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Economic Complexity and Human Capital Development in the Philippines

Michael R. Cabalfin

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UP PRESIDENT
EDGARDO J. ANGARA
FELLOWSHIP

The **UP President Edgardo J. Angara (UPPEJA) Fellowship** is a grant for pioneering policy research. It aims to promote high-level policy discussions and research on a wide range of topics that address national development goals and imperatives, such as science and technology, economic development, environment and climate change, good governance, and communications.

The Fellowship was established by the University of the Philippines Board of Regents on September 29, 2008 in honor of the late Senator Edgardo J. Angara, who served as UP President from 1981 to 1987 and concurrent UP Diliman Chancellor from 1982 to 1983.

Angara, also a former Senate President, is known for his contributions to Philippine education, serving as the Chairperson of the First Congressional Commission on Education in 1990, which was credited with a number of pioneering reforms in the education sector, including its “trifocalization” and the Free Higher Education Act.

In addition to his notable contributions as a legislator, Angara’s leadership also gave rise to the **UP Center for Integrative and Development Studies (CIDS)**, which he initiated during his presidency.

Officially established on June 13, 1985, and originally called the University Center for Strategic and Development Studies (UCSDS), CIDS serves as a think tank that leverages the multidisciplinary expertise of UP to address the nation's most pressing challenges. The core objectives of CIDS encompass the development, organization, and management of research on national significance, the promotion of research and study among various university units and individual scholars, the securing of funding from both public and private sources, and the publication and wide dissemination of research outputs and recommendations.

For 2024, the Higher Education Research and Policy Reform Program (HERPRP) served as the UP PEJA Fellowship Awards secretariat in partnership with the Second Congressional Commission on Education (EDCOM II).

From the Executive Director of UP CIDS

It has been a long time in the making, but I am pleased to see the UP PEJA Fellowship finally coming to fruition. After all the forums, meetings, presentations, and threads of communication between and among the PEJA Fellows, UP CIDS' Higher Education Research and Policy Reform Program (HERPRP), and the Second Congressional Committee on Education (EDCOM 2), we now have a series of papers that tackle the various facets of Philippine higher education. The series includes the study you're reading.

For much of its history, the UP PEJA Fellowship has been housed in and implemented through the Center for Integrative and Development Studies (CIDS), the University of the Philippines' policy research unit. Over the years, the Fellowship has funded and published the studies of policy scholars, many of them luminaries in their respective fields.

In 2023, after a few years' hiatus, not least because of the COVID-19 pandemic, the UP PEJA Fellowship resumed and began looking for a new set of Fellows. This time, however, UP CIDS, through its Higher Education Research program, embarked on a historic partnership with the Second Congressional Committee on Education (EDCOM 2).

Linking directly with the government in administering the UP PEJA Fellowship was a first for UP CIDS. And that this was a partnership with a national-level policy-making body made it even more special.

As I have always maintained, this type of linkage is exactly what UP CIDS, as a policy research unit, must do: embedding research within a framework of stakeholder engagement.

Guided by the policy objectives of EDCOM 2, the PEJA papers not only tackle the complex issues in education, but also show stakeholders – the state, civil society, and the teachers themselves – how we can tackle them. For all our efforts in improving education in the Philippines, what else can and should we do?

Many thanks to the PEJA fellows for their valuable contribution, and to the UP CIDS Higher Education Research Program for shepherding this important undertaking. With collaboration, great things do happen.

Rosalie A. Hall, PhD
Executive Director
UP Center for Integrative and Development Studies

From the Convenor of UP CIDS-HERPRP

We at the Higher Education Research and Policy Reform Program serve as a convening body that builds partnerships and networks that pursue a shared research agenda and build an evidence basis for policy. Our activities include fellowships for scholars who publish with us and consultancies for junior researchers who wish to begin a career in higher education studies. We maintain databases, conduct events, and publish various manuscripts on higher education.

For 2024, our full attention was devoted to the UP PEJA Fellowship Program, serving as a secretariat for the researchers who studied higher education as it intersected with government and finance, industry and agriculture, regulation and tuition and technical and vocational education, training and lifelong learning, the UP PEJA Program awards grants for pioneering work on a wide range of topics that address national development concerns. This was the very first time that the program focused on a singular topic. This demonstrates the commitment of the University of the Philippines to higher education.

With the support of the UP Foundation, we have assembled what we have been calling the *Avengers* of Philippine education. They are preeminent scholars whose findings and recommendations directly address key policy concerns. Their papers at once draw from empirical data as well as their professional expertise for which they have been identified as a UP PEJA fellow.

Fernando dlC. Paragas, PhD
Convenor
Higher Education Research and Policy Program
UP Center for Integrative and Development Studies

Letter from the Executive Director of EDCOM II

The **Second Congressional Commission on Education (EDCOM II)** is collaborating with scholars across various institutions to provide valuable insights for the development of evidence-based policies that address the unique challenges and opportunities in the Philippine education landscape.

Our commitment to excellence, integrity, and ethical conduct in advancing research and disseminating knowledge, which we share with our research partners, is defined by the following principles:

The Commission is dedicated to upholding the highest standards of academic rigor in the evaluation, review, and dissemination of research publications. Our pledge is to ensure the integrity and quality of the knowledge we contribute to the scholarly community.

The Commission is committed to fostering transparency and data integrity in all aspects of research. This includes transparent communication, disclosure of methodologies and data sources, and providing clear guidelines to authors, reviewers, and the broader academic community.

The Commission promotes ethical research conduct, emphasizing the responsible and respectful treatment of research participants.

The Commission places a strong emphasis on accessibility. We are committed to facilitating the translation of research findings into accessible formats in order to engage the broader public, taking into account ethical and legal considerations. Our goal is to promote public understanding and awareness of scientific advancements.

In adherence to these principles, the members of the Second Congressional Commission on Education (EDCOM II) pledge to be stewards of good scholarly research for a better, more inclusive educational system for the Filipino people.

Karol Mark R. Yee, PhD
EDCOM II Executive Director

Declaration of Funding

This research was conducted in collaboration with the Second Congressional Commission (EDCOM II).

The funding source played no role in the design of the study, data interpretation, or decision to publish the findings as the author(s) maintained complete autonomy in the research process, ensuring objectivity and impartiality in the presentation of results.

Declaration of Interest

None

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Economic Complexity and Human Capital Development in the Philippines

Michael R. Cabalfin[1]

Introduction

In 2021, the Philippines ranked 33rd out of 133 countries in terms of Economic Complexity (Growth Lab, n.d.). However, it fell to 37th place in the latest (2022) ranking (OEC, n.d.). Economic complexity measures the available know-how in a country based on the goods it produces (Hidalgo & Hausmann, 2009; Growth Lab, n.d.). It depends on the diversity of products it exports and their ubiquity or the number of countries producing them. Countries that produce a wider variety of and more unique goods are considered more complex.

The overall objective of the study is to analyze the economic complexity of Philippine exports and determine the effect of human capital on economic complexity. To achieve this, the study will:

1. Analyze the values of the country's key exports and their product complexity
2. Analyze the growth of key exports, their shares to economic output, and their contribution to economic growth
3. Analyze domestic production of key export products

1 Michael Cabalfin, Fellow, University of the Philippines President Edgardo J. Angara

4. Analyze employment in key production sectors
5. Analyze human capital endowment in key production sectors.

The study concludes with some recommendations regarding the further promotion of Philippine exports.

Model, Methodology, and Data

We analyze key exports and outputs in terms of their growth rates, shares to total exports (or outputs), and their shares to the growth of total exports and the overall output. For this purpose, we use the growth accounting framework (Solow, 1957), simplified in the following equation:

$$\frac{dY}{Y} = \sum_{i=1}^{n} \left(\frac{X_i}{Y} \frac{dX_i}{X_i} \right)$$

where Y is total exports (or output) and X_i is a component export (or output). X_i/Y is the share of X_i to total exports (or output) and dX_i/X_i is the growth rate of X_i. Their product, $X_i/Y \; dX_i/X_i$, is the share of X_i to the growth of total exports (or output). Therefore, the growth of total exports (or output), dY/Y, is just the sum of the growth shares of the various components X_i. To implement this model, we derive the growth rates, shares, and growth shares of various exports and outputs and estimate the averages using ordinary least squares, accounting for structural breaks. Estimates of growth shares may not exactly correspond to the product of the estimated growth rates and shares as the estimates are period averages and the different series may have different structural breaks.

Data on the product complexity index and export values (in current United States Dollars (USD) are from The Growth Lab at Harvard University (2019). Data on gross domestic product/total value added are from the United Nations Statistics Division (2023). Employment and worker education data are from the International Labour Organization (2020). Data on enrollment in higher education and assessment and certification in technical and vocational education and training are from the Philippine Statistics Authority (2023) and the Technical Education and Skills Development Authority.

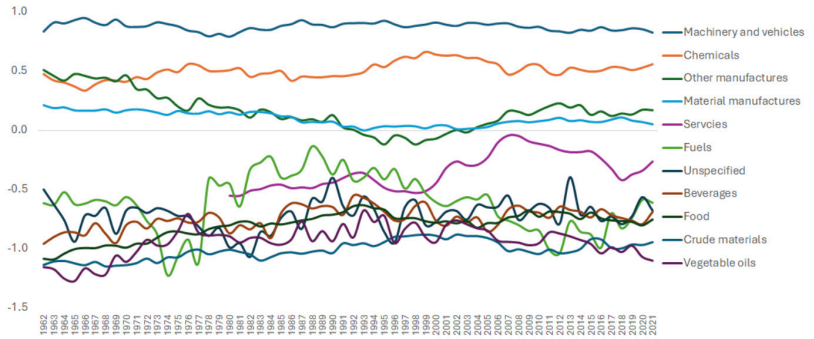
Discussion

Exports and Product Complexity

In this section, we analyze the key exports of the Philippines in terms of the value of exports and the product complexity index.

Figure 1 shows the product complexity indexes for Philippine exports from 1962 to 2021. Among the products exported by the Philippines, machinery and vehicles are the most complex, with an average product complexity index of 0.82 in 2021. This is followed by chemicals with an average product complexity index of 0.56, other manufactures (0.17), and material manufactures (0.05). The rest of the products exported by the Philippines have negative average product complexity indexes.

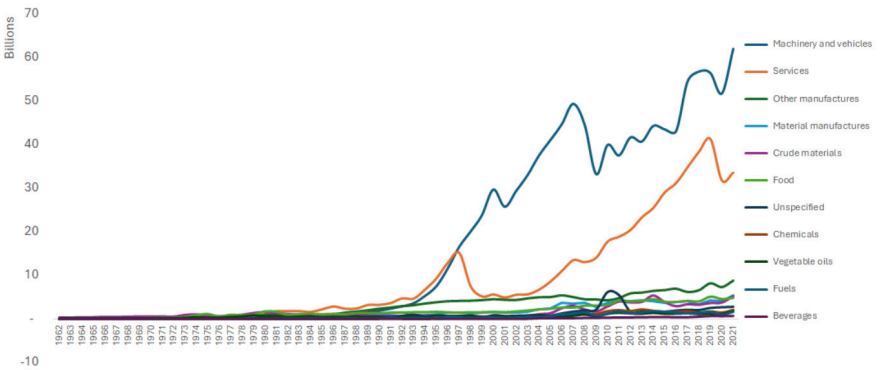
FIGURE 1. EXPORTS PRODUCT COMPLEXITY INDEX (1962-2021)



Source: The Growth Lab at Harvard University (2019)

Figure 2 shows the values of Philippines exports by major groupings from 1962 to 2021. Philippine exports are dominated by two main products: machinery and vehicles and services. Machinery and vehicles made up 48 percent of the total value of exports in 2021, while services accounted for 26 percent. However, while machinery and vehicles are complex products, services are not very complex. Machinery and vehicles had an average product complexity index (PCI) of 0.82 in 2021, while services had an average PCI of only -0.26.

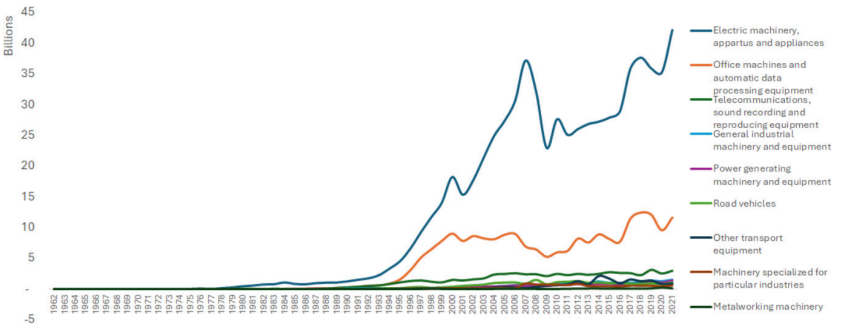
FIGURE 2. EXPORT VALUES OF PHILIPPINE EXPORTS BY MAJOR GROUPINGS (USD) (1962 – 2021)



Source: The Growth Lab at Harvard University (2019)

Among the machinery and vehicle exports, electric machinery, apparatus, and appliances had the biggest share at 68 percent in 2021, followed by office machines and automatic data processing equipment at 19 percent, and telecommunications, sound recording, and reproducing equipment at five percent (Figure 3). The rest of the components each had around 2 percent share or less.

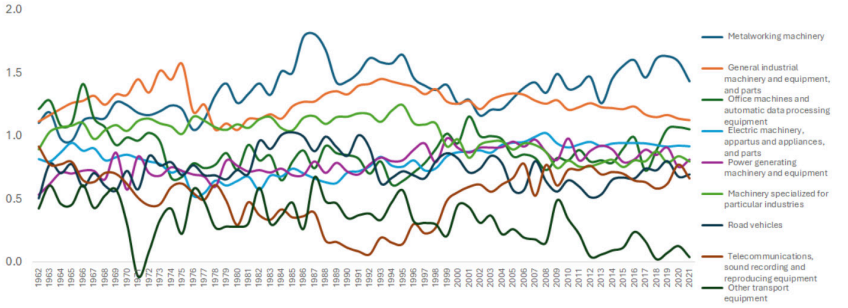
FIGURE 3. EXPORT VALUES (USD) - MACHINERY AND VEHICLES (1962-2021)



Source: The Growth Lab at Harvard University (2019)

Among the machinery and vehicles exports of the country, those with the highest PCI are metalworking machinery (1.43) and general industrial machinery and equipment (1.13) (Figure 4). However, their shares in the section's exports are only 0.2 percent and 2.3 percent, respectively. If we want to improve the product complexity and increase the value of our exports, exports of these products should be promoted. Notwithstanding their huge export share, electric machinery, apparatus, and appliances only rank fourth among machinery and vehicle exports in terms of product complexity index, averaging only 0.92 in 2021. Office machines and automatic data processing equipment had a somewhat higher product complexity index of 1.05, while telecommunications, sound recording, and reproducing equipment had a PCI of 0.66.

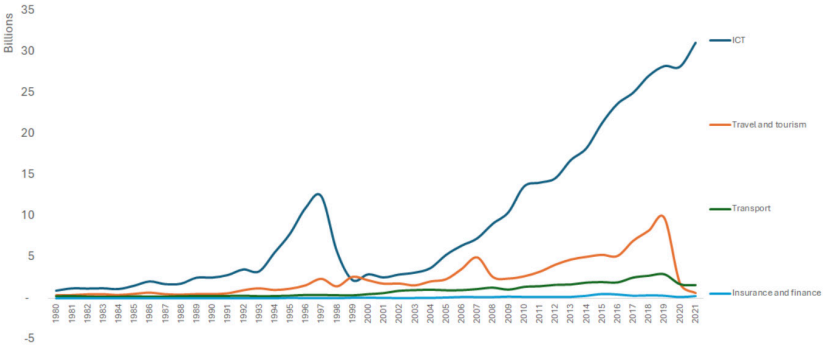
FIGURE 4. PRODUCT COMPLEXITY INDEX - MACHINERY AND VEHICLES (1962-2021)



Source: The Growth Lab at Harvard University (2019)

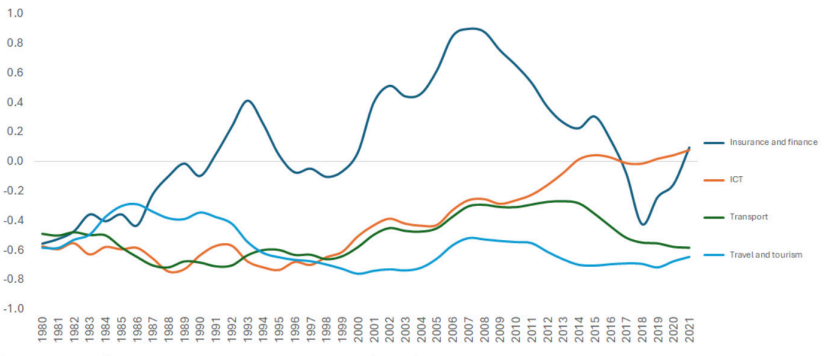
Among service exports, Information and Communication Technology (ICT) has the largest share at 93 percent in 2021 (Figure 5). Travel and tourism had a 24 percent share in 2019 but decreased during the pandemic to six percent in 2020 and two percent in 2021. However, services generally have low product complexity indexes, averaging only -0.26. Among services, Insurance and finance have the highest PCI (0.10), followed by ICT (0.08) (Figure 6). Transport and Travel and tourism both have negative PCIs at -0.58 and -0.64, respectively.

FIGURE 5. EXPORT VALUES (USD) - SERVICES (1980-2021)



Source: The Growth Lab at Harvard University (2019)

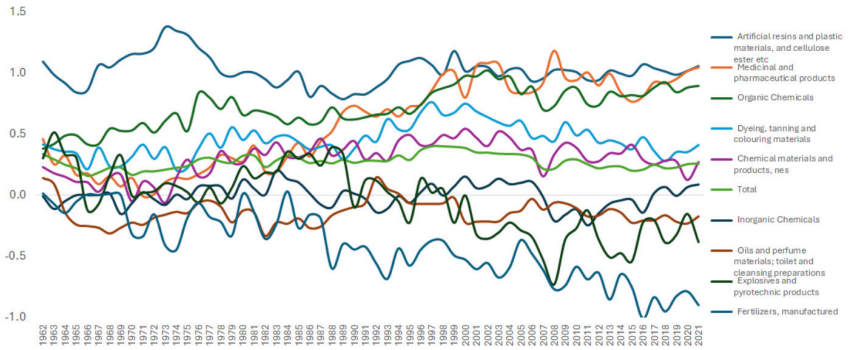
FIGURE 6. PRODUCT COMPLEXITY INDEX - SERVICES (1980-2021)



Source: The Growth Lab at Harvard University (2019)

Chemicals have the second-highest average PCI at 0.56. Among chemical exports, Artificial resins and plastic materials, and cellulose ester had the highest product complexity index (1.06), followed by medicinal and pharmaceutical products (1.05) and organic chemicals (0.90) (Figure 7).

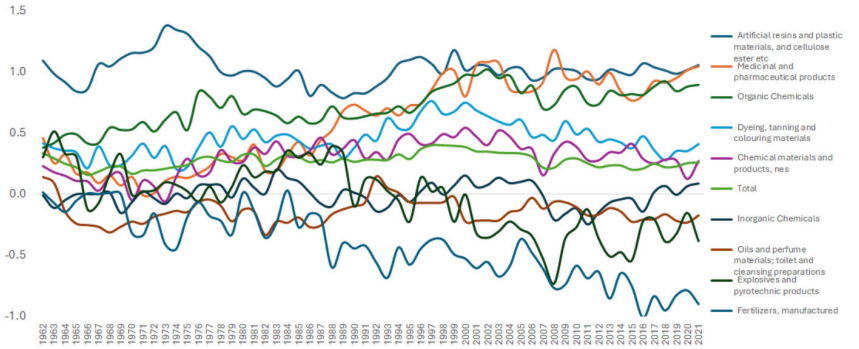
FIGURE 7. PRODUCT COMPLEXITY INDEX - CHEMICALS (1962-2021)



Source: The Growth Lab at Harvard University (2019)

Notwithstanding their high product complexity, chemicals have less than two percent share to total exports in 2021. Among chemicals exported, organic chemicals have the largest share (36 percent), followed by artificial resins and plastic materials, and cellulose ester, etc. (23 percent), chemical materials and products (12 percent), and oils and perfume materials; toilet and cleansing preparations (9 percent). To improve the product complexity of our exports and improve the economic complexity and economic growth of the country, it is worth promoting our chemical product exports, such as artificial resins and plastic materials, and cellulose ester, medicinal and pharmaceutical products, and organic chemicals.

FIGURE 8. EXPORT VALUES (USD) - CHEMICALS (1962-2021)



Source: The Growth Lab at Harvard University (2019)

Export Growth

Economic growth is related to economic complexity. Hidalgo & Hausmann (2009) found that their measures of economic complexity predict economic growth well, controlling for country characteristics.

The importance of exports to economic growth in the Philippines has increased over time.[2] The share of the growth of exports to overall economic growth has increased from an average of 17 percent in 1971-1996 to 63 percent in 2000-2021. The importance of exports is due to its robust growth and significant share in output. Exports have grown by an average of 10.7 percent per year from USD 602 Million in 1970 to USD 128.6 Billion in 2021. On the other hand, while gross domestic product grew by an average of 17.4 percent in 1971-1980, it grew slower than exports at 6.3 percent in 1981-2021. Moreover, the share of exports to GDP has increased from an average of 16 percent in 1970-1983 to 50 percent in 1997-2007, although it decreased to 34 percent in 2008-2021.

Merchandise comprise the bulk of exports, accounting for 86 percent of total exports in 1998-2008, although its share declined to 70 percent in 2015-2021. The value of merchandise exports continued to increase, growing by an average of 7.5 percent per year between 1981 and 2021. The share of merchandise exports to the growth of exports declined from 77 percent in 1986-2014 to 40 percent in 2016-2021.

Machinery and Transport Equipment

Of the merchandise exports, the share of machinery and transport equipment has increased over time and now constitutes the largest component. From an average of 17 percent in 1980-1988, the share of machinery and transport equipment rose to 68 percent in 1996-2021. This increase is due to the robust growth in the value of machinery and transport equipment exports, rising by an average of 13 percent per year between 1981 and 2021, higher than the growth rate for total merchandise exports. In 2013-2021, the contribution of machinery and transport equipment exports to the growth in merchandise exports was 28 percent. However, this is lower than its 52 percent share from 1982 to 2011.

Of machinery and transport equipment exports, the share of electric machinery, apparatus, and appliances is the highest, rising from an average of 2 percent in 1962-1970 to an average of 69 percent in 1978-2021, as its growth averaged 16 percent between 1979 and 2021. Between 1990 and 2011, electric machinery, apparatus, and appliances contributed an average of 74 percent to the growth of machinery and transport equipment exports. However, its share has fluctuated much thereafter.

2 Normally, growth rates should be estimated on real values. However, since the export data in the economic complexity dataset are in current US Dollars, growth rates are estimated on nominal values.

Since 1994, office machines and automatic data processing equipment had the second largest share of machinery and transport equipment exports, rising from 20 percent in 1990-1997 to 28 percent in 1998-2005 but decreasing to 18 percent in 2006-2021. Office machines and automatic data processing equipment exports grew by 29 percent between 1973 and 2021. The share of office machines and automatic data processing equipment exports to the growth of machinery and transport equipment exports rose from 2 percent in 1963-1985 to 25 percent in 1987-2002 to 62 percent in 2012-2021.

Services

The share of services to total exports grew from an average of 27 percent in 1980-1991 to 34 percent in 1992-1997 but fell to 14 percent in 1998-2008. It has since risen to 24 percent in 2009-2014 and 30 percent in 2015-2021. The value of service exports grew by an average of 9.9 percent per year since 1981. The share of service exports to export growth increased from 23 percent in 1986-2014 to 60 percent in 2016-2021. While the share of services to total exports is lower than that for goods exports, its share to export growth is much higher given its higher growth rate.

The share of ICT to service exports rose from 64 percent in 1980 to 85 percent in 1996 before crashing to 43 percent in 1999. However, it has since risen and reached 93 percent in 2021. The rise in its share is due to the fast growth in ICT exports, averaging 12.1 percent between 1981 and 2021, faster than the growth of total service exports. Consequently, the share of ICT to the growth of service exports averaged 86 percent over the same period.

Chemicals

The share of chemicals to merchandise exports increased from 2 percent in 1980 -1984 to 3.6 percent in 1985-1992 but decreased to 1.4 percent in 1993-2007. It has since risen, averaging 2.4 percent in 2008-2021. Notwithstanding its small share, the value of chemical exports has risen considerably, growing by an average of 18 percent per year since 1963. Consequently, its share to the growth of merchandise exports (10 percent in 2013-2021) is higher than its share to the value of merchandise exports.

Output Growth

Exports rely on a strong production base, particularly in manufacturing. In this section, we assess the share of manufacturing to total production and economic growth.

For most of the country's economic history, national output has been continuously increasing. However, economic growth has been punctuated by several shocks.

Between 1970 and 2022, the total value added grew from USD 51 Billion to USD 408 Billion. Total value added grew by an average of 5.2 percent in 1971-1983, but this period culminated in a political crisis. While recovering from the crisis, economic growth was more subdued, averaging only 2.4 percent in 1984-2002. However, economic reforms during this period allowed for higher growth in subsequent periods. In 2009-2019, economic growth averaged 5.9 percent. However, this growth momentum was disrupted by the pandemic, with growth averaging 1.3 percent in 2020-2022.

The share of manufacturing to total value added decreased from an average of 25 percent in 1970-1980 to 22 percent in 1981-2008 and further to 20 percent in 2009-2022. Nevertheless, the average growth rate of the gross value added in manufacturing remained relatively constant at 3.7 percent since 1970. The contribution of manufacturing to overall economic growth rose from an average of 18.4 percent in 1971-1990 to 23.3 percent in 1993-2008 but declined to 18.9 percent in 2010-2022. The share of machinery and transport equipment to gross value added in manufacturing increased from an average of 4.4 percent in 1974 -1995 to 23 percent in 1996 -2005 to 31 percent in 2006-2022 (World Bank, 2024).

Services grew faster than manufacturing. Gross value added in services grew by an average of 5.1 percent in 1971-1983, somewhat slumped to 3 percent in 1984-1999, but surged to 6.6 percent in 2001-2019. Consequently, the share of services to gross value added increased from 25 percent in 1970-1984 to 33 percent in 2016-2022. The contribution of services to economic growth rose from 31 percent in 2001-2008 to 36 percent in 2010-2022.

Employment and Productivity

Employment in manufacturing grew by an average of 3.1 percent per year from USD 1 Million in 1977 to USD 2.96 Million in 2022. However, the share of manufacturing employment to total employment decreased from 17 percent in 1992 to 10 percent in 2022. Nevertheless, the share of manufacturing employment to the growth of total employment rose from less than 1 percent in 1992-2016 to 7 percent in 2018-2022.

Labor productivity in manufacturing increased from an average of USD 14,755 in 1984-2011 to USD 23,663 in 2012-2017 and to USD 26,446 in 2018-2022. Labor productivity in manufacturing is higher than average labor productivity for the entire economy by 40 percent in 1991-1999 and by 80 percent in 2000-2022. Only in mining and utilities is labor productivity higher than that for manufacturing. However, labor earnings averaged only USD 2,895 in 2012 and USD 3,285 in 2019-2022. Between 2012 and 2022, labor productivity to wage ratio averaged 8.2.

Human Capital Development

Most workers in the manufacturing sector are low-skilled. Only 17 percent of workers completed tertiary education, with 76 percent having completed only secondary education or lower, while 6 percent have technical and vocational education and training (TVET). Workers in the manufacturing sector have a little more education than those in the industry sector in general, where only 13 percent completed tertiary education, 83 percent completed secondary education or lower, and 4 percent have TVET.

On the other hand, workers in the services sector have more education compared to workers in the manufacturing and industry sectors. Almost a third of workers in the services sector (32%) completed tertiary education, while five percent have TVET, and 63 percent completed secondary education or lower. Among service sector workers, 44 percent of those in Public Administration, Community, Social, and other Services and Activities have tertiary education, 4 percent have TVET, and 52 percent completed secondary education or lower. Of those in Trade, Transportation, Accommodation and Food, and Business and Administrative Services, 27 percent have tertiary education, 5 percent have TVET, and 68 percent completed secondary education or lower.

In technical and vocational education and training, machinery and equipment-related courses[3] constitute 33.8 percent of enrolment, 34.9 percent of graduates, 31.6 percent of graduates assessed, and 31.3 percent of graduates certified. Among machinery and equipment-related courses, metals and engineering constitute 34.4% of enrolment, 36.3% of graduates, 27.2% of graduates assessed, and 27.9% of graduates certified. While there is high enrolment and an even higher proportion of graduates in metals and engineering, the proportion of graduates assessed and certified is lower. There is a need to ensure trainees not only complete their courses but also obtain certification.

The majority (91%) of trainees in metals and engineering undertook Shielded Metal Arc Welding (SMAW). Other metals and engineering courses should be promoted, including finer welding techniques such as Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), and Flux Cored Arc Welding (FCAW), as well as Machining and CNC Lathe Machine Operation. Most of the enrollees in finer welding techniques took NC II, indicating a lower intake at the NC I level in recent years. The advantages of these welding techniques and other advanced engineering courses should be promoted, as well as enrolment in metal and engineering courses at NC III level and higher.

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3 Automotive and Land Transportation, Electrical and Electronics, Heating, Ventilation, Airconditioning and Refrigeration, and Metals and Engineering

TABLE 1. PROPORTION OF ENROLLED, GRADUATES, ASSESSED AND CERTIFIED IN SELECT TESDA QUALIFICATIONS (2020-2023)

SECTOR OF QUALIFICATION	PROPORTION OF TOTAL (%)			
	Enrolled	Graduate	Assessed	Certified
Automotive and Land Transportation	11.7	11.5	11.0	11.1
Electrical and Electronics	10.1	10.3	11.4	11.0
Heating, Ventilation, Airconditioning and Refrigeration	0.4	0.4	0.5	0.5
Metals and Engineering	11.6	12.6	8.6	8.7
Chemicals / Plastics / Petrochemicals	-	-	0	0
Information and Communication Technology	4.9	5.1	0.5	0.4
Tourism (Hotel and Restaurant)	22.2	21.2	23.5	24.0

There is no data on enrolment and graduation for students in the Chemicals / Plastics / Petrochemicals sector, with the proportions of assessed and certified at zero. There is a need to consider the promotion of chemical engineering courses at the TVET level, apart from higher education. The proportion of both enrollees and graduates in ICT were both around 5 percent, higher than the proportion of employment in ICT in 2023. However, the proportion of those assessed and certified are lower at 0.5 percent and 0.4 percent respectively, with an assessment rate of 18 percent of graduates and a certification rate of 13 percent. There is a need to improve accountability among trainees in ICT courses to ensure certification. Most of the enrolment in ICT courses (85%) is in Contact Center Services. There is a need to promote enrolment in more advanced ICT courses such as programming, web development, and visual graphic design.

The highest proportion of enrollees, graduates, assessed, and certified are from the Tourism sector despite its low economic complexity/value added. Apart from low returns to tourism, it has high negative social costs, including congestion and environmental degradation. It's about time the government reconsiders its over-promotion of tourism in favor of higher value industries.

In higher education, enrollment in engineering and technology grew by an average of 8.9 percent per year in 2013-2016, decreased by 15 percent per year in 2017-2018 due to the K-to-12 transition, and grew by 7.3 percent per year in 2019-2021. The share of enrollment in engineering and technology to total higher education enrollment increased from 12.1 percent in 2012 to 13.2 in 2019. However, this share decreased in 2020-2021, presumably due to the pandemic. The share of enrollment in engineering and technology to the growth

of total higher education enrollment increased from seven percent in 2014 to 18.4 percent in 2016. It decreased to 13 percent in 2017-2018 during the K-to-12 transition period but surged to 23.2 percent in 2019. However, it again decreased during the pandemic to a low of 6.3 percent in 2021. Enrollment in engineering and technology should be increased to help increase employment and productivity in manufacturing and promote merchandise exports, especially of machinery and transport equipment.

The proportion of higher education enrolment in natural sciences (including chemistry) is very small, remaining at only 1 percent from academic years 2011-12 and 2020-21. Enrolment in chemistry must be promoted to increase employment, production, and exports of chemicals, which are complex, high-value goods. ICT enrolments are low. Only nine percent of those in higher education are enrolled in information technology. More advanced ICT such as programming, web development, and visual graphic design should be promoted.

Conclusion

Philippine exports are dominated by two main products: machinery and vehicles, and services. However, while machinery and vehicles are complex products, services are not. Among the machinery and vehicle exports, electric machinery, apparatus, and appliances had the biggest share as they showed remarkable growth for decades. Notwithstanding their smaller share, office machines and automatic data processing equipment have grown even faster, contributing the most to the growth of machinery and vehicle exports in recent years. While both types of machinery are more complex than the average machinery and vehicle exports, other machinery, such as metalworking machinery and general industrial machinery and equipment are even more complex— production and exports of which should be promoted further. The share of machinery and transport equipment to manufacturing output has increased despite the decline of the share of manufacturing to total output and economic growth over time, which remain relatively high.

ICT has the largest share of service exports. Insurance and finance services are more complex and should be promoted further. Chemicals have a small share to total exports, but they are the second most complex exports, which also warrants further promotion, especially those of artificial resins and plastic materials and cellulose ester, medicinal and pharmaceutical products, and organic chemicals.

In terms of output, manufacturing had stable growth, but its shares to total production and economic growth have declined over time. Services output has grown faster in the two decades before the pandemic, as well as its shares to total output and economic growth. Employment in manufacturing has also grown steadily, but its share to total employment

has declined, and its share to employment growth has been low. Nevertheless, labor productivity in manufacturing has been increasing and is higher than in most sectors, except mining and utilities. However, only a small proportion of this productivity accrues to labor as wages.

Labor productivity in manufacturing is higher than in most sectors despite its relatively lower human capital endowment. This suggests that returns to education are higher in manufacturing, although this is likely to be downward-biased due to the disparity between productivity and wages. It also suggests that a lower level of education is not necessarily a handicap for increased productivity. Certain manufacturing and machinery jobs may only require a minimum of secondary education. However, skills upgrading should enhance productivity and welfare. This may not require higher education, as technical and vocational education and training may suffice.

Machinery and equipment-related skills training comprise a third of TVET enrolments. In higher education, one in eight students are enrolled in engineering and technology. This proportion is lower than the share of manufacturing employment.

Policy Recommendations

- Metalworking machinery and general industrial machinery and equipment are complex exports. Their production and exports should be promoted further.
- Insurance and finance services are complex service exports and should be promoted further.
- Chemicals, especially those of artificial resins and plastic materials and cellulose ester, medicinal and pharmaceutical products, and organic chemicals, should be promoted.
- Learning opportunities in Science, Technology, Engineering, and Mathematics (STEM) should be promoted from basic education to TVET and higher education.
- In TVET, Machinery and Equipment-related courses, including Automotive and Land Transportation, Electrical and Electronics, Heating, Ventilation, Airconditioning and Refrigeration, and Metals and Engineering, should be promoted. Finer or higher value welding techniques such as Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), and Flux Cored Arc Welding (FCAW), as well as courses in Machining and CNC Lathe Machine Operation should also be promoted. The promotion of TVET-level chemical engineering courses should also be considered.

- The government should make a paradigm shift from promoting low-value tourism services to promoting higher value services and courses. There should be a shift in promotion from ICT Contact Center Services to more advanced ICT courses such as programming, web development, and visual graphic design. Similarly, Engineering and Technology, Finance, and Chemistry should be promoted in higher education.

Biographical note

Michael Reyes Cabalfin is currently a Research Fellow and Lecturer at the Australian National University. Prior to joining ANU, he held various appointments with the academe and government, as Supervising Research Specialist at the Philippine Institute for Development Studies, Assistant Professor in Economics at the University of the Philippines, Senior Economist at the Ateneo School of Government, and most recently as Economist V at the Philippine Department of Finance. He has consulted for various national and international organizations including as Principal Investigator for the Philippine Institute for Development Studies, as National Consultant for the Philippine Competition Commission, as Technical Assistant for the World Bank, as Consultant for Education Research and Data Analysis for UNICEF, and as Senior Labor Economist / Econometrician for the Asian Development Bank. He obtained his bachelor's and master's degrees in economics from the University of the Philippines and his PhD in Economics from the Australian National University.

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