cashless, and banknotes and coins will continue to be produced.

Immediate and gradual changes in the use of physical cash and digital payments in other jurisdictions have also been observed. In the Euro area, cash is still the most frequently used means of payment at point of sale based on the 2022 Survey on the Payment Attitudes of Consumers in the Euro Area (SPACE).[1] However, there has been a considerable decline from 72 percent in 2019 to 59 percent in 2022. While the reason for this decline is yet to be determined, it may be inferred that the consumption and payment behavior adapted to the pandemic may have been retained post-pandemic.

Even if growing use of electronic means of payment reduces the demand for cash, it is still far from approaching zero at least in the medium term, largely because of consumer preference [Cabezas and Jara 2021]. This is evident in the case of China. On one hand, two leading platforms for payments and digital services, WeChat Pay and Alipay, accounted for 91 percent of digital payments in 2021. The cumulative digital payment value in China is set to reach USD 3.5 trillion, making it a global powerhouse in digital payments. On the other hand, it has been reported that cash on delivery remains the preferred online payment method in China ["Payment methods in China" 2022]. Assurance of quality before payment, and lack of online payment accounts (e.g., senior, rural citizens) explain preference for this method of payment.

The same is true for Japan. In the study by Saito [2021], demand for cash continued to expand in all regions of Japan, except Kinki, with positive net supply of cash by the Bank of Japan despite a long history of payment digitalization. The study highlighted that while cashless payments can be linked to credit and debit cards, a large portion of the financing came from charging by cash, which may reflect consumers' concern with credit card or debit card information as well as precaution against unmonitored expenses. Precautionary holdings of cash were noted to have increased during periods of uncertainty such as COVID-19, natural calamities, power outages, and ATM system malfunction. Zero deposit interest rates may have also made the public indifferent to hold deposits or cash. Naoko [2022] cited results of a survey that showed less than 30 percent of companies are considering implementing the government's plan to implement digital salary payment due to system and increased operational costs.

Increased usage of electronic payment was found to have a small substitution effect on cash demand (Chucherd et al. [2019]; Srouji [2020]). As pointed out by

[1] SPACE is a regularly conducted survey on payment trends.

Trütsch [2020], consumers' decision to use contactless payment is an endogenous choice, thus the overall effect on cash usage may remain unaffected. The varying motivations for using cash in different jurisdictions and cultures underline the persistence of physical cash usage. In Europe, the share of the senior population, the level of digitalization, and the average size of card transactions are among the identified drivers of cash usage [Alonso et al. 2018].

In a study, Flannigan and Staib [2017] found that cash usage continued to rise in Australia along with the size of the economy. Despite the increase in card payments over cash, the value of banknotes in circulation continued to grow with the economy, supporting the transactional demand for cash. In a more recent 2022 report by Mulqueeney and Livermore [2023], however, a significant reduction in in-person transactions was noted, with cash usage dramatically declining from 32 percent to 16 percent since the 2020 pandemic. The decline was pronounced in small value transactions, indicating a strong consumer shift towards digital payment methods for day-to-day expenses, with contactless methods even in traditionally cash-dominant sectors like transportation and small retail purchases partly driving the change. Despite the decline in cash use, cash is still important for certain demographic groups, particularly in non-metropolitan areas, emphasizing the need for balanced financial services that cater to all segments of society.

For Indonesia, Wasiaturrahma et al. [2019] reckoned that in the short term, credit cards and e-money are not significant for real money demand. But in the long run, they found credit cards to have a significant negative effect. Only debit cards have a significant positive effect on cash circulation.

A recent IMF working paper by Khiaonarong and Humphrey [2023] used a panel of 14 advanced and emerging market economies representing half of the world's population. The study found that on one hand, cash is still strongly used for payments in some countries using currency in circulation (CIC) as a ratio to GDP. When measured as the ratio of the value of cash withdrawn from automatic teller machines (ATMs) to GDP, use of cash seems to be falling. The authors attributed the divergence to the fact that CIC includes cash used for payments, hoarding, and even illegal use while ATM cash is focused more on the use of cash payments alone.

The preference for using digital payments, physical cash, or both may also come down to a business decision. The research by Arvidsson et al. [2017] predicted Sweden's rapid transition to a cashless society by 2023 at the earliest. They estimated a threshold of seven percent cash transactions over total payment transactions for Sweden, below which "it becomes more costly to manage cash than the marginal profit on cash sales" [Arvidsson et al. 2017].

Botta et al. [2022], highlighted that even with the continued dominance of cash in Africa, offline channels, especially agent networks, represent an important element of the growing African e-payments infrastructure. These networks have extended beyond cash-in, cash-out (CICO) services and facilitated the expansion

and complexity of electronic payments as a platform for financial services. These include SANEF in Nigeria, Mukuru in Southern Africa, and Fawry in Egypt, which are just a few examples of non-telecom agent networks. For banks, these networks with their lower operating costs have become a critical channel for customer acquisition and servicing, enabling access to a new segment of customers. In Latin America, the overall point of sale [POS] transactions rebounded from the 2020 slump and cash remains the leading payment method [Cash Matters 2022].

For all the benefits of going cashless, policymakers still have to manage an individual's fundamental concerns about privacy, anonymity, and security. Like Sweden, Norway is considered as one of the pioneers in the shift to digital payments, with a plan to eliminate paper money by 2030. Vipps is a dominant mobile payment app deployed by Norwegian banks, with 69 percent of their population using it to pay online. About 53 percent of online transactions are via mobile commerce, reportedly to be more than that of similar advanced economies like France and Germany. But despite the lofty goals set by the government, there remains a strong lobby for the continued use of physical cash, mainly for privacy and security reasons ["Norway strives to get rid of cash" n.d.].

Available empirical estimates show a small impact of digitalization on cash usage, implying more complementarity than complete substitution (Table 1).

TABLE 1. Estimated impact of digitalization on currency in circulation (CIC)

Author	Results of the Study	Estimates of Impact of Digitalization on CIC
Raj et al. [2020]	The change in the value of transactions is found to be statistically insignificant; however, the number of transactions is found to be [marginally] statistically significant and negative (with one period lag).	• ΔLog of value of digital transactions = 0.009 • ΔLog of value of digital transactions (-1) = 0.023 • ΔLog of number of digital transactions = -0.027 • ΔLog of number of digital transactions (-1) = -0.052*
Chucherd et al. [2019]	E-payment usage led to a slight decline in money demand and shows gradual substitution impact. Cash remains as the most preferred payment method.	• Retail e-payment = -0.058** • Card payment = -0.089*** • Internet and mobile banking = -0.054** • e-Money = 0.023
Qin [2017]	Using data of central bank in China during 1999 to 2010, electronic money has a negative impact on M0 (CIC), but a positive impact on M1.	• Relationship between e-Money and M0 = -0.13 • Relationship between e-Money and M1 = 0.74
Kartika and Nugroho [2015]	Analyzing electronic money and the velocity of money in ASEAN, it is found that GDP, M1, and velocity of money had a positive and significant effect on electronic money transactions	• Relationship between e-Money and M1 = 0.1

TABLE 1. Estimated impact of digitalization (continued)

Author	Results of the Study	Estimates of Impact of Digitalization on CIC
Hataiseree and Banchuen [2010]	Given the low degree of debit card usage for making payments and the slow change in the payment behavior, it is unlikely that this development will have noticeable impact on the future use of cash	• Relationship between e-Money and CIC = -0.15

Note: ***, **, * = significance level at 0.01, 0.05, and 0.1, respectively.

3. Stylized facts on currency and payment digitalization trends

3.1. Demand for cash

Data gathered on 19 selected economies show that the ratio of CIC to GDP has generally been rising, except for China, Norway, and Sweden. The ratio of CIC to M1, on the other hand, is on a general downtrend, with Malaysia, South Korea, and India bucking the trend, although a nascent post-pandemic decline is observed for these three economies (See Annex 1 Figure 10).

The trend for the Philippines is consistent with the general experience of other jurisdictions. The ratio of CIC to GDP had been rising until the 2020 pandemic and declined thereafter, a similar trend experienced during the 2008-2009 Global Financial Crisis (GFC). In terms of ratio to different aggregate measures of money, CIC-to-narrow money (M1) was on a steady decline from 2002 until mid-2013. It started to rise thereafter and stabilized at roughly around 30 percent (Figure 2). Consistent with robust economic growth performance, the CIC trend has become steeper since 2016 with marked gyration in the cyclical component in recent years (Figure 3). This may be traced to a number of significant shocks since 2019, which are mirrored in banks' withdrawals from the BSP.

The shocks include the bankruptcy of a major international banknote paper supplier; the pandemic that led to substantial precautionary demand for cash; introduction of the Cash Service Alliance (CSA) that mobilizes and recirculates largely high-denomination fit currencies; retail payment digitalization; and a high inflation environment that affected currency demand dynamics at the denominational level. As such, the recent downtrend cannot be attributed solely to a specific shock. Moreover, it remains to be seen whether the pandemic-induced shocks are (i) transitory and thus, mean-reverting, or (ii) structural in nature and would thus, lead to a new steady state level of CIC (Figures 2 and 3).

FIGURE 2. Ratios of currency to different measures of monetary aggregates

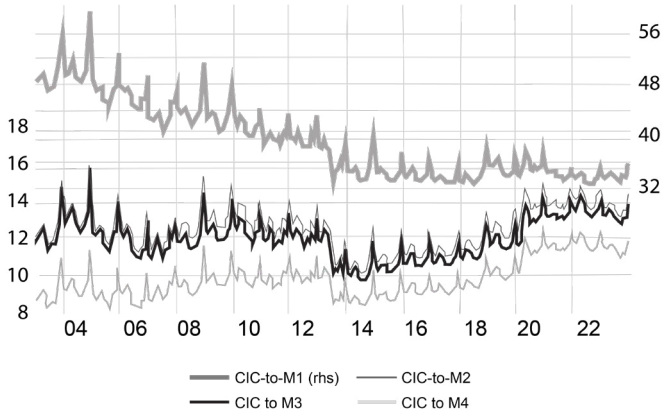
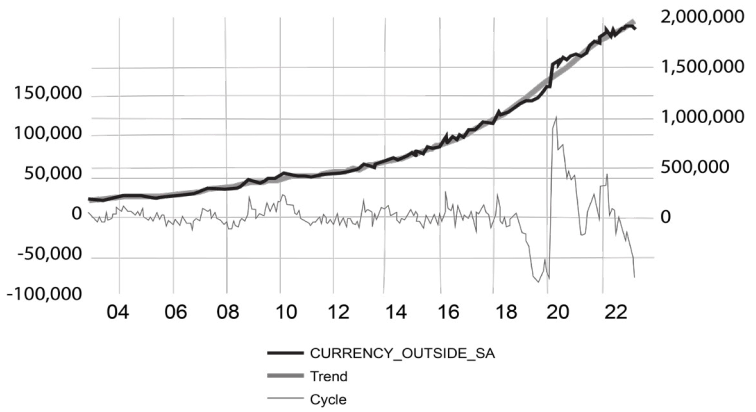


FIGURE 3. Trend and cyclical components of seasonally-adjusted CIC



Note: Authors' estimates.
Source of basic data: BSP Financial System Accounts - Depository Corporations Survey [n.d.].

The dynamics in currency denominational mix make bank withdrawals more nuanced, especially during periods of large shocks. In 2020 when the pandemic struck, the value of bank withdrawals from the BSP surged, largely driven by the two largest denominations i.e., 1000-Piso and 500-Piso for precautionary reasons (Figure 4a). Volume-wise, demand for low denominations is expectedly higher, particularly against the backdrop of a persistently high inflation environment and the greater volume of high denomination fit currencies mobilized and exchanged through the CSA (Figure 4b).

Providentially, the two automated clearing houses (i.e., PESONet and InstaPay) were already fully operating when the pandemic hit. With heightened public concerns on hygiene and mobility restrictions, the availability of digital payment platforms facilitated economic transactions and the distribution of financial aid during the pandemic.

FIGURE 4a. Value of withdrawals from the BSP of high and low denominations (in mPHP)

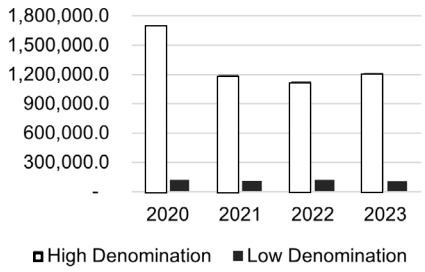
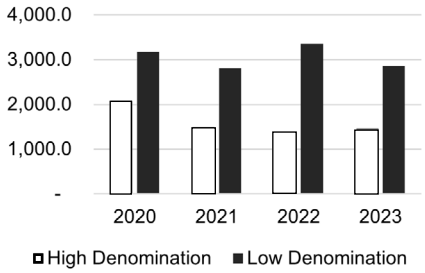


FIGURE 4b. Volume of withdrawals from the BSP of high and low denominations (in mpcs)



Note: Authors' estimates.
Source of basic data: BSP Currency Policy and Integrity Department (CPID) [n.d.]

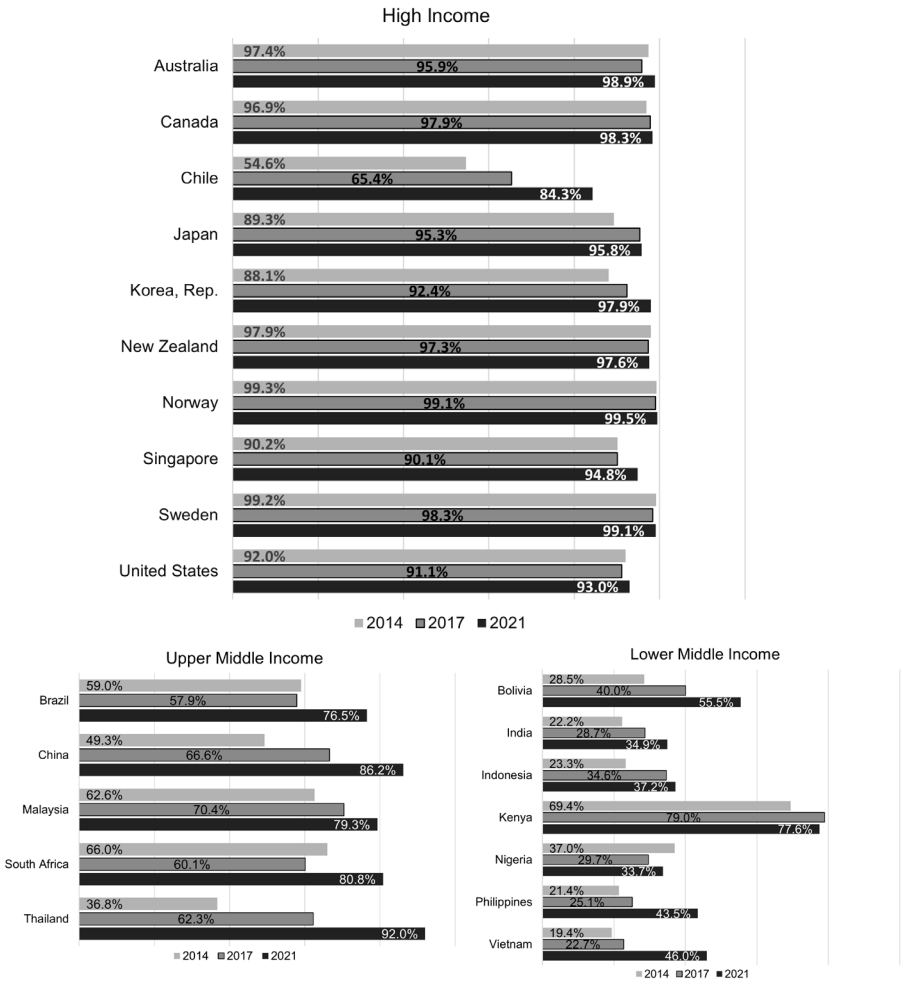
3.2. Retail payments digitalization[2]

Based on the Global Financial Inclusion (Global Findex) database,[3] the share of adults making or receiving digital payments in developing economies grew from 35 percent in 2014 to 57 percent in 2021, while in high-income economies, the figure is nearly universal at 95 percent. Moreover, there is a ten to 20 percent growth in the use of digital financial services in the upper middle and lower middle-income economies from 2017 to 2021. This rise can be attributed to the impact of the COVID-19 pandemic, as payment digitalization initiatives were strongly implemented worldwide amid large-scale community lockdowns (Figure 5).

In the area of mobile money, Sub-Saharan Africa dominates, accounting for 70 percent of the global market. In 2021, the digital transactions were driven by the increase in mobile account ownership, almost 50 percent of which were used for digital transactions. With a wider network of service providers, mobile money has become highly prevalent in so-called under or unbanked areas. They utilize mobile money to send remittances to family and friends within the country. Further, partnerships of mobile money platforms with banks, health care services, and even agricultural sectors have been observed in the past few years, reinforcing mobile money's key position in the financial ecosystem (Global System for Mobile Communications Association, as cited in Onyango [2022]).

[2] Annex 2 synthesizes some notable payment digitalization developments in selected jurisdictions.
[3] Launched by the World Bank in 2011, it provides in-depth data showing how people save, borrow, make payments, and manage risk.

FIGURE 5. Global digital payments trends



Source of basic data: The World Bank, Global Findex Database [2021].

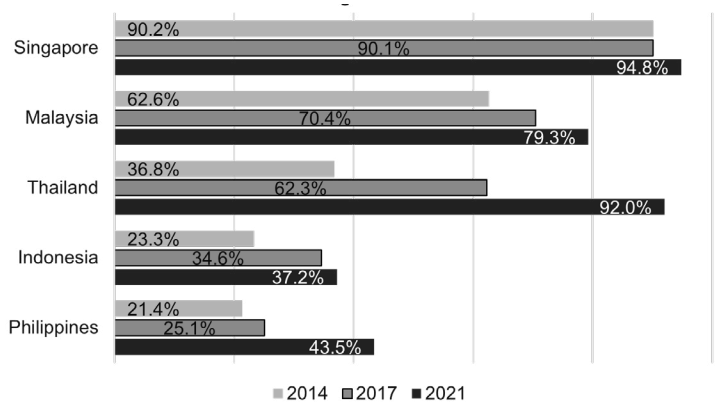
Among the ASEAN-5 economies, digital transactions in Thailand tripled from 2014 to 2021 (Figure 6). Other than the effect of the COVID-19 pandemic, this significant increase in digital payment usage is also attributed to the implementation of the Bank of Thailand's (BOT) Payment Systems Roadmap[4] and the National E-Payment Master Plan,[5] aimed at promoting safe, efficient, and

[4] The BOT set up the Payment Systems Committee (PSC) on August 27, 2001 to formulate policies of promoting safety and efficiency in the national payment systems. The PSC approved three roadmaps for the payment systems, which are the Payment Systems Roadmap 2004, the Payment Systems Roadmap 2010 and the Payment Systems Roadmap 2012-2016.

[5] The National e-Payment Master Plan is a national strategy created by the Ministry of Finance and the BOT, in cooperation with related government and private entities, in 2015 in order to push the development of payment infrastructures and to promote the use of electronic payment services in all sectors.

smooth operations to support a high level of trade and financial transactions. Likewise in Malaysia, the steady growth in digital transactions is reported to be driven by regulatory policy, global developments and active competition, greater use of technology, and consumer behavior.

FIGURE 6. ASEAN-5 digital transactions



Source of basic data: The World Bank, Global Findex Database [2021].

In the Philippines, the increase from 25.1 percent to 43.5 percent in digital transactions from 2017-2021 was buoyed by regulatory reforms that were established by the BSP under the National Retail Payment System (NRPS) Framework[6] to enable Filipino consumers, businesses, and the government to smoothly transition to payments digitalization. The growth of the value and volume of PESONet (Figures 7a and 7b) and InstaPay transactions (Figures 8a and 8b) spiked during the pandemic and decelerated thereafter.

The growth in the digitalization of retail payments also saw a concomitant rise in e-money accounts. Without corresponding bank accounts for cash-in transactions, however, holders of e-money accounts would still require cash to enable digital transactions. Even with bank accounts, income constraints and transaction fees may hinder end-to-end retail digital transactions. Thus, there is no one-to-one mapping between higher digital payment transactions and reduction in cash usage. It can be reasonably inferred that while there may be some substitution, it is far from complete. In contrast, there may still be a high degree of complementarity rather than outright substitution.

[6] The NRPS framework is founded on the principles of interoperability, inclusivity and "coopetition." Interoperability allows customers to transfer funds from their own account to any BSP-regulated transaction account using any device. Inclusivity requires effective participation in the system of all qualified financial service providers, regardless of size and type of transaction accounts offer. "Coopetition", coined from the words "cooperation" and "competition", pertains to cooperation in matters directly impacting shared objectives of system efficiency and resilience.

FIGURE 7a. Value of PESONet transactions

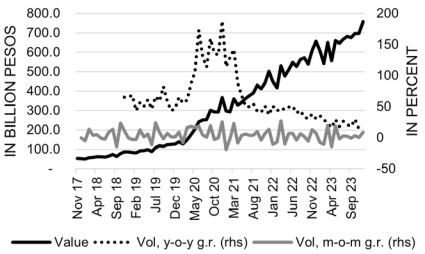
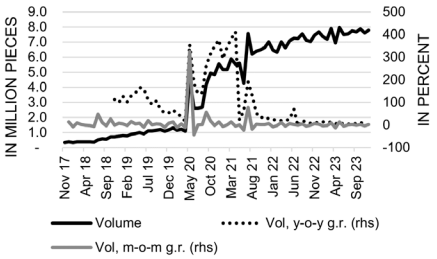


FIGURE 7b. Volume of PESONet transactions



Note: Authors' estimates.
Source of basic data: BSP [n.d.].

FIGURE 8a. Value of InstaPay transactions

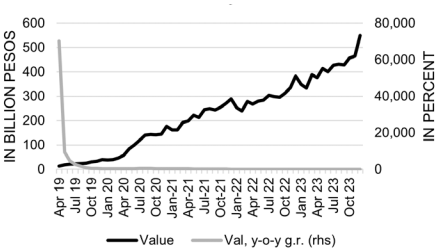
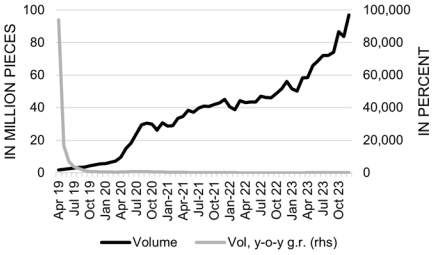


FIGURE 8b. Volume of InstaPay transactions



Note: Authors' estimates.
Source of basic data: BSP Payments and Settlements - National Retail Payment System [n.d.].

As depicted in Figures 9a and 9b, digital payments made through electronic money issuers (EMIs) still entailed substantial cash requirements.

FIGURE 9a. Value of cash-in and cashout transactions of EMIs (in bPHP)

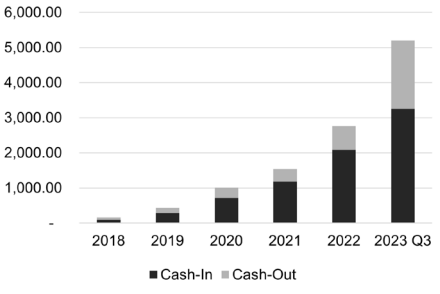
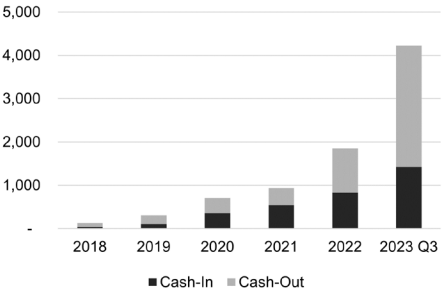


FIGURE 9b. Volume of cash-in and cashout transactions of EMIs (in mPHP)



Note: Authors' estimates. Data capture is incomplete for 2019, 2021, 2022; data for 2023 are up to Q3 2023 only.
Source of basic data: BSP Payments Policy and Development Department [n.d.]

An important consideration is the role of institutional, infrastructural, and cultural factors in determining the degree of substitution between physical and digital cash. In a competitive business environment, ease of market entry and a stronger drive to innovate, including in the financial services sector, can lead to increased availability and adoption of digital payment technologies as businesses seek to streamline operations and improve customer experience, thereby, making digital cash options more attractive than traditional cash. As faster and more convenient digital options become more ubiquitous and dependable, consumers, and businesses, payment habits, and preferences likewise adjust. The shift can be accelerated by factors such as government policies on user-centric use cases and stronger financial literacy programs.

Based on competitiveness indicators, however, the favorable effects of various reform measures have yet to reflect in the Philippines' global ranking. The country ranks lowest among ASEAN-5 economies in terms of ease of doing business score and digital competitiveness index (Tables 2 and 3).

TABLE 2. Ease of doing business scores

	2019	2020
Brunei Darussalam	69.6	70.1
Cambodia	53.8	53.8
China	74.0	77.9
Indonesia	68.2	69.6
Lao PDR	49.8	50.8
Malaysia	81.3	81.5
Myanmar	43.5	46.8
Philippines	60.9	62.8
Singapore	85.8	86.2
South Korea	84.0	84.0
Thailand	79.5	80.1
Vietnam	68.6	69.8

Source: The World Bank [n.d].

TABLE 3. International Institute for Management Development IMD digital competitiveness index, 2023

	Rank	Score
China	19	84.4
Hong Kong	10	93.6
Indonesia	45	60.4
Mongolia	63	43.0
Malaysia	33	75.3
Philippines	59	48.3

TABLE 3. IMD digital competitiveness index, 2023 (continued)

	Rank	Score
Singapore	3	97.4
South Korea	6	94.8
Thailand	35	70.5

Source: IMD World Digital Competitiveness Ranking [2023].

4. Empirical methodology

The empirical estimation was carried out using aggregate bank currency withdrawals (BCW) from the BSP as the dependent variable, which is the micro-level representation of currency demand. Following the work of Khiaonarong and Humphrey [2022], BCW proxies for ATM or over-the-counter withdrawals by the public. This is premised on banks acting as conduits for currency distribution to the public. Given that it is costly to maintain significant cash holdings, banks are presumed to maintain a reasonable level of cash for servicing the public's requirements.

The quantitative impact of digitalization on BCW was estimated on the following specification using simple ordinary least squares. The payment digitalization undercurrent is seen to induce some substitution, hence, expectation of a negative sign.

$$log(BCW_t) = \alpha_0 + \alpha_1 \Delta log(CIC_t) + \alpha_2 \Delta log(Digital_t) + \alpha_3 \Delta log(Demography_t) + \epsilon_t \quad (1)$$

The change in CIC, primarily driven by economic growth and inflation, embodies the impact of macroeconomic developments on currency demand, with an expected positive sign. Further, demographic shifts and their impact on payment preference are represented by birth rates and death rates. The higher inter-generational replacement through higher birth and death rates means that an increase in the proportion of younger population, who are adept and comfortable in using digital transactions, reduces preference for cash.

The general specification in Equation 1did not control for the pandemic because of the shortness of the digitalization series and occurrence of simultaneous shocks that render it difficult to disentangle its distinct effect. However, alternative specifications were attempted wherein a dummy indicator for the period of mobility restrictions due to the pandemic was used. It is important to underscore that the unprecedented nature of the pandemic led to widespread disruptions in economic, social, and healthcare systems, creating a complex web of interconnected variables that can confound statistical relationships. For instance, the sudden shift to remote work, changes in consumer behavior, and government interventions such as lockdowns have introduced new variables that were not present before the pandemic.

Moreover, the temporal nature of the pandemic, with its evolving phases and varying degrees of severity across different regions and time periods, adds an additional layer of complexity to regression analyses. Apart from the brief period of time for the data series that covers the pandemic, there remains the challenge of disentangling the direct effects of digitalization from the indirect effects mediated by the pandemic-related factors.

5. Data and presentation of results

5.1. Data and limitations of the study

The digitalization indicator is given by the value of the extracted digital component of the monthly aggregate data from the EPFS of Philippine banks for the period January 2018 to June 2022. The EPFS data were also cleaned to remove the cash component and avoid double counting of digital transactions. For 2018-2019, however, only annual EPFS data are available. As such, temporal disaggregation technique was employed for these years to generate monthly observations. Otherwise, the sample size would not be ideal for regression analysis. Variables are expressed in logarithms, except for the intervention variable. Hence, estimated coefficients correspond to elasticities.

Currency demand at the micro level is given by the aggregate bank currency withdrawals from the BSP. Demographic factors such as birth rate and death rate are obtained from the Census of Population and Housing by the Philippine Statistics Authority (PSA) (Table 4).

TABLE 4. Summary of regression variables

Variable name	Description	Source of basic data
BCW	Bank currency withdrawals from the BSP, in value	BSP
CIC	Currency in circulation, in value	BSP
Digitalization	Digital payment transactions via PESONet, InstaPay, ATM, Internet, Mobile, and POS transactions, sans cash component, in value	BSP
Birth	Birth rate corresponding to the number of live births per 1,000 people	Philippine Statistics Authority (PSA)
Death	Death rate corresponding to the number of deaths per 1,000 people	PSA

5.2. Estimation results

Different model specifications were tested to gauge the impact of various digitalization indicators on bank withdrawals. Preliminary results show that holding other factors constant, the elasticity of BCW with respect to digitalization is negative, albeit small, indicating some substitution between cash and digital

payments. The results further signify that for the Philippine case, population age structure plays an important role in the interplay between physical cash and digital payments (Table 5).

Proxying for generational payment preference, death rate has a consistent statistically significant negative impact on BCW. Presumably, older people prefer physical cash over digital payments because physical cash is relatively simple to use than the alternative. People from the younger generation are more adaptable and more receptive in exploring alternative means of payment. The negative impact of death rate on BCW may mean that as higher inter-generational replacement occurs, there would be lower preference in using physical cash. Alternative model specifications that include a dummy indicator for months of mobility restrictions due to COVID-19[7] showed statistically insignificant impact on BCW.

TABLE 5. Summary of estimates on the impact of digitalization on bank currency withdrawals from the BSP model

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	11.14 ***	12.68 ***	14.92 ***	12.94 ***	11.05 ***	12.72 ***
Change in CIC	7.17 ***	7.33 ***	7.09 ***	7.02 ***	7.06 ***	6.90 ***
Digitalization	-0.10 *	-0.20 ***	-0.23 ***	-0.12 *	-0.09	-0.11 *
Birth rate	0.38 **	-0.04		0.47 **	0.43 **	0.52 ***
Death rate	-0.46 ***		-0.22 **	-0.51 ***	-0.53 ***	-0.60 ***
Lagged BCW	0.13	0.16 *			0.13	
Covid					0.05	0.06
N	69	69	69	69	69	69
R^2	0.84	0.81	0.81	0.82	0.84	0.83
D.W.	1.91	1.89	1.81	1.79	1.89	1.78

Notes: Authors' estimates, as of April 17, 2024. ***, **, * = significant level at 0.01, 0.05, and 0.1, respectively using Newey West covariance method to account for presence of heteroskedasticity of unknown form. Ramsey Regression Equation Specification Error Test (RESET) test indicates no specification error.
Sources of basic data: BSP CPID; BSP Depository Corporations Survey; BSP PPDD, and Philippine Statistics Authority (PSA).

An important implication of the small estimated substitution effect is that despite milestone payment digitalization reforms, there remains huge scope to expand the reach of digital modes of payment raise the volume of digital transactions and achieve the vision of a cash-lite society. Policy reforms on competitive pricing policy framework, interoperable transit payment systems, credit push payment for person-to-merchant transactions, fee-less micropayments, offline payments, liberalization of access to satellites for internet connectivity, and stronger consumer and merchant protection, among others, would go a long way in expanding and deepening the traction of retail payments digitalization.

[7] Dummy indicator that takes value of one for the period March 2020–December 2021.

Moreover, the complementary upgrading of cash cycle infrastructure and cash management processes provides an essential backstop, particularly when there are shocks and technical malfunctions. An efficient cash management, even at reduced scale, safeguards access to payment, especially for the segment of the population that cannot readily shift to digital modes of payment, due to confluence of ingrained habits, strong preference for autonomy and privacy, and lack of access to affordable payment services. As aptly pointed out by Mulqueeney and Livermore [2023], the ongoing shift requires careful consideration from policymakers to balance the benefits of digital payments with the needs of those who still rely on cash.

6. Conclusion and recommendations

Overall, the literature suggests that digitalization has had some significant impact on cash usage in some jurisdictions, particularly in advanced economies. However, there is no evidence yet of a massive substitution effect of digitalization on cash usage. This is also borne out in the preliminary empirical estimates for the Philippines.

It cannot be denied that a sustained advance in payment digitalization will eventually bring about a significant behavioral shift in cash usage. However, the pace and extent of substitution would be contingent on policy reforms aimed at widening access through affordable services, secure infrastructure, and strong privacy protection, among others. Realistically, there are still a number of fundamental rigidities that need to be addressed. The high costs of electricity and internet are some of the constraints to accessible digital payment services (Tables 6 and 7).

TABLE 6. Electricity rates

	2021 Average Price of 1 Kw/hr (USD)
Japan	0.211
Singapore	0.195
Hong Kong	0.173
Philippines	0.165
Taiwan	0.142
South Korea	0.133
Thailand	0.107
Indonesia	0.101
China	0.084
Vietnam	0.081
Malaysia	0.070

Source: "The price of electricity per KWh in 230 countries" [n.d.].

TABLE 7. Internet costs

	2023 Cost per Mbps (USD)
Indonesia	1.50
Philippines	0.77
Malaysia	0.32
Japan	0.29
Taiwan	0.24
South Korea	0.20
Singapore	0.16
Vietnam	0.15
Hong Kong	0.15
Thailand	0.10
China	0.08

Source: "Analysis: internet speed vs cost by country in 2023" [n.d.].

The market fee structure crucially determines affordability and hence, adoption of digital payment transactions. While the benefits of increased efficiency and convenience from digital modes of payment are indisputable, it is equally important to think and prepare for mitigating the potential downsides such as vulnerability to cyberattacks and the risk of exclusion of individuals who lack the capacity to make an informed and empowered choice about the use of digital payment solutions.

Developing a database on payment attitudes of consumers, like Euro's biannual SPACE, would also provide important insights on how the dynamics between cash usage and retail payment digitalization develop over time. This would also inform strategies to ensure that Filipinos have access to safe and reliable payment systems, including cash. After all, financial inclusion is about empowering Filipinos with safe access to and capacity to choose from a wide array of financial services and payment options that suit their lifestyle and preference. Thus, both cash infrastructure and digital payment infrastructure would need to progressively adapt to changing times to ensure that the freedom of choice in payments is safeguarded.

Interesting areas of research being explored are the development of digitalization indices from diverse data sources, and a more nuanced examination of currency demand based on age, population, and digitalization indices. As society traverses further into the digital age, understanding how different age groups engage with and adopt digital financial tools becomes imperative. Deeper examination could shed light on the preferences, behaviors, and barriers that influence the utilization of cash and digital modes of payment across age cohorts. Additionally, examining how digitalization indices affect the tempo of socio-economic and financial inclusion would provide valuable insights for policymakers, financial institutions, and technology developers on how they can tailor their strategies to the changing needs and preferences of diverse demographic segments in an increasingly digitized global landscape.

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Annex 1. Cross-country roads

To ensure data comparability, the basic data used are sourced from the IMF International Financial Statistics and Federal Reserve Economic Data.

FIGURE 10. Cross-country trends in CIC-to-GDP ratio, 2001-2023 (in percent)

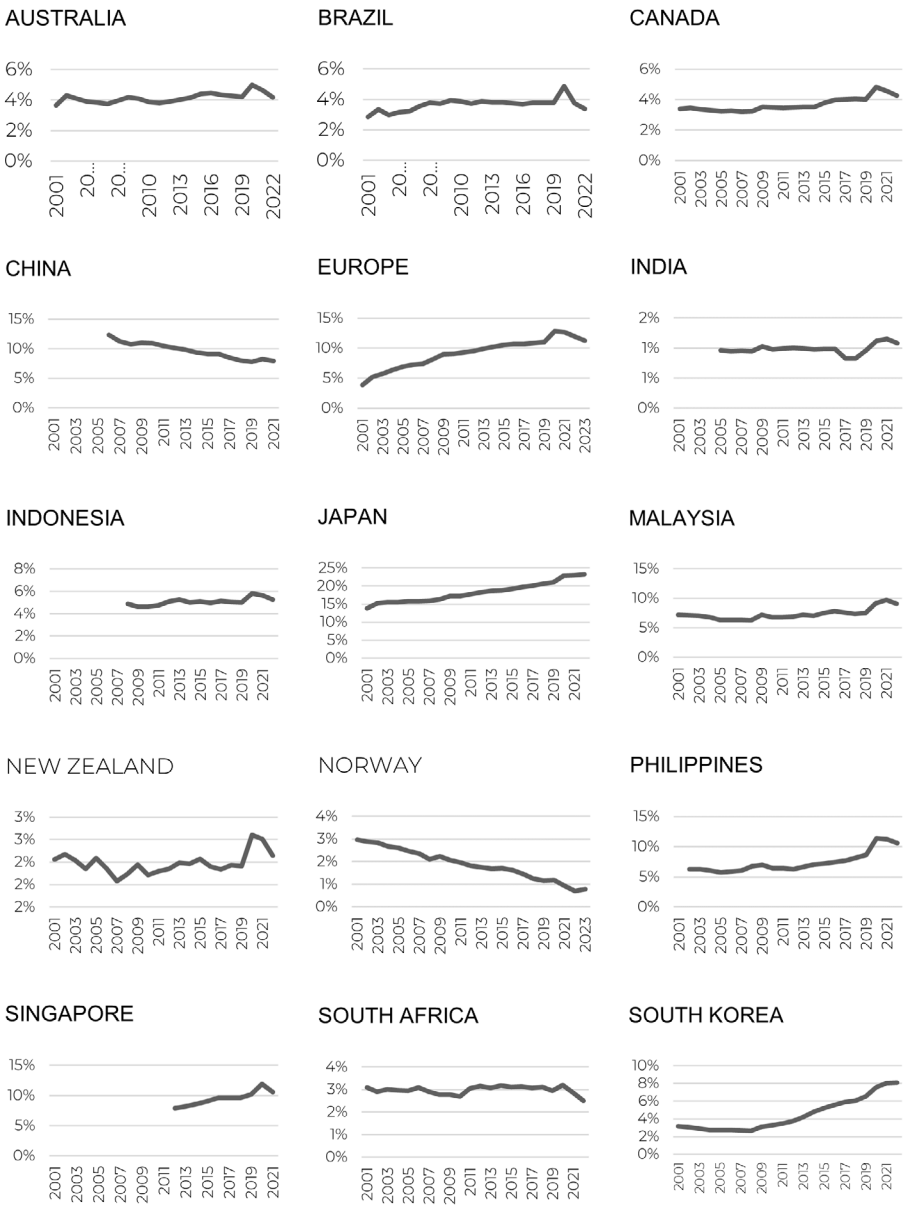


FIGURE 10. Cross-country trends in CIC-to-GDP ratio, 2001-2023 (in percent) (continued)

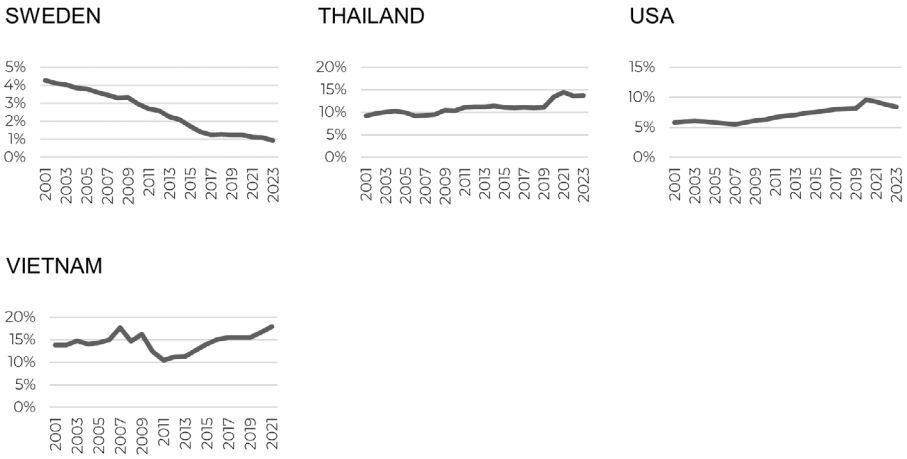


FIGURE 11. Cross-country trends in CIC-to-M1 (in percent)

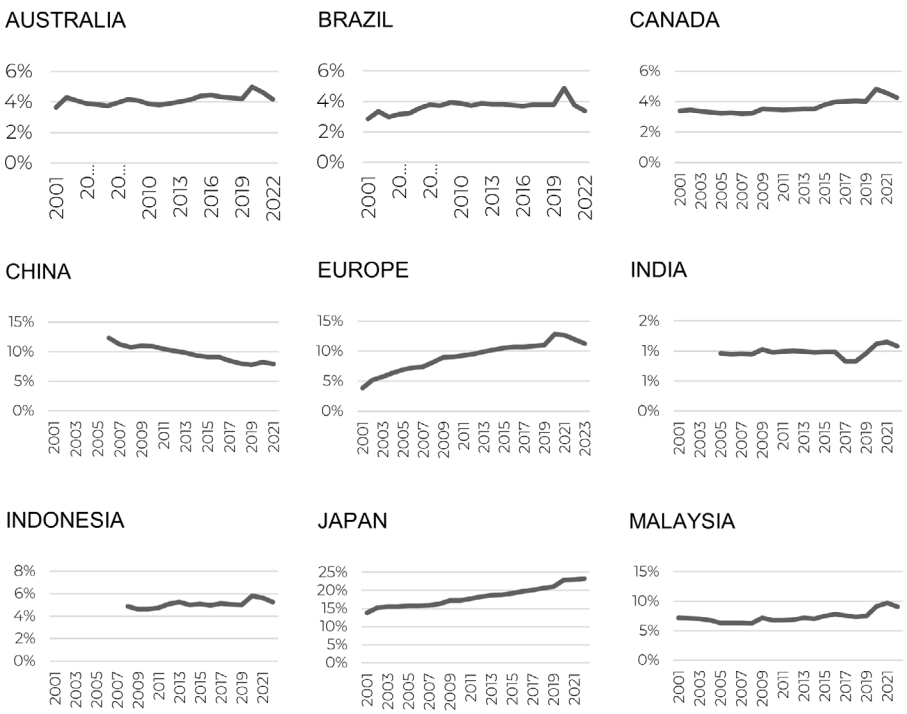
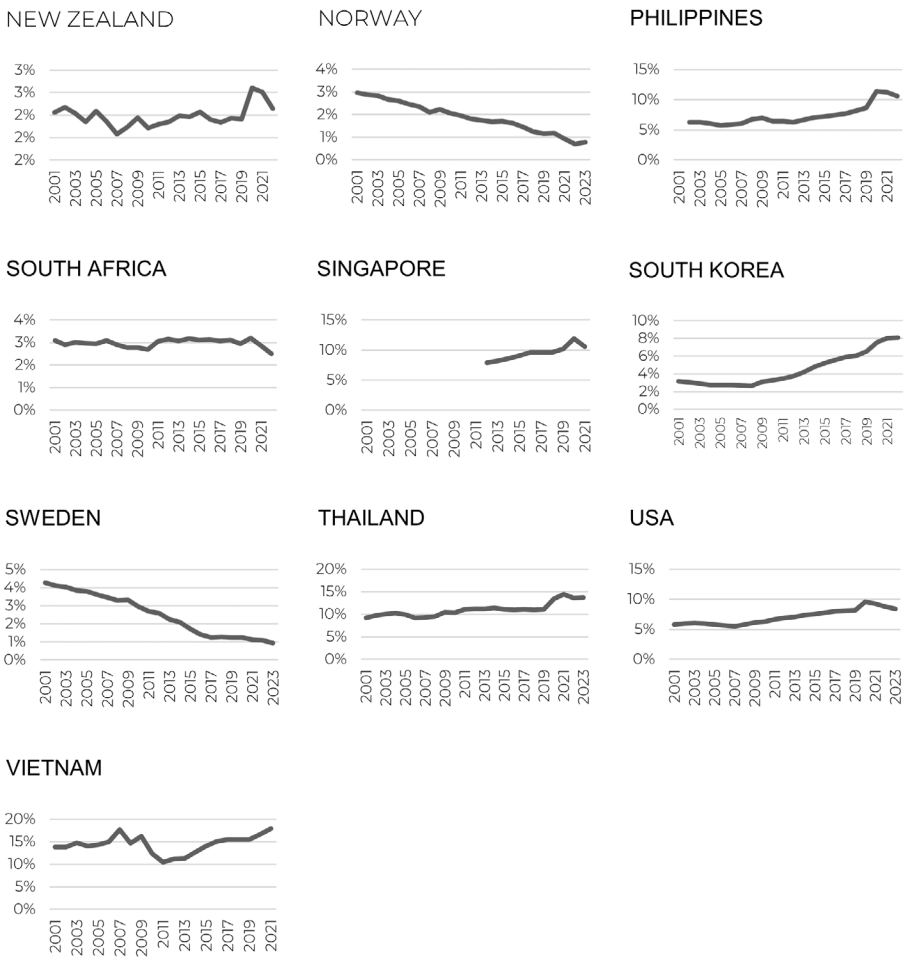


FIGURE 11. Cross-country trends in CIC-to-M1 (in percent) (continued)



Annex 2. Cross-country comparison of payments digitalization journey

This table provides a snapshot of drivers of payments digitalization in notable cases of payments digitalization.

Sweden	As early as 1950s, when central banking in developing countries was at its infancy, payment cards were already widely used in Sweden. Digitalization of bank accounts shortly followed, and internet infrastructure and internet banking were already set up by the 1990s. By the 2000s, the central bank started to outsource its printing and distribution of cash. These factors fostered behavioral shift among the consumers.

Annex 2. Cross-country comparison of payments (continued)

Norway	Norway plans to eliminate paper money by 2030 ["Norway strives to get ride of cash" n.d.]. Norwegian mobile payment app, Vipps, has a reported reach of 69 percent of their population for online payments. Usage rates for online transactions via mobile have exceeded that of similar advanced economies like France and Germany. On the other hand, there is an equally strong push to retain use of cash for privacy and security reasons.
Kenya	Kenya dominates in mobile money payments, which reached a record of KES 7.9 trillion (or USD 5.7 billion) in 2022 due to increased demand for cashless transactions and establishment new money agents [Wakarima 2023]. This is evident in the success of Safaricom's M-Pesa,[8] which has more than 50 million active monthly users across Africa [Armstrong 2022].
Nigeria	Central Bank of Nigeria's cashless policy in 2012 aimed to reduce the amount of physical cash circulating in the economy and to encourage more electronic-based transactions. This paved the way for Nigeria to become Africa's leader in real-time payments and digital payments with 3.7 billion real-time transactions in 2021 ["Nigeria reaps…" 2022]. Nigeria's real-time payments scheme, NIBSS Instant Payments, is driven by its leading payments technology company, Interswitch Group, that has been actively driving payments innovation for 20 years ["Nigeria reaps…" 2022].
South Africa	Unlike Kenya and Nigeria, South Africa has been slower to adapt to digitalization of payments, due in part to a more developed traditional banking infrastructure and a lower mobile phone penetration rate [Wachira 2023]. To address this, the South African Reserve Bank (SARB) launched Payshap in 2021, a low-value, real-time digital payment service that stemmed out of its Rapid Payments Programme (RPP)[9] making South Africa a step closer to a more accessible national payment system that will offer safer and faster payment options for all South Africans.
Brazil	The Brazilian government promotes the digital push through Pix, the instant payments platform powered by the Central Bank of Brazil. Since its introduction in 2020, six out of ten Brazilians use it regularly [PYMNTS 2022]. By January 2022, Pix was already used by 71 percent of the Brazilian population. In its latest Brazilian Central Bank reports, Pix generated a monthly volume of BRL 600 million (more than USD 100 million) of funds transferred.
Venezuela	Venezuela's hyperinflation decimated the country's currency, the bolivar, leading majority of its citizens to live in poverty and lose trust in its currency. Moving to a fully cashless society was deemed favorable to Venezuela as their paper dollars were in too short supply to be useful. Hence, Venezuelans turned to digital payments services to make dollar transactions. However, as Lago [2021] cautioned, Venezuela still needs to have competent management, and develop a reliable, accessible, and pervasive information and communication technology (ICT) infrastructure for the digital economy to be successful.
Chile	The COVID-19 pandemic pushed Chileans to embrace digital payment methods that it has become so entrenched that 62 percent of consumers said they would not patronize a merchant that does not offer some form of digital payment. Bank transfer has also become the most popular digital payment type. These transactions are much less vulnerable to theft and users can easily make payments via banking apps on their smartphones [PYMNTS 2021]. The popularization of digital wallets provides coverage of the industry's means of payment to the digital population in Chile, in addition to providing value-added services to users, such as transfers, savings, and payment of services [The Fintech Times 2022].

[8] M-Pesa is a mobile banking service which was launched in March 2007.
[9] The RPP, which was grounded in the NPS Framework and Strategy: Vision 2025, aims to provide a mobile-friendly instant payments service to assist with financial inclusion and stimulate economic recovery and future growth.

Annex 2. Cross-country comparison of payments (continued)

Bolivia	While internet services remain quite expensive, digital payments and e-commerce transactions keep on growing. The Bolivian government is investing more than BOB 140 million (USD 20.3 million) to build a data center wherein identity information of Bolivians throughout the national territory will be stored. The data center would support the General Personal Identification Service (Segip) around identity cards and driving license. The project is considered by no less than President Luis Arce as pivotal lead to the digitization of the country [Swinhoe 2023].

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Claudia Goldin and the economics of women and work

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Claudia Goldin won the 2023 Nobel Memorial Prize in Economic Sciences "for having advanced our understanding of women's labor market outcomes." Wielding her expertise in economic history and labor economics, she produced the first comprehensive account of the evolution of women's labor supply and earnings in a span of 200 years. While recognizing the role of discrimination, Goldin is known for exploring alternative drivers of the gender gap by using the lens of education, fertility, parenthood, social norms, institutional change, and women's aspirations and identity. Her body of work was key for the study of women's labor market outcomes—a subject that had been largely overlooked—to enter mainstream economics. This paper highlights Goldin's major contributions to economics as a field and influence on policy research.

JEL classification: J16, N3
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1. Introduction

> "My question was, I know where women are today and I know where they once were, how did they get to today? That's sort of why women won. That does not mean that women have won exactly what they should win, or that along the way all women won what they should have gotten. But it is a statement that where we are today is very, very different where we were in my own lifetime, not when I was born, not even when I was in college, but when I was in graduate school, and even when I was an assistant professor at Princeton."—Claudia Goldin on why she chose the title "Why women won" for her 2023 paper ["Transcript" 2023][1]

Women are underrepresented in the labor market. Though women are increasingly entering the labor force, there remains a large gender gap in the global

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[1] This is from the transcript of the Nobel Prize interview with Claudia Goldin. https://www.nobelprize.org/prizes/economic-sciences/2023/goldin/217472-interview-transcript/ (Accessed 6 April 2024).

labor force participation rate: 52.2 percent for women versus 79.8 percent for men.[2] In addition, when women are employed, they tend to earn less than men. Global estimates indicate that women are paid approximately 20 percent less than men [ILO 2018a]. Knowing the presence of gender gaps is one matter; understanding why these persist and are still prevalent is another. If women are undervalued in the labor market relative to men, it becomes both an equity and efficiency issue [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. The gender pay gap, for instance, is deemed a manifestation of social injustice [ILO 2018b]. Despite the increase in women's labor force participation rates, they are more likely to be employed as unpaid family workers or be in part-time employment. The lower access of women to good employment opportunities, even if they are equally skilled as their male counterparts, means that women's potential contribution to economic output is not being fully realized. These create inefficiencies, leading to lower aggregate productivity and income. Thus, addressing the gender gap could likely result in higher global GDP analogous to the impact of globalization on economic growth [Krugman 2023].

Recognizing the relevance of studying female labor market outcomes, however, was far from conventional and arguably disregarded up until nearly half a century ago. The early models in mainstream economics focused on representative agents, and the heterogeneity in economic agents was only introduced in the context of socioeconomic status and economic outcomes [Goldberg 2023]. This changed when Claudia Goldin's influential research on women's work in the 1980s—and continuing in current times—paved way for the field to enter mainstream economics.

An economic historian and labor economist, Claudia Goldin won the 2023 Nobel Memorial Prize in Economic Sciences "for having advanced our understanding of women's labor market outcomes." Goldin developed a unifying framework—something that was lacking prior to her work—that explains the gender differentials in labor force participation, employment, and earnings using the lens of education, fertility, parenthood, social norms, institutional change, and women's aspirations and identity [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. Identifying as an economics detective, she combined her expertise in economic history and labor economics to provide the first comprehensive account of women's labor force participation and earnings and how these have changed over time by digging records of more than 200 years' worth of US history. Goldin is often described as the trailblazer in the economics of women and is credited for providing the backbone of the advances in research agendas on gender [Petrongolo 2024]. Wright [1991] seems to have foreseen this in his review of Goldin's 1990 book, *Understanding the gender gap: an economic history of American women*,[3] where he concluded that this work was

[2] International Labor Organization (ILO) modelled estimates in November 2023 for people aged 25 years and above.

[3] This is the second book written by Goldin, and it won two awards in 1990: the Allan Sharlin Book Award and the Richard A. Lester Prize.

just the beginning in which the economic history of women will not be merely regarded as "a narrow subspecialty largely isolated from the major themes and developments of the economy as a whole."

As her analysis puts women in the center, Goldin's win is both groundbreaking and symbolic. Out of the 93 Nobel Laureates in Economic Sciences, she is only the third woman to win the Prize and the first to win it solo. This is, however, not the first time she broke glass ceilings. In 1990, she became the first woman to be granted tenure at Harvard University's Department of Economics. Her pursuit to understand women's labor market outcomes has thus not only reshaped labor economics and economics in general but is also considered to be a model for women to prosper in a field that is historically dominated by men [Perrin 2024].

This paper seeks to highlight Goldin's key contributions to labor economics and gender studies. Section 2 summarizes Goldin's research that was central to her Nobel Prize win. Section 3 discusses the influence and policy implications of Goldin's work. Section 4 concludes the paper.

2. Goldin's Nobel-winning research

The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel [2023] attributed Goldin's Nobel Prize win to her account of the economic history of women and determining the remaining barriers for women in contemporary times. Before Goldin's research, producing meaningful estimates of women's work tended to be dismissed, because documenting the long-run changes in the gender disparities in the labor market had been believed to be impossible given the lack of historical data and, if available, their unreliability [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. It has been then crucial to Goldin's research, especially the seminal ones, to dig novel sources of data, and to identify and remedy the systematic errors in these data. With a much longer time-series data at hand, Goldin managed to uncover the evolution in the driving forces of the gender gap and women's work in the US from the 1790s to modern times.

2.1. U-shaped female labor supply function

Prior to Goldin's work, the common empirical finding was that the female labor force participation rate increases with economic development, but this emanated from the absence of accurate and reliable census data before 1940 [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. Goldin [1986,1990] and Goldin and Sokoloff [1982] dug new quantitative and qualitative information such as those from Labor Department surveys, a retrospective survey of working histories of women, office firm surveys, and directories, among others, to construct new data in documenting women's work in the US. Goldin's further empirical innovation in this regard was to probe for the factors to explain why

female work and earnings had been historically underestimated and then correct these biases and errors. One example of these errors was recording a married woman as "wife" in the censuses before 1940, despite working, say, in the family farm or business.[4] Changing definitions of labor force participation was another prevalent issue, among others.[5] As she traced back time-series data to as early as the 1790s, Goldin was able to establish that the female labor force participation rate in relation to economic development was in fact "U-shaped."[6] She showed that the increase in the female labor force participation rate during the 20th century as observed in previous studies was actually preceded by a decline in female participation in the 19th century. Goldin [1995] also demonstrated that the U-shaped pattern can be constructed in the international context using cross-country data.

Goldin's narrative behind the U-shaped pattern in the US is as compelling as the empirical work she has done (Goldin [1986,1988,1990,2024]; Goldin and Sokoloff [1982]). The participation of women in the labor market declined as the economy transitioned from an agrarian society to an industrial society. The proximity of farm work to households enabled women to combine home and market work during the agricultural period, but the movement of work out of the home during the Industrial Revolution constrained the occupational choices of women. There was also social stigma surrounding the employment of married women, especially in jobs associated with heavy, "dirty" work mostly found in manufacturing. This social stigma often stems from the belief of the community that a husband who allows his wife to work in an unsafe environment is indolent. On the other hand, the growth in the services sector led to increasing female labor force participation. The expansion of the services sector amid the rise of clerical and office work with better working conditions and higher returns to education encouraged more women to finish secondary education and participate in the labor market. Goldin noted, however, that the increase in the female labor supply associated with the expansion of the services sector was only clearly observed when "marriage bars",[7] which had legally prevented married women from being

[4] Before the censuses in 1940, Goldin [1990,2024] inferred that the nature of the question about one's occupation might have impelled responders, especially married women, to exclude economic activities even if these were valid occupations. In this regard, women might have been engaged in "hidden market work" as Goldin called it.

[5] Although expectedly less problematic, changing definition of labor force participation remains a concern in modern statistical data. In the Philippines, for example, official labor market statistics have been subject to several data breaks such as changing reference periods, labor force coverage, and unemployment definition in a span of almost 50 years. There is also the issue of differing definitions across countries which makes it more challenging to make cross-country comparisons. The ILO seeks to address this data issue by producing comparable estimates (called ILO modelled estimates) across countries.

[6] Goldin ([1995], as cited by Goldin [2024]) discussed the roots of the U-shaped relationship in the work of Boserup [1970] and Durand [1975].

[7] Goldin [1988] documented that "marriage bars" can take the form of either firing women once they got married or not hiring married women. The latter case was less restrictive, since single women who had been hired and eventually got married were allowed to retain their jobs. She estimated that, at the peak of this policy, 75 percent of school boards and 50 percent of office workers had been affected.

employed, were removed in the 1950s.[8] In other words, expanding employment opportunities for women is good, but unless barriers to seizing these opportunities are removed, female labor market participation would not improve.

Goldin pieced together the economic, social, and institutional factors across time in deciphering the changing economic participation of women. Nonetheless, as Goldin [1990] showed, the impact of these factors on female employment was mixed (e.g., married vs. single women, white vs. black women[9]), and the change in female labor supply could also be slow because of cohort effects. Statistically speaking, labor force participation rates are usually expressed on an average basis which does not reveal the variation in labor supply decisions between cohorts. The participation of cohorts in the labor market depends on the existing social norms and institutional barriers during their time, their own aspirations, investment in human capital, fertility decisions, and perception of labor market success based on the experiences of previous cohorts. In the US case, Goldin [1990] observed that in the 20th century each successive cohort exhibited a higher participation rate than the one before them, as women adjusted to new structures, obtained increasingly more accurate information on their employment prospects, and invested more in their education.

Goldin [1995] also proposed a framework of household and market production to explain the U-shaped female labor force participation over the course of economic development. The downward portion is associated with a strong income effect and a weak substitution effect. Because of the social stigma about female employment as work moves from the home to the market, female employment (especially among the married) is restricted, and female labor supply is more sensitive to family income and is less sensitive to their own wages. At higher stages of development, the upward portion manifests as the substitution effect dominates the income effect because of lower social stigma. As constraints to educational resources loosen, female education improves; so is their ability to occupy white-collar jobs upon school completion. This leads to a large increase in women entering the labor force. The social norms then become costlier to enforce, and their imposition declines. Goldin [2024] added that the rise of part-time employment and the emergence of household conveniences such as appliances and frozen food contributed to altering the female labor supply function. Despite the general framework, Goldin acknowledged that differing contexts may lead to differing progress in women's economic status in relation to education. As argued by Goldin [2024], countries can even get stuck near the bottom of the U because

[8] The removal of marriage bars does not mean that discriminatory practices towards hiring had been eliminated [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. For instance, Goldin and Rouse [2000] showed that blind auditions which conceal the candidate's identity increases the probability of a woman being hired in symphony orchestras.

[9] Goldin [1977] studied in more detail the historical differences in the labor force participation between white and black women. She observed that black women exhibited higher labor force participation rates compared to white women. Updating the data up to the 2020s, Goldin [2024] showed that this pattern has persisted.

of social stigma and traditions about women's paid employment, and this is still the case in many countries in the world.

2.2. Evolution of the gender earnings gap and wage discrimination

One of Goldin's most significant early works was her analysis of the gender earnings gap in the US that was published in her 1990 book, *Understanding the gender gap: an economic history of women*, where she dissected the different factors behind the gender gap in the 19th and 20th centuries [Perrin 2024]. This book is widely considered the foundational work on the rise of women in the US labor force and its impact on the economy [Fitzgerald 2014]. Goldin showed that gender-based wage discrimination[10] had not been constant over time and only clearly manifested in the US at the turn of the 20th century as a product of institutional and organizational changes in the labor market.

Goldin established three core facts in her analysis of the gender earnings gap in the US.[11] First, the gap narrowed significantly during the American Industrial Revolution (1820-1850) and the rise of white-collar employment (1890-1930), both of which were associated with new employment opportunities for women even before the social movement towards equal pay. Second, the narrowing of the gap stalled and did not change much in the 20th century despite the major structural and social changes that occurred.

Third, the nature and magnitude of the gap, as substantiated by the first two points, changed over time. In the transition from agriculture to manufacturing, Goldin estimated that female wages nearly doubled relative to that of men, since female agricultural and domestic services wages had come from a very low base. However, in the late 19th century up to the early 20th century, occupation segregation became quite evident in manufacturing, which slowed the convergence in the gap. Women were confined in select industries and to jobs with no qualification requirements, little avenue for promotion, and piece-rate payment scheme. Goldin did not find, though, evidence of wage discrimination. She argued that monitoring output was quite straightforward in the manufacturing sector, so there was little room for non-productivity-related wage differentials. Much of the gender earnings differentials was because of difference in characteristics, primarily job experience.[12]

The surge of clerical jobs between 1890 and 1930 was beneficial for women for several reasons: earnings were higher, it incentivized them to finish secondary education, and working in an office was more acceptable for women than working

[10] Wage discrimination exists when workers with identical productive characteristics are paid lower wages because of the demographic group they belong to (e.g., based on gender, race, ethnicity, etc.).

[11] The discussion on the three core facts is heavily sourced from the Committee for the Prize in Economic Sciences in Memory of Alfred Nobel [2023] and Wright [1991].

[12] Nonetheless, Goldin [1990] emphasized that other forms of discrimination could be observed in this time. Women had little incentive to gain work experience and had no chance of promotion. Most women worked only up to ten years, possibly stopping because of marriage.

in a factory. The new employment opportunity provided by clerical jobs led to the increase in the relative earnings of women, but the intriguing finding by Goldin was that it was also in this sector where wage discrimination became prevalent. Goldin estimated that wage discrimination accounted for at most 20 percent of the gender wage differentials in manufacturing, while it was as much as 55 percent in office work in 1940.

How did this paradox in the services sector come about? Goldin explained that the institutional conditions of office work led to the persistence of discrimination. In contrast to the piece-rate payment scheme where wages were adjusted according to productivity, office work entailed more structured salary schedules and occupational ladders, which made measuring productivity more obscure. Instead, workers with longer tenures were rewarded with promotions and thus higher salaries. Women tended to have shorter tenures as they were likely to exit the labor market upon marriage, so employers possibly used gender as a basis for promotions amid limited information about one's productivity and the presence of imperfect incentives.[13]

Goldin made two major arguments in her book. First, the lessons from the past can be used to understand the gender differences in today's economy. Second, economic progress can lead to gender equality, but this should be accompanied by legislation and social change. The latter is echoed by Goldin and Katz [2002], emphasizing that genuine change in the economic and social status of American women was not simply reflected by higher labor force participation rates but by increased representation of women in career professions. The next subsection delves into the analysis of Goldin of such change that brought forward the significant shift in the economic role of American women.

2.3. The quiet revolution and the power of the pill

Goldin often mentions that women used to be relegated as secondary earners in the family and, unlike men, were likely to have jobs and not careers if they participated in the labor market.[14,15] Women's labor supply, especially those who were married, was less elastic and more sensitive to their husbands' income. In

[13] Goldin [1990] called this a form of "statistical discrimination." Statistical discrimination occurs when, in the absence of means to observe actual productivity, employers evaluate the potential productivity of workers based on the average characteristics of the group they belong to.

[14] The concept of "added worker effect" is an example where women are treated as secondary earners. It refers to the increase in female labor supply, particularly that of married women, when their husbands become unemployed. It assumes that married women have a lower attachment to the labor market and would only likely enter the labor force as a response to reduced family income due to the job loss of their husbands, especially during recessions.

[15] Goldin [2004] distinguished American female college graduates over the 20th century into five cohorts. Women who graduated in college between 1900 and 1920 either had a family or career. Those who graduated between 1920 and 1945 had a job first then a family. Those who graduated in 1946 until the mid-1960s had a family first then a job. Those who graduated in the late 1960s until 1980 established a career then had a family. The last cohort, which graduated between 1980 and 1990, had a career and a family.

a series of studies, Goldin and her coauthors saw and analyzed the sharp turning point—akin to a structural break—between the early 1960s and the late 1970s in young women's expectations about their future work life, college graduation rates, choice of degree programs, age at first marriage, and labor force participation rates (Goldin [2005,2006]; Goldin and Katz [2000,2002]; Goldin et al. [2006]), all of which demonstrated that women were becoming more inclined to having a career. Goldin [2005,2006,2024] characterized this period where the modern economic role of American women emerged as the "quiet revolution".[16]

Before the turning point, Goldin [2005,2006,2024] and Goldin et al. [2006] observed that young women formed their labor market expectations based on the labor market outcomes of their mothers. However, in 1975, more young women expected to be working at the age of 35, which was more than double than what was observed seven years prior. Since investments in education are mostly made by people when they are young, expectations about future employment prospects are an important factor in deciding how much to invest in education. The changing expectations of young women about their employment thus led to increased college attendance and completion.[17] And it was not just college attendance that changed. Women took more math and science courses in high school such that, in the 1970s, women's degree program choices shifted from "consumption" degrees to "investment" degrees. More women opted to take professional degree programs such as medicine, law, business, and dentistry—meaning, their choices were becoming more similar to those of their male peers. Unsurprisingly, given the greater and longer human capital investments being made by women, a large increase in the median age at first marriage was observed within a short period of time, which was 23 years for those born in 1949 versus 25.5 years for those born in 1957.

What propelled the quiet revolution? There are several potential factors, as the turning point identified by Goldin coincided with prominent legislative and social changes. The government legally prohibited discrimination in employment practices and directed equal treatment in educational programs. The period was also known for the resurgence of the feminist movement. While recognizing the roles of these events in the quiet revolution, Goldin and Katz [2000,2002] offered a novel explanation: the diffusion of the oral contraceptive, simply known as the "pill."

Goldin and Katz [2000,2002] built on the premise that the reliability, ease of use, and feminine control of the pill lowered the cost of making longer-time career investments for women. The pill, they argued, reduced the uncertainty regarding pregnancy and lowered the cost of delaying marriage for women, especially those

[16] Goldin [2006,2024] contrasted the "quiet revolution" to the "noisy revolution." The former was characterized by the changing education and career choices made by women. The latter was marked by the civil rights, anti-war, and women's liberation movements that started in the 1960s.

[17] Goldin [2024] noted that women's increased college attendance in the US has continued until today and can now be observed globally.

who wanted to pursue a career.[18] The US Food and Drug Administration approved the use of the pill in 1960, but there was differential access to the pill. Although married women immediately gained access, minors required parental consent, thus limiting the diffusion of the pill to young, unmarried women. Goldin and Katz [2002] took advantage of the differential effect of legal changes in the age of majority and rights of minors by cohort and state. They found that these legal changes are positively associated with the age at first marriage and the proportion of women in professional degree programs, thus establishing "the power of the pill" in raising the age at first marriage and encouraging more women to take professional degree programs. Goldin [2006,2024] claimed that the increase in female labor force and employment was an "evolutionary" change, but the change in women's expectations, in their sense of identity, and in their newfound ability to better control their destinies was a "revolutionary" change.

2.4. Remaining barriers

In her historical and empirical accounting of the evolution of women's economic role in the US from the 18th to the 20th century, Goldin has drawn attention to the progress made towards gender equality in the labor market. In the US, the gender gap in college attendance had disappeared in 1980 and reversed in the 2000s as more women relative to men are going to college [Goldin et al. 2006]. As a result, although differences in human capital and occupational choices accounted for much of the gender earnings gap in the past, these have become less important amid the convergence of human capital investments between men and women. For example, Blau and Kahn [2017] estimated that human capital factors (i.e., education and experience) only account for eight percent of the gender earnings gap in 2010 compared to 27 percent in 1980 in the US. Goldin's more recent research focuses on the sources of the remaining gender gap in earnings, particularly the earnings per unit of time or the wage. While the earnings of women relative to men are at near-parity at the beginning of their working lives, the relative earnings of women decline with age, and the gender earnings gap widens over the life cycle [Goldin 2024]. This is especially observed among college graduates and in high-paying occupations.

Goldin [2014] argued that much of the gender earnings gap is occurring within occupations and not much between occupations. This is based on the proposition that some occupations have a nonlinear (convex) pay structure with respect to hours worked; such that people laboring long hours and working particular hours are rewarded with a higher wage per hour, while people who want fewer hours of work and a more flexible working environment are penalized with a lower wage per hour. Goldin and Katz [2011,2016] and Goldin [2014] developed a

[18] Goldin and Katz [2000,2002] postulated that, with the introduction of the pill, all women can delay marriage and not pay a large penalty, i.e., in terms of being left out in the marriage market. This suggests that the pill created a "thicker" marriage market for career-oriented women.

compensating differentials framework to formally understand how the nonlinear hours-wage relationship comes about. They proposed that temporal flexibility is an amenity that people are willing to pay for and that firms may allow at a cost. The costs of temporal flexibility vary by firm or sector, and these depend on the substitutability between employees.[19] The costlier it is to allow an employee to assume the work of another employee, the higher is the cost of temporal flexibility. Since women are usually the on-call parents and the men the on-call employees, it is the women who have the disproportionate demand for temporal flexibility. Therefore, gender differences in pay do not arise from productivity-related factors but from differential preferences and costs associated with the amenity of flexibility.

Focusing on US college graduates, Goldin [2014] estimated that occupations with higher elasticities of annual earnings with respect to weekly hours have a larger gender earnings gap.[20] Inflexibility at the workplace, Goldin argued, adversely affects women's labor supply and earnings as they take on greater child-rearing responsibilities. One example where any time off is heavily penalized is business occupations. Bertrand et al. [2010] found that male and female MBA graduates have nearly similar earnings at the onset of their careers. Their earnings, however, significantly diverge and grow a decade after graduation. New MBA mothers, particularly those with higher-earning husbands, tend to reduce their labor supply as indicated by greater career interruptions and shorter weekly work hours, leading to substantial declines in women's earnings. On the other hand, the labor market outcomes of men are unaffected by parenthood and, if anything, their earnings increase over time. The same results are found for male and female law graduates, which is another field where temporal flexibility is quite costly [Goldin 2014].[21] In contrast, pharmacy is a female-dominated, high-earning profession with low gender earnings gap, that Goldin and Katz [2016] described it as "a most egalitarian profession." They explained that technological changes in the pharmacy industry and the shift from self-employment to employment in retail chains and hospitals all reduced the penalty to part-time work. Hence, little work interruptions were observed among female pharmacists even if they have children. As a thought for policy, the authors also demonstrated that the narrowing of the gender earnings gap in pharmacy has little to do with family-friendly workplace amenities and is more consistent with the change in the structure of work.

[19] Using O*Net data, Goldin [2014] associated the following job characteristics with low degree of worker substitutability: greater time pressure, frequent contact with others, more interpersonal relationships, highly structured work, and greater freedom to make decisions.

[20] Business occupations have the largest elasticities, while technology, science, and health occupations have the lowest.

[21] Like what was found in MBA-related careers, Goldin [2014] showed that part-time work for lawyers is insufficiently remunerated, thus discouraging married women with children from becoming or remaining employed. This is especially observed among women with high-earning husbands.

Goldin [2021a,2024] called the jobs that are demanding more and inflexible time from employees as "greedy work" and stressed that it is the structure of work that perpetuates gender inequality as women balance career and family. The greedier the work is, the more expensive it is for couples to have equity. Goldin explained that, instead of both taking flexible work, it is more rational that one of them gets the greedy but higher-paying work (usually the husband), while the other takes the more flexible but lower-paying work (usually the wife). The labor market, Goldin argued, incentivizes them to specialize.

But what happens to the gender earnings gap when children grow up and the demand for childcare is reduced? To answer this, Goldin et al. [2022] estimated the parental gender gap which is composed of the motherhood penalty, the price of being female, and the fatherhood premium. As children grow up, mothers increase their hours of work relative to fathers, so they experience an increase in earnings. The earnings gap between mothers and fathers, however, does not change much because of the motherhood penalty and the fatherhood premium. Goldin [2024] explained that women's earnings fell and never recovered with the event of a birth and saw that gender differentials in earnings hold even in countries with family-friendly policies.

With the role parenthood plays in the persistence of gender inequality, Goldin [2021a] explained that anti-discrimination laws and fair employment policies are valuable but not enough to address the gap. In other words, even without discrimination, she argued that the gender gap would persist because of the tendency of married women to take on more childcare duties.[22] Goldin [2021,2024] instead emphasized the need to make fundamental changes in the way we work, make the workplace less greedy, make flexible work more productive, and recognize the importance of childcare to remove the remaining barriers to gender equality. The COVID-19 pandemic, Goldin [2024] noted, interestingly reduced the time demands in certain greedy occupations and increased the productivity of those with flexible jobs as firms and workers learned how to use technology to work from home. She argued that these changes benefited caregivers, especially women.[23]

3. Goldin's influence on economics and policy

Goldin's work shows how powerful it is to combine history and economics in explaining what happened and why such things happened to women in the labor market [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. Majority of Goldin's work, especially the earlier ones, is positive in nature and does not make normative policy prescriptions, but this does not mean that her work does not have policy implications [Committee for the Prize in

[22] Goldin [2024] observed that single mothers, unlike mothers with a husband or partner present, have higher employment rates. Furthermore, they take care of their children. They do not have the luxury of specialization.
[23] Goldin [2024] quipped that work from home has its benefits as long as it does not become "work from hell".

Economic Sciences in Memory of Alfred Nobel 2023]. The following are some of the insights from Goldin's research that can be useful for policy.

First, the sources of the gender gap are not constant and are changing over time as the economy transitions from one stage of development to another [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. Goldin's [1990] comprehensive and long-run account of the gender gap in the US is the precursor to discovering that the relationship between female labor supply and economic development is U-shaped. Her later analysis in Goldin [1995] demonstrated the external validity of the US case, and studies that replicated this research arrived at the same finding (e.g., Mammen and Paxson [2000]; Olivetti [2014]). Recent data by income group does imply a U-shaped pattern. The female labor force participation rate is highest in low-income countries at 61.4 percent, lowest in lower-middle-income countries at 41.9 percent, and relatively higher in upper-middle-income countries and high-income countries at 58.5 percent and 55.6 percent, respectively.[24]

As countries are at different stages of development, Goldin's work can be used to investigate which factors are primarily driving the gender gap and the interactions between these factors while acknowledging contextual differences. What can be learned from US history is that better employment opportunities, coupled with better education, enabled women to enter the labor market and that social stigma consequently becomes more expensive to maintain [Goldin 2024]. Nonetheless, Goldin's studies also suggest that policies that support better education for women would not necessarily lead to a reduced gender gap, and improved education outcomes for women are not necessarily a product of advanced economic development. For instance, Goldin [1995] cited Korea, a newly industrialized economy at the period of her study, as an example where women's representation in the clerical sector remained very low despite the significant progress in women's education. She also mentioned the Philippine case which was characterized by much lower income than the newly industrialized Asian economies, but where schooling levels were quite high. As a contemporary example, the educational attainment of women has been improving in India which is attributed to increased public expenditure on education. However, female labor force participation is seen to be declining, and one factor is restrictive social norms about women engaging in paid work, especially in rural areas [Mehrotra and Parida 2017].

Second, it is important to determine the root causes of the gender gap for policy that seeks to increase female labor market representation and earnings to be effective. The gender earnings gap has significantly narrowed, especially in high-income countries. However, the gap remains persistent, and the progress towards reducing the gap seems to have stalled. Parenthood is a commonly cited explanation behind the remaining gender earnings gap, and Goldin's research has inspired the proliferation of studies that analyze the effect of family policies on

[24] ILO modelled estimates in November 2023 for women aged 25 years and above.

female labor supply and earnings [Committee for the Prize in Economic Sciences in Memory of Alfred Nobel 2023]. For example, Albanesi et al. [2023] studied family policies in 24 countries and found little evidence on the benefits of longer parental leaves.[25] Instead, generous childcare support in terms of public provision or subsidies appears to encourage female labor force participation where subsidized childcare replaces maternal childcare.

On a related note, Goldin [2014] and Goldin and Katz [2016] have shown that parenthood does not have to result in diverging earnings between mothers and fathers. In occupations that do not heavily penalize temporal flexibility (i.e., less greedy), like pharmacy, women have high representation, and the gender earnings gap is small. Goldin [2021a] acknowledges that it would be difficult to make work more flexible and less greedy on a wider scale; but lowering the cost of childcare, say, through subsidized childcare, can at least make parental time less critical. Nonetheless, it should also be noted that the increase in age at first marriage and reduction in fertility have not always been associated with more women having careers. Goldin and Katz [2000] considered Japan as an example where there had been increased age at first marriage and reduced birth rate,[26] but these did not coincide with career changes among women. Looking at more recent data, Goldin [2024] also noted that the labor force participation of prime-age women in Japan already surpassed that of the US, but a large share of employed Japanese women still work fewer hours and are not in lifetime jobs that bring higher earnings and benefits. The Japan case thus demonstrates the importance of identifying the root causes behind low female engagement in career-oriented work.

Third, realizing the effects of policy, social, and other changes on female labor supply and earnings can take a long time. Human capital investments, especially those involving advanced education, require long-term commitment and are usually made by younger cohorts. Therefore, policies that encourage people to acquire more education would have a lagged effect on labor market outcomes. More importantly, as Goldin reiterated in several studies, changing career expectations are an important determinant of human capital decisions. In the US, for example, expectations of young women on whether they would be working at age 35 had changed over time as information about their future employment was updated and became more accurate for each succeeding cohort. Greater career expectations incentivized more young women to go to college, choose professional career programs, and eventually work in career-driven occupations that were previously dominated by men. These suggest two things that need to be considered when studying female labor market outcomes. For one, differentials

[25] The authors argued that longer parental leaves only delay the return of mothers to the labor market, which results in shorter work experience. Nonetheless, they did not find any consequences of longer maternal leaves on the careers of mothers.

[26] The authors added that the pill was made available in Japan only in 1999. They further argued that the pill is not a requirement for changing careers, but the pill is one mechanism which enabled women to better plan for their careers at an early stage.

in labor market outcomes, such as by cohort, can also be examined rather than just aggregate outcomes. For another, unlike that of men, women's decisions over their labor supply greatly vary over their life cycle.

4. Conclusion

For almost 50 years, collecting novel data, employing empirical methods, using historical context to situate economic and social issues faced by women, and grounding research on economic theory have been central to Goldin's work in understanding women's labor market outcomes; the process towards the convergence in gender-based market participation, career, and earnings; and the remaining sources of the gender gap. Owing to Goldin's expertise in economic history, her work is greatly rooted in history but clearly is still relevant in present times. As Goldin [2021b] said, "[k]nowing the barriers that stood in the way and came down makes us more aware of current impediments." Goldin also established the first unified framework in explaining the gender disparities in the labor market, centering around family, career, structure of work, and economic development. And although most of her studies do not make normative prescriptions, Goldin inspired many researchers to similarly collect historical data, explore alternative drivers of the gender gap aside from discrimination, and analyze the effect of parenthood on female labor market outcomes and diverging gender gaps between couples. Understanding the sources of the problem and pivotal factors for change—as what Goldin's research on women's work seeks to do—is crucial in forming policies and interventions that can properly address gender gaps and elevate the economic status of women.

Goldin's recent research is clearly geared towards gender and couple equality and argues that making work more flexible benefits both women and men. As Petrongolo [2024] aptly articulated, the pursuit of gender equality in economic opportunities is not necessarily a zero-sum game where one group's success is detrimental to that of the other. Breaking the remaining barriers to achieving gender equality in opportunities will lead to a more equitable and efficient society where the potential contribution of every individual is fully realized. Goldin's key role in paving the way for the economics of women and work to be recognized in mainstream economics cannot be understated.

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Book Review

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Jonna P. Estudillo, Yoko Kijima, and Tetsushi Sonobe, eds. *Agricultural development in Asia and Africa: essays in honor of Keijiro Otsuka*. 2023. Singapore: Springer Singapore.

1. Introduction

This compendium, spanning 27 chapters, traverses the diverse landscapes of Asia and Africa and journeys back to the inception of the Green Revolution in the 1960s. It delves into comparative research across specific contexts and forwards some of the most insightful and less obvious knowledge produced in development economics.

The editors and authors, all of whom have collaborated with Keijiro Otsuka, have collectively authored over four hundred papers. Professor Otsuka's collaborative research approach stands as a testament to his leadership and has enabled contributions to a broad spectrum of knowledge areas—not only concerning the Green Revolution and agriculture, but also state capacities, entrepreneurship, small- and medium-scale industries, and foreign investments.

The book addresses a variety of contexts requiring dedicated institutions to adapt technological innovations to become fit-for-purpose. It features the harvest of insights when longitudinal surveys are used. It illustrates work methods, including anecdotes of how Professor Otsuka transformed field observations into economic insights—sometimes by dinner, after a day's fieldwork—and developed them into hypotheses. For example: in the case of rice seeds and fertilizers from Southeast Asia that are known to also lead to high yields in Sub-Saharan Africa but have not been widely adopted there, Professor Otsuka fruitfully formulates his hypothesis that, perhaps, the key is in cultivation and water and soil management capabilities, and in the delivery systems for this know-how that work and do not [Otsuka and Muraoka 2017]. This hypothesis then is studied and tested repeatedly over many years, until it ascends to the status of wisdom in the scientific community.

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The chapters also highlight the strategies for data collection, including tedious soil sampling, for example, to account for unobserved variables, as well as the development of publications aimed at delivering policy-relevant recommendations. The book moreover showcases the thoughtful data gathering and cutting-edge econometric work that characterized these collaborations.

The book is divided into four parts: i) Green Revolution in Asia and Africa; ii) Land Tenure and Natural Resource Management; iii) Transformation of the Rural Economy; and iv) Emerging Issues in Agriculture.

This review probes the core themes of this extensive work, particularly resonating with the lessons from the first Green Revolution and their recent application in Africa. It examines chapters in Part I in-depth and selectively draws from the other sections.

The review highlights the gap between knowledge production and its practical application in African countries and notes that essential corrective programs remain underappreciated in countries like the Philippines, even decades after their own Green Revolution. It acknowledges that technological advancements, environmental challenges, and economic shifts necessitate a continuous reevaluation of strategies for agricultural modernization and rural development.

While this review concentrates on specific themes within the volume, it acknowledges the breadth of knowledge contributed by each chapter, including those not covered here.

2. Key chapters

In addition to the excellent introductory and concluding sections, Chapter 2 by Prabhu Pingali reprises lessons from the Asian Green Revolution. It also anticipates the challenges as Africa embarks on its own Green Revolution, and also as Asia must embark on a second wave of post-Green Revolution agricultural and rural development. This chapter collates empirical literature demonstrating the Green Revolution's significant impact on staple crop production in Asia and its role in averting a Malthusian food scarcity crisis. It also discusses the initial absorption of unemployed rural workers due to new varieties and technologies, which created more farm tasks for unskilled rural populations, raising wages and creating the impetus for non-farm livelihoods [Pingali 2023].

However, the research also indicates that rice monoculture in Asia displaced other crops critical for nutrition, and chemical fertilizers polluted soil and water resources. Incomes in areas without irrigation did not rise all that significantly unless the household members migrated to the lowland regions where modern agriculture was flourishing. Chapter 18 by Jonna Estudillo [2023] shows that in villages that she and Professor Otsuka tracked over time, non-farm incomes, rather than employment in Green Revolution farms, have provided the main pathways out of poverty for children of landless farmers.

Yasuyuki Sawada [2023] in Chapter 19 asks why the Philippines has so far failed to replicate the structural transformation seen in other Green Revolution countries in Asia, whereby workers shed by agriculture would find employment in manufacturing.

The book offers guidance on effectively disseminating and locally adapting Green Revolution technologies, but it also provides cautionary tales for the ongoing African Green Revolution.

3. Emerging concerns

The first-generation modern varieties were not resilient to weather extremes and have been susceptible to disease outbreaks as noted in Chapters 2, 3, and 4. The same challenge is no less of a concern when staples are replaced by higher-value crops catering to more diversified tastes and to demand from more distant markets. In Chapter 21, for example, Suzuki and Nam [2023] note that shrimp disease in Vietnamese farms often spreads to neighboring farms.

The longitudinal loop studies of Central Luzon covering 1961-2021 (Chapter 3) revealed that after the adoption of modern agriculture, factors such as factory and road construction and increased rainwater runoff from deforested upstream areas have exacerbated floods and affected yields. The still incomplete adoption of mechanization has led to stagnant and variable yields; this shows that rising nonfarm household incomes are not always able to adequately underwrite investments in farm mechanization [Kajisa et al. 2023].

In the post-Green Revolution period, Central Luzon faces challenges. Kajisa et al. [2023] in Chapter 3 discuss the crossroads at which post-Green Revolution agriculture finds itself, with the release of hybrid and genetically modified rice varieties resilient to submersion and pests. However, the adoption of such flood-resilient second-generation varieties in India is episodic as Yamano [2023] argues in Chapter 4, indicating a need for further investigation into the adoption patterns of flood-resilient varieties. The adoption of flood-resilient crop varieties tends to surge following instances of notably more destructive flooding.

In retrospect, and as a contribution to Africa, the chapters that focus on sub-Saharan Africa (Chapters 5, 6, 8, and 12) provide operational guidance on the most effective combinations or sequences of Green Revolution initiatives. Key empirical puzzles, such as the above-mentioned importance of agronomic or rice cultivation practices, the low uptake of credit and technology when irrigation is limited, or the low adoption of good varieties and fertilizer use when there are high fixed costs to acquiring these inputs due to geography and thin upstream suppliers become solid guides for recommendations.

The initial signs of an African Green Revolution are evident in Tanzania's rising rice imports, despite yield increases from 3.7 to 4.2 tons per hectare between 2009 and 2018. This paradox is attributed in Chapter 6 to population pressures

outpacing yield gains. The same chapter by Nakano and Magezi [2023] evaluates recent literature on the effectiveness of irrigation, credit, and training and extension services. The findings suggest that credit facilitates investments in machinery, seeds, and fertilizers, with the greatest uptake and marginal benefits occurring on already irrigated land and where training and extension services mitigate uncertainties and demonstrate the viability of new business models at the farm level. Training and, more importantly, the adoption of the correct cultivation and agronomic practices have been known to deliver a three-fold increase in productivity.

Beyond providing operational guidance from Asia and sharing examples on some of the necessary adaptations, these chapters on Africa also discuss the returns to various investments in land titling and tenure reforms to encourage investments in soil quality improvements and conservation in general. Building on Otsuka's suggestive study [Otsuka et al. 2015] and referencing Elinor Ostrom's work on common-pool resources, the chapter on forest management by Takahashi [2023] (Chapter 10) reveals that assigning individual responsibility for timber resources incentivizes intensive production, while community management of non-timber resources (such as mushrooms, animals, and wood fuel) is more effective when supported by programs that enable communities to develop collective sustainable management rules.

Research on crops, technologies, and methods for upland and rolling landscapes—which are the areas left behind by the lowland-focused Asian Green Revolution—remains limited. This is also the case in Africa. Pingali [2023], in Chapter 2, argues for increased scientific research on traditional and nutrition-rich crops (such as millets, sorghum, and cassava) to address both geographical inequalities and the nutritional deficits caused by a staple-focused Green Revolution. The contributors furtively inquire whether entities like local governments can rise to the challenge of managing the heterogeneous and often idiosyncratic character of these non-lowland ecosystems. This concern is particularly pertinent for Indonesia and the Philippines, where agricultural tasks have been devolved for over two decades. A recent development in the Philippines is a second round of financial resource devolution following a Supreme Court ruling [*Mandanas et al. v. Ochoa et al.* 2019], further detailed by central government instructions to implement devolution transition plans. Related to this, Muraoka [2023] in Chapter 12 tackles the prospects and constraints to creating the local institutional arrangements that would foster the adoption of integrated farm management practices for sustainability and adaptation and resilience to climate change.

Otsuka's collaborators describe the vigor of small, field-based scientific teams that anticipate sustainability and inclusivity challenges—issues that students of the Asian Green Revolution mainly recognized in hindsight. However, Chapter 10 by Takahashi [2023], which is about property rights and natural resource management, raises the well-known concern that sustainability and equity, unlike the rapid yield increases for staples, tragically remain distant goals, fraught with open access problems and with dispersed and uninfluential stakeholders.

One contentious phenomenon across countries like Ethiopia, Tanzania and Uganda that is not directly mentioned in the chapters, are the Large Scale Land Acquisitions (LSLAs) that were sometimes either preceded by low-cost tenure improvements or simply through government action that took possession of the lands with a view to conveying them to corporate investors, with little regard to prior informal rights. In the best scenario LSLAs would impose their own kind of clarity with regard to tenure security for those who might invest, especially foreigners who will supposedly bring in the seeds, the fertilizers and modern logistical arrangements (see for example D'Odorico et al. [2017]). But in the process, the program for supporting the productivity and for evolving the local institutional arrangements for smallholders and even pastoralists is set aside.

African grassroots movements anticipate that LSLAs will be corporate enclaves where standardized technologies will pre-empt the emergence of diverse agro-ecological adaptations. Perhaps the still limited state capacities in sub-Saharan Africa also make this panacea of inviting foreign investors attractive—creating institutions that can create, customize and disseminate adaptations of Asian Green Revolution technologies is after all a far more complex way to proceed.

It is certainly too much to ask for more chapters in this already substantive volume. Yet, below are three areas of curiosity that arose for this reviewer after reading the book.

First, converting knowledge into policy. Many of the scholars contributing to this volume are researchers first but they also cannot help but be policy advocates. But as Arsenio Balisacan, an eminent agricultural scholar and now a ranking government official in the Philippines (also a contributor to this volume on competition policies), once said to this reviewer, diagnostics are crucial, but implementing better practices at scale is always more challenging. Some of Otsuka's collaborators may have even joined the public sector, wielding some authority and experiencing both successes and failures in influencing top policy makers and practice at the frontlines. This adjacent, though maybe still tacit, body of knowledge could be as important as what one finds in this volume.

Second, using limited financial resources and limited institutional capabilities as the starting point, a substantive discussion structured after the manner perhaps of Hausmann and Rodrik's "binding constraints schema" [Hausmann et al. 2008] can already be stitched together from insights in this book. This analytical and expository approach recognizes that resources are limited and may be deployed sequentially; with some reforms being prerequisites for other reforms, whose later deployment can then happen with greater effectiveness. Perhaps one is induced to look for such implementation-focused schemas because of the great number of actions featured in the different chapters that can all plausibly drive significant technology adaptation and adoption.

Finally, since this is also a book about technology transfer as a means for countries to reach the frontiers of productivity, a little survey of the literature on

systems of innovation could be a nice way of helping the reader put these ongoing efforts in perspective, the better to steer focus towards new kinds of questions about technology transfer that the scientific community represented in this volume can also take on.

This volume is a testament to the professional approach and mentorship of Keijiro Otsuka, showcasing the empirical work of his students and collaborators across Asia, Africa, and international institutions. Their contributions underscore the exceptional productivity of Otsuka's problem-focused, empirical approach.

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