HARVARD Kennedy School
JOHN F. KENNEDY SCHOOL OF GOVERNMENT

Industrial Upgrading Adaptiveness in Vietnam:

An Ecosystem for Further Industrialization

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Acknowledgement

When I visited Southeast Asia in 2010, I was amazed to see how the industrial activities have created jobs, increased wages, and improved the living standards of people. However, a continuous upgrading of industrial activities is critical for sustainable growth. Otherwise, a country is trapped in the middle of its growth journey. This motivated me to uncover the industrial upgrading situation and its potential in Vietnam, one of the strongest growth engines in the ASEAN, and identify the determinants of industrial upgrading.

This paper would not have been possible without the support of many people. First, I would like to thank Professor David Dapice and Ms. Hien Le from the Vietnam Program in the Ash Center for Democratic Governance and Innovations. Their valuable insights on local contexts and continuous encouragements have enabled me to overcome numerous challenges. Second, I would like to thank Professor Jie Bai for providing me with inspirational feedback and countless office hours. Third, I would like to thank Professor Celestin Monga for his support throughout the research and writing process. While there are too many to name, I would like to appreciate Professor Nguyen Xuan Thanh from Fulbright University Vietnam, former colleagues in Japan International Cooperation Agency, and everyone in Vietnam whom I interacted during this research for their thoughtful comments.

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Executive Summary

Vietnam has experienced a robust economic growth in the last four decades. Yet, Vietnam is still in the midst of the development journey. There remain several policy areas that potentially place Vietnam in a risk of losing its growth momentum and falling into the middle-income trap. Low labor productivity in the manufacturing sector is a crucial challenge. Thus, **promoting industrial upgrading activities to improve labor productivity is a critical policy agenda item for Vietnam to sustain its growth.**

Here, industrial upgrading is classified into four types: *(1) production innovation, (2) technology adoption, (3) quality control, and (4) process innovation*. **In Vietnam, the second type, technology adoption, which is mainly installing new machinery was the most adapted type** of industrial upgrading activity among manufacturing firms. Yet, the industrial upgrading adaptiveness (IUA) which comprehensively measures industrial upgrading situation revealed **a low level of industrial upgrading in Vietnam manufacturing sector**.

There are four key sub-systems within the ecosystem where industrial upgrading is active: *(1) market sub-system, (2) government sub-system, (3) education sub-system, and (4) labor market sub-system.* The empirical analysis revealed that **the following three channels within the four sub-systems trigger industrial upgrading: *(1) output side* such as consumer preference, *(2) input side* such as foreign origin inputs, and *(3) firm capabilities* such as learning culture of the firm.**

The paper proposes policies that improve the structure and functioning of the industrial upgrading ecosystem. The policy package focuses on **fostering the interaction among key stakeholders in sub-systems** to build and facilitate the three channels for industrial upgrading.

Unfortunately, the analysis in the paper has several limitations due to the various circumstances and data limitations. However, the paper still provides valuable insights on industrial upgrading policy and hopes to be a building block for future research.

I. Vietnam Economy

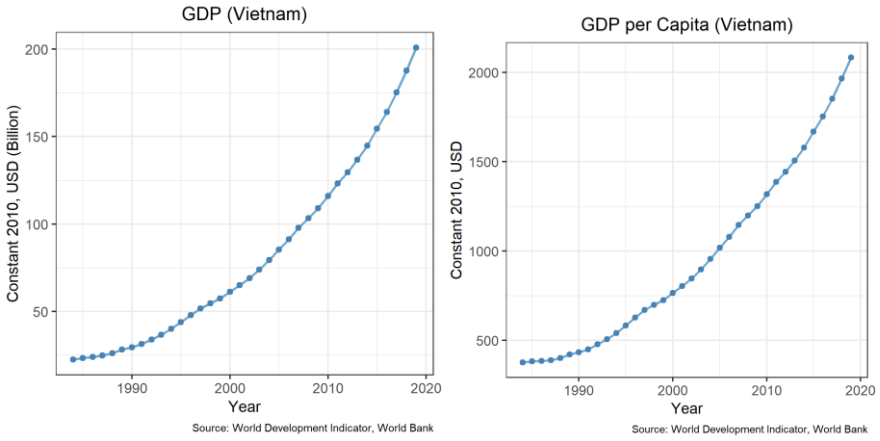
KEY POINTS:

- *Since the mid-1980s, Vietnam has successfully grown its economy and reduced poverty. Its development story is regarded as one of the successful cases in the world.*
- *However, the development journey of Vietnam is incomplete. Vietnam needs to overcome various risks to secure a path to sustain its development. Especially, the improvement of labor productivity in the manufacturing sector is a key policy challenge.*

I – I. Successful Development Trajectory

1. Vietnam has been one of the successful economic development stories in the world. The country has more than quadrupled its absolute GDP and GDP per capita in the last four decades (Figure 1). Vietnam's economy remained robust even in both Asian Financial Crisis in 1997 and Global Financial Crises in 2009 and even grew in 2020 under the global COVID-19 pandemic. Both the GDP and GDP per capita did not decline during these historical global incidents. In 2009, the World Bank updated Vietnam to a lower-middle-income economy from a low-income economy.

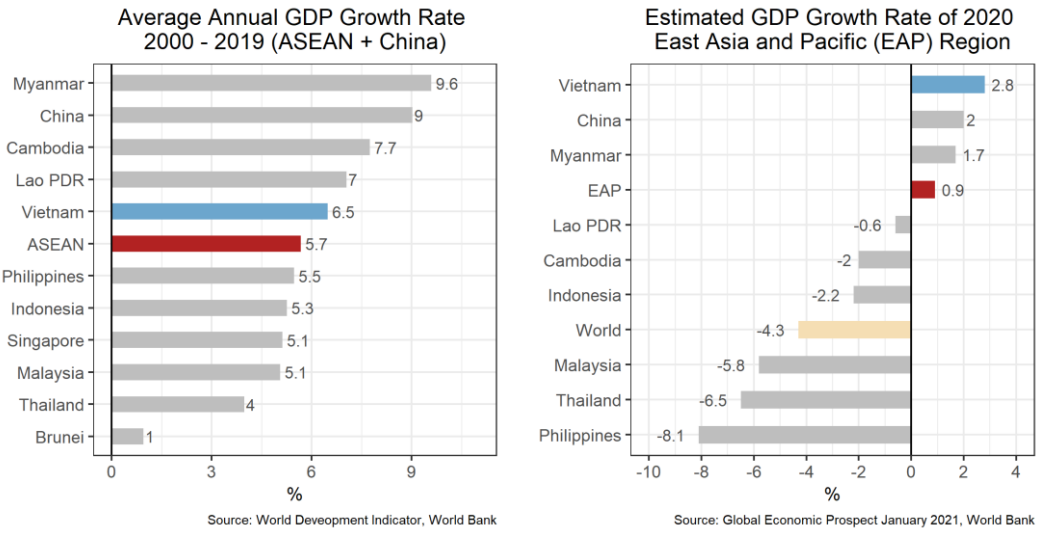
Figure 1



2. The growth in Vietnam has been robust compared to the other ASEAN neighboring countries. From 2000 to 2019, the average annual GDP growth rate of Vietnam was 6.5% while ASEAN regional average was 5.7% though several neighboring countries grew

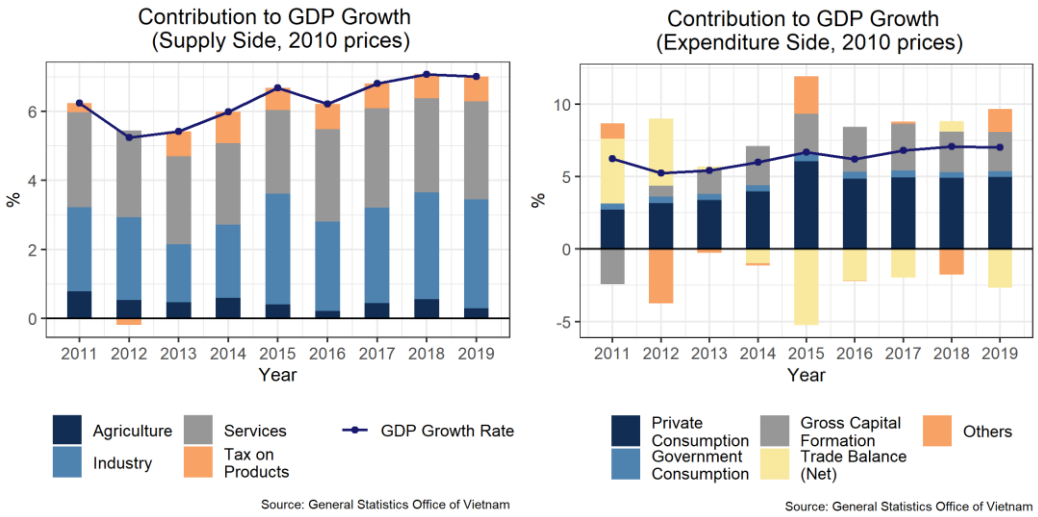
at similar GDP growth rates when their GDP per capita was lower and similar to that of Vietnam (Figure 2). Vietnam is expected to continue its steady growth with a projection of 6.5% for the annual GDP growth rate until 2024 (International Monetary Fund, 2019). However, the recent projection by the World Bank has revealed that the expected GDP growth rate in 2020 will be 2.8% under the baseline scenario due to the COVID-19 pandemic (The World Bank Group, 2020a). Furthermore, the General Statistics Office of Vietnam has announced that the GDP growth in 2020 was 2.9%. Although these are far lower than its historical trajectory, "Vietnam is expected to remain one of the fastest-growing economies in the world in 2020" as the Figure 2 shows when the global GDP is expected to shrink by 4.3% and other surrounding ASEAN countries such as Philippines is estimated to have their GDP decline by 8.1% (The World Bank Group, 2020a).

Figure 2



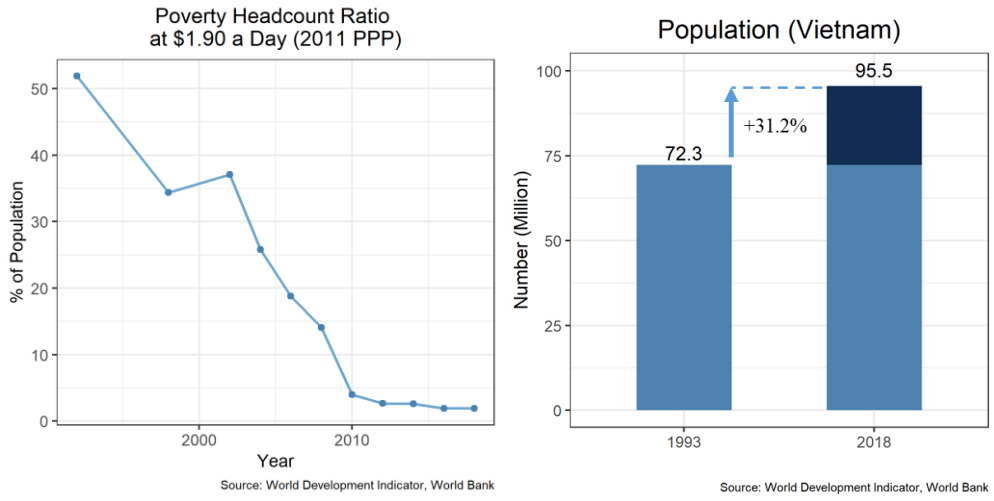
3. The industry and service sectors have been the engines of economic growth in Vietnam. Since 2011, the contribution of both sectors on the GDP growth rate are dominant, and approximately 80% of the GDP growth originates from these two sectors (Figure 3). The strong economic growth is also reflected in domestic demand. Private consumption and gross capital formation are the major drivers of economic development in Vietnam (Figure 3).

Figure 3



4. Vietnam has also successfully achieved social development. The proportion of the population living under $1.90 a day has declined from 51.9% in 1993 to 1.9% in 2018 (Figure 4). This is a remarkable achievement as the total population grew by 31.2% from 1993 to 2018 (Figure 4). Furthermore, the infant mortality rate decreased from 33 to 19 per 1,000 lives from 1993 to 2012; 99% of the population in 2012 has access to electricity while it was merely 14% in 1993; and the proportion of population who has access to sanitation facilities increased from 36% in 1993 to 67% in 2012 (The World Bank Group, 2017).

Figure 4

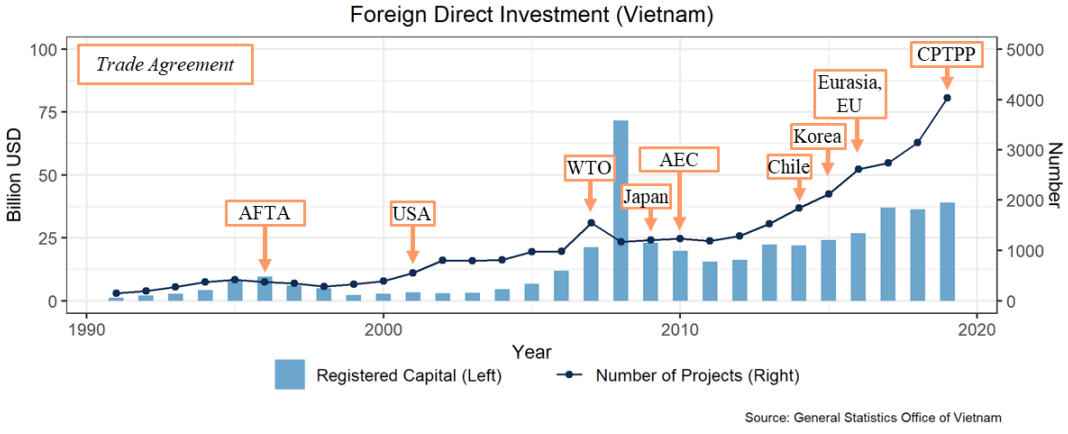


5. The steady growth of Vietnam was not a miracle but a consequence of various development efforts by the government. Vietnam climbed up the ladder of economic development and began to uplift its economic status in 1986 when the government introduced

"Doi Moi", a series of economic and political reforms with a focus of shifting the country towards a market-oriented economy. There are three components behind this success story: trade and market liberalization, business climate reform, and both human and physical investments (Eckardt, Deepak Mishraand, & Viet Tuan Dinh 2018).

6. The Doi Moi reforms have transformed Vietnam into an attractive investment destination for foreign investors. The number of registered foreign direct investment (FDI) projects has reached 4,028 in 2019 from 152 in 1991, which implies nearly 140 new FDI projects per year (Figure 5). There were three occasions when Vietnam had gained attention from foreign investors that led to a rapid increase in FDI during the transformation period. First is in the mid-1990s when the Indochina War ended in the early 1990s and Vietnam was recognized as the new Asia's frontier for investment. Second is in the early 2000s when the U.S. and Vietnam had agreed on the bilateral trade agreement. Third occasion happened in 2007 when Vietnam became an official member of the World Trade Organization. Furthermore, the series of bilateral and multilateral trade agreements along with the rising labor cost in China and growing China-US trade tensions have generated a stronger FDI trend in the 2010s.

Figure 5



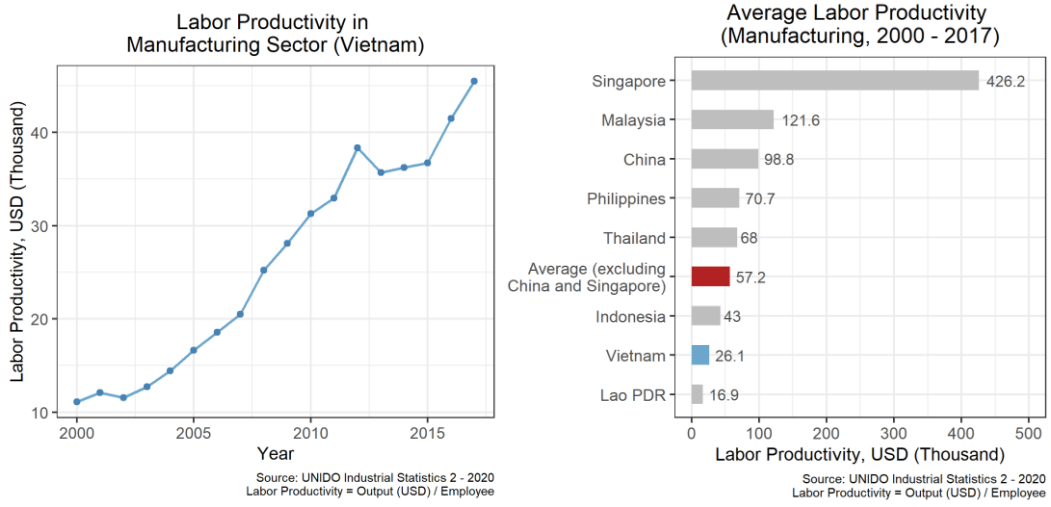
I – II. Managing Headwinds

7. Despite the undeniable and robust achievements in the past, Vietnam is in the midst of its development journey and the current strong performance is not an end of the story. According to the World Bank, GDP per capita of Vietnam is only 40% of the global

average, 20% of the ASEAN average, and a mere 5% of high-income economies average (The World Bank Group, 2020b). If Vietnam continues its growth by 7%, it will take about 30 years to reach South Korea's 2017 GDP per capita level and 10 years to reach China's 2017 GDP per capita level (The World Bank Group, 2020b). The world is full of uncertainties and Vietnam needs to act strategically to manage various risks that may threaten its sustainable growth.

8. The low labor productivity in the manufacturing sector is a critical policy challenge that needs to be addressed for sustainable economic development. Labor productivity is one of the fundamental parameters which reveals the efficiency and the competitiveness of economic activities in a country. While Vietnam increased its absolute labor productivity in the manufacturing sector since 2000, the average annual labor productivity in the manufacturing sector from 2000 to 2017 in Vietnam is significantly lower than that of other neighboring countries (Figure 6). Furthermore, the ADB Key Indicators for Asia and Pacific 2020 revealed that the value added per worker in Vietnam manufacturing sector is one sixth of that in Thailand in 2019. While Vietnam recorded $3,825, it was $22,457 in Thailand.

Figure 6



9. As Vietnam deepens its integration to the international economy, strengthening the competitiveness of its manufacturing industry is crucial. Without doubt, opening the country and lowering the barriers to access the international market through trade agreements bolstered Vietnam to achieve a rapid development. Yet, it also suggests that Vietnamese

companies are increasingly exposed to intense competition (Tho, 2013). One may argue that technical transfer from FDI inflow would contribute to improving labor productivity. Nevertheless, the low labor productivity compared to surrounding countries despite the increasing FDI inflow suggests that those FDI inflows are mostly in the low productive activities such as assembly work. Since the low labor productivity under the competitive international market reveals the inefficiency and the vulnerability of the manufacturing sector in Vietnam, underestimating this issue could lead to a potential slowdown of the development progress in future. In addition, assembly-type FDI may leave unless better local supplier industries emerge to make it "stickier" and less likely to migrate to counties with lower costs.

10. Structural reforms that require harder effort remain in Vietnam. The initial Doi Moi has focused on reforming policy areas that are relatively easier to start with. As a result, Vietnam has successfully realized remarkable development achievements and lifted itself to a lower-middle-income country. However, the country is left with policy areas that require harder efforts. The state-owned enterprises (SOEs) reform is one of them. While many small SOEs have been privatized or semi-privatized, larger SOEs still exist through reorganization, enjoying protection and possessing advantages in many aspects such as access to credit or land, and became state conglomerates having an influence on economic policies and factor markets (Tho, 2013).

11. Vietnam needs to adapt to the rapidly changing external environment. Trade in Vietnam is an important source for growth but more sensitive to changes in income of the high income trading partners than the low income trading partners (Narayan & Nguyen, 2016). This dependency makes Vietnam vulnerable to various external shocks that affect high-income economies. For example, trade protectionism among high income countries and the historical economic downturn across the world due to the COVID-19 pandemic could impose challenges. While a positive growth was expected in Vietnam in 2020, the end of COVID-19 pandemic and the time when the global economy returns to normality are uncertain. Also, the global

economy after the pandemic may be completely different from the previous economic structure and new patterns of economic activities may emerge. For instance, companies may apply new information and communication technologies such as 3D printing or remote-controlled industrial machines to reduce the production amount and employment overseas. In other words, the current global supply chain may transform into a model where countries that benefited from traditional elements of comparative advantages such as a simple low labor cost require a shift for its strategy, and Vietnam is not an exception.

12. Industrial upgrading is the key policy agenda among several policy areas that require reform for Vietnam to sustain its growth and avoid falling into the middle-income trap. Perhaps industrial upgrading itself would not solve diverse challenges that potentially hinder sustainable growth in Vietnam. Nevertheless, a robust industrial activity is a crucial component for constructing a solid foundation of a strong and resilient economic growth model. Vietnam needs to transform its economic growth model toward the one that does not rely heavily on simple expansion of capital and labor, and uplifting the labor productivity is essential to survive the rapidly changing external environment where the advantages of low labor costs may no longer benefit the country (Monga, Lin, Thi Thu Hoai, Tarp, & van Seventer, 2019). Economic policies such as deregulation, privatization of SOEs, integration with international market through trade agreements, and presence of a sound business environment such as decent hard and soft infrastructures are important for a country to shift towards a certain level of industrialization but are insufficient to break through the ceiling and progress further beyond the middle-income trap (Ohno, 2009). Unless a proactive approach is taken to upgrade its industries and improve labor productivity, Vietnam's growth may stagnate and Vietnam would then experience the middle-income trap (Tho, 2013).

13. This paper aims to identify the potentials and the determinants of industrial upgrading activities in Vietnam manufacturing sector and propose policy recommendations that will bolster industrial upgrading activities. First, the paper

organizes the current situations surrounding manufacturing industries in Vietnam. Second, the adaptiveness of industrial upgrading activities is measured for various manufacturing sectors in Vietnam to clarify the industrial upgrading situation. Third, a detailed analysis is conducted to identify the factors that trigger industrial upgrading activities by using firm-level survey data. Lastly, the paper proposes a series of policy recommendations to foster industrial upgrading activities in Vietnam. This will help the country to prepare for the potential risks that may prevent sustainable growth and to exploit the potential for new technologies to boost productivity and competitiveness.

II. Vietnam Industries

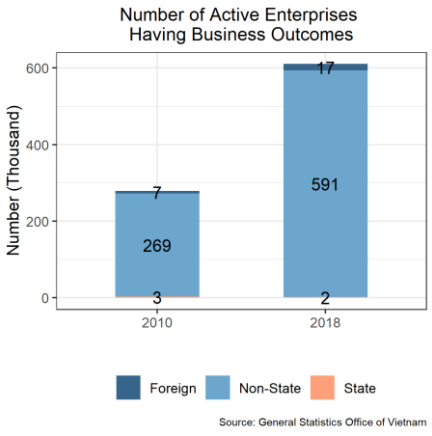
KEY POINTS:

- *Various characteristics of the manufacturing sector in Vietnam revealed its signal of transformation and potential to progress into the next stage of industrialization.*

II – I. Industry Overview

14. Economic activities in Vietnam have grown rapidly in the last decade. The number of active firms in Vietnam has doubled between 2010 and 2018 (Figure 7). During this period, the number of state-owned enterprises slightly decreased while both the domestic non-state and foreign investment firms increased. Especially, the increase in the number of domestic non-state enterprises is remarkable. This suggests a strong potential to achieve an economic growth that does not rely on external factors but is mainly driven by endogenous factors.

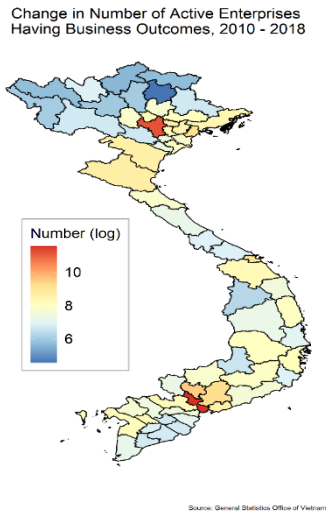
Figure 7



15. The expansion of economic activities was experienced throughout the country. Figure 8 shows the distribution of the change in number of active enterprises having business

outcomes from 2000 to 2018 across 63 provinces in Vietnam. This reveals that both Ho Chi Minh City and Hanoi had the largest increase in the number of active enterprises. Yet, other parts of the country, especially those closer to Ho Chi Minh City and Hanoi, had also increased the number of active firms. The expansion of economic activity in Vietnam was not polarized and centered only on certain parts of the country.

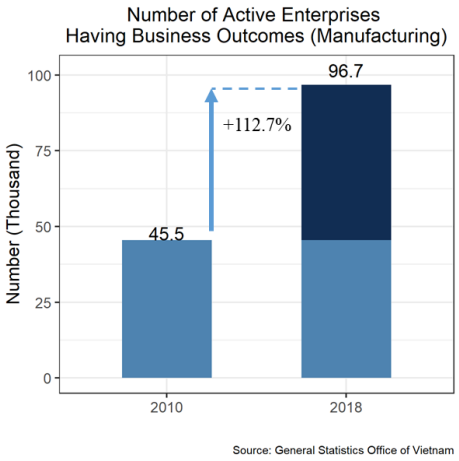
Figure 8



II – II. Manufacturing Sector

16. The size of the manufacturing sector in Vietnam more than doubled since 2010. The number of active enterprises has increased by 112.7% and recorded 96.7 thousand in 2018 (Figure 9). This is approximately 15.8% of the total number of active enterprises in Vietnam. The strong increase in the number of manufacturing sectors implies a positive expectation among people on doing business in the manufacturing sector in Vietnam. The improvement of labor productivity in the manufacturing sector would not only directly impact this large number of firms but also indirectly contributes to fostering the growth of manufacturing market size by further expanding business opportunities in the manufacturing sector. A robust manufacturing sector could set the base for Vietnam to bolster its sustainable growth and continue its successful development journey.

Figure 9

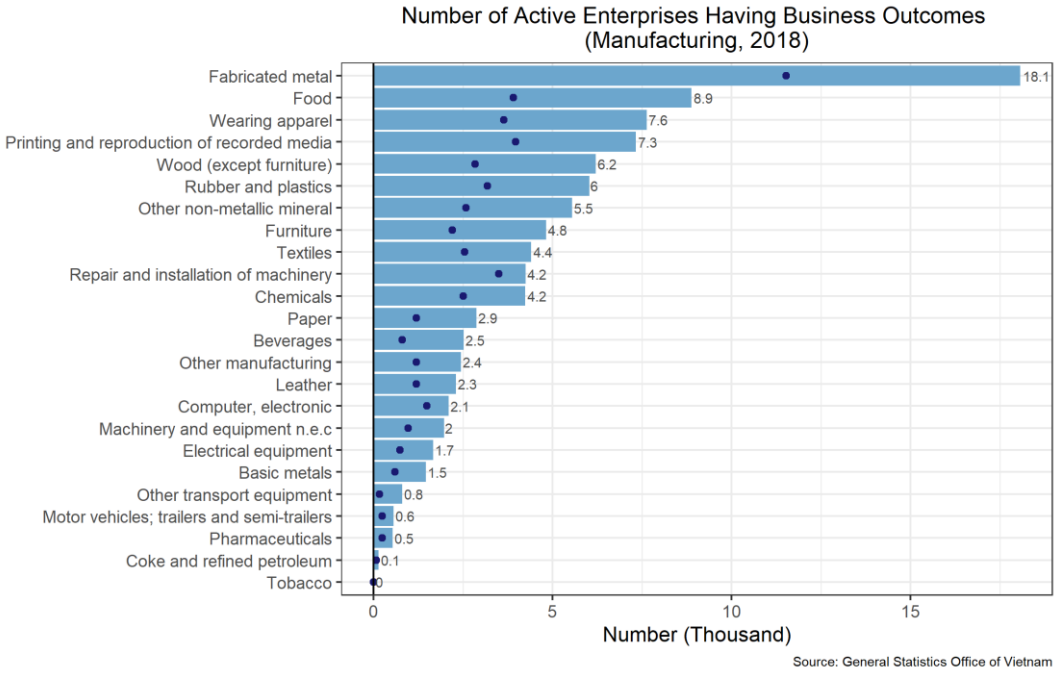


17. The majority of enterprises in the manufacturing sector in Vietnam currently produce low value-added products. In 2018, there were 18.1 thousand active firms in the fabricated metal production industry (Figure 10) followed by the food and textile production. This suggests firms in Vietnam either perceive a potential in the fabricated metal production activities or have difficulties in producing higher value-added products that require specialized

knowledge. Although the fabricated metal production is an important element to support the further industrialization of the country, it does not require a complicated production process when compared to certain other products.

18. Yet, the products that Vietnam produces have been changing. Each dot in Figure 10 represents the difference between the number of active enterprises from 2010 to 2018 for each industry. In other words, the industry had grown rapidly if the point is near the end of the bar chart because it reveals the majority of active enterprises in that industry were generated within the last decade. In this regard, repair and installation of machinery and equipment, and computer, electronic industries experienced a rapid growth between 2010 and 2018. However, the production activity itself remains to be low in value addition since most of the electronics are produced through simple assembly works. Furthermore, some industries such as garments are centered around cut, make and trim (CTM), and struggle to move into original equipment manufacturer (OEM) or original design manufacturer (ODM).

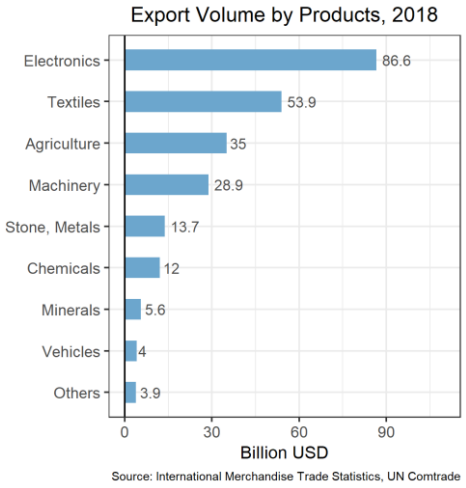
Figure 10



19. The export trend also signals the possibility of transformation in the manufacturing sector. The exported products of Vietnam were identified based on 97

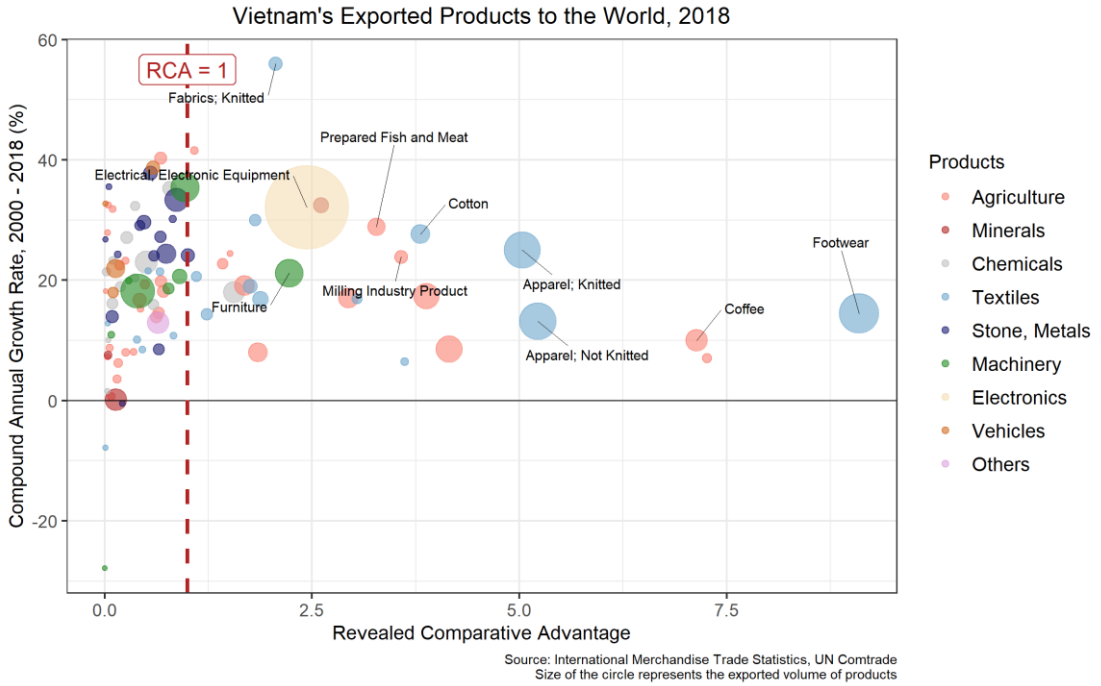
categories using the two-digit Harmonized System (HS) code. HS code is an international nomenclature for the classification of products that the World Customs Organization announces. Based on the two-digit HS code, the paper reclassified each product into nine larger categories for easier comparison. In 2018, Vietnam mostly exported electronics followed by textiles especially apparel and footwear, and agricultural products (Figure 11). The exported amount of electronics amounted to 86.6 billion USD which is 35.6% of the total exported amount. Among the electronics, 62.2% are telephone sets.

Figure 11



20. The export of electronics was not only the largest in terms of size but also one of the products that Vietnam demonstrated a comparative advantage in besides various primary goods. In other words, Vietnam is becoming competitive in either producing or assembling a certain higher value-added product. Figure 12 shows the compounded annual growth rate (CAGR) from 2000 to 2018 and the revealed comparative advantage (RCA) as of 2018 for each exported product. Each point represents the exported product based on the two-digit HS code, and the size of the point shows the exported amount in USD for each product. Dividing this into four quadrants with the origin at RCA = 1 and CAGR = 0%, products that position to the upper right quadrants are the products which Vietnam is rapidly increasing its influence in international markets. Figure 12 demonstrates that electronics have RCA above 1 though textile and agricultural products have higher RCA among all the exported goods. However, the export of electronics grew rapidly in the last two decades compared to the other products that had higher RCA than electronics. Electronics increased its export amount by more than 30% annually since 2000. These suggest that the manufacturing sector in Vietnam has the potential to play an internationally significant role even in production of the higher value-added products.

Figure 12



Box: Revealed Comparative Advantage (RCA)[1]

RCA is a measurement that identifies whether a country has a relative advantage or disadvantage in exporting a certain product. RCA compares the share of the export of a certain product to the total exports in a certain country and in the world as shown below:

$$RCA = \frac{\frac{X_{ij}}{\sum_{j \in P} X_{ij}}}{\frac{X_j}{\sum_{j \in P} X_j}}$$

$P =$ the set of all exported products
$X_{ij} =$ the export of product j by country i
$\sum_{j \in P} X_{ij} =$ the total export of all product j in P by country i
$X_j =$ the world export of product j
$\sum_{j \in P} X_{ij} =$ the total world export of all product j in P

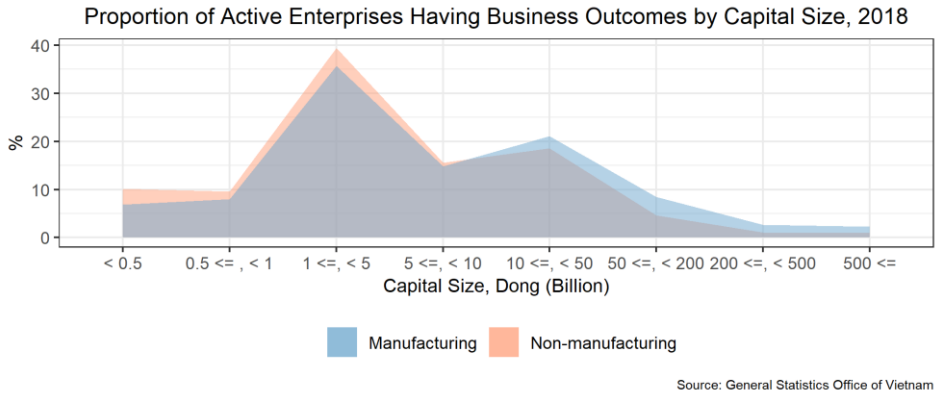
A country is considered to have a comparative advantage in exporting a certain product when $RCA \geq 1$ since the country exports a share of that product more than that of the world.

21. The manufacturing sector has a larger capital size compared to the non-manufacturing sector. Figure 13 illustrates the distribution of the active enterprises in both

[1] See UNCTAD (https://unctadstat.unctad.org/EN/RcaRadar.html) for further explanation.

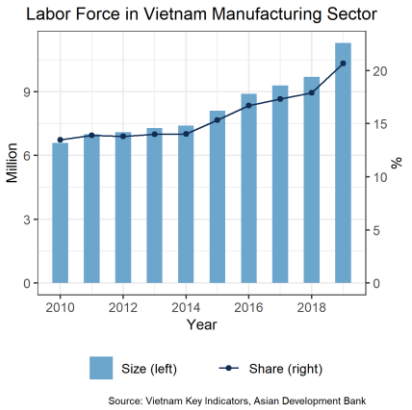
manufacturing and non-manufacturing sectors based on the categorical capital size. Although some non-manufacturing industries such as financial services possess larger capital size than some manufacturing industries, firms with the capital of 1 billion to 5 billion Dong and 10 billion to 50 billion Dong are the largest groups for both sectors. However, the manufacturing sector has a slightly greater number of firms with larger capital size than the non-manufacturing sector. The proportion of firms above 10 billion Dong is higher for the manufacturing sector than the non-manufacturing sector. This suggests that the firms in the manufacturing sector are relatively financially capable to upgrade their industrial activities.

Figure 13



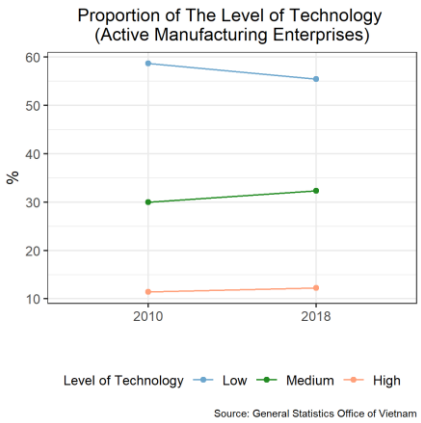
22. The manufacturing sector is an important source of stable employment with social security and health insurance for workers. The number of labor forces in the manufacturing sector was 11.3 million in 2019 (Figure 14). Nearly 1 in 5 (20.7%) of the total employed labor force works in the manufacturing sector. In addition, both the size and the share of the labor force in the manufacturing sector has been increasing in the last decade. This demonstrates a significant socio-economic role that the manufacturing sector plays in Vietnam and suggests that the transformation in the manufacturing sector would consequently have a large impact on society as well.

Figure 14



23. The technological level in the manufacturing sector has improved in the last decade.[2] As of 2018, more than 50% of firms in the manufacturing sector belong to low technology activities (Figure 15). This is a natural consequence since the majority of manufacturing firms in Vietnam produce primary goods that do not require higher value-added products. However, this share has decreased since 2010 and, in contrast, both medium and high technology activities have increased their share. Although this structural change is marginal, this trend clearly implies that the industrial upgrading is present in Vietnam. Nevertheless, it is important to note that whether this technology level refers to the production process or the product itself is unclear in the original data, and thus, requires further research.

Figure 15



III. Industrial Upgrading Adaptiveness

KEY POINTS:

- *While technology adoption is the most observed form of industrial upgrading, the overall industrial upgrading adaptiveness is limited in Vietnam's manufacturing sector.*
- *The industrial upgrading adaptiveness differs by region, industry, and firm ownership.*

III – I. The Types of Industrial Upgrading Activities

24. Industrial upgrading can occur in multiple forms. While the previous section revealed the growth in manufacturing activities in Vietnam, the industrial upgrading situation remains unclear. Thus, in order to analyze the situation clearly, this paper focuses on the following four types of industrial upgrading activities (Verhoogen, 2020).

(1) ***Product Innovation:*** Adding new values to the existing products that the firm produces. In other words, if the firm produces new products that were not previously produced or

[2] Although some services industries such as finance may have improved their technology level, this paper focuses on the industrial upgrading in the manufacturing sector and the analysis for the service sector is left for another occasion.

upgrades the functions of already producing goods, the firm is experiencing a product innovation.

(2) ***Technology Adoption***: Introducing new technologies that were not previously used in the firm. Installing new machines or upgrading the existing machines to incorporate new functions belong to this category. The externality of this activity such as a product innovation is categorized under the product innovation.

(3) ***Quality Control:*** Improving the quality of products that the firms produce.

(4) ***Process Innovation:*** Introducing new or improved methods to the manufacturing processes. Perhaps some may wonder the difference between technology adoption and process innovation. While technology adoption is related to the hard infrastructure, process innovation is focused on intangible aspects.

III – II. The Model of Measuring the Industrial Upgrading Adaptiveness

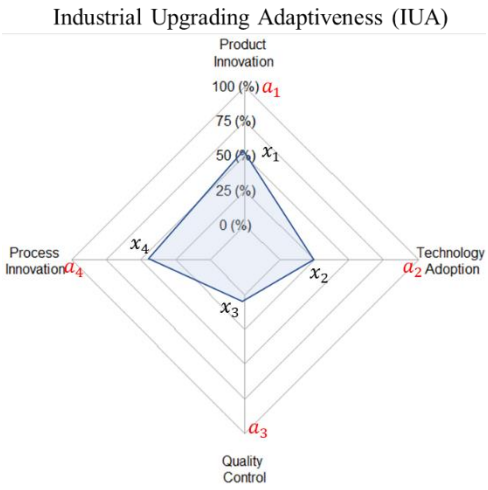
III – II – I. Conceptual Framework

25. Based on the four industrial upgrading activities mentioned above, the paper will measure the industrial upgrading adaptiveness (IUA) in Vietnam. This model of measuring the IUA was inspired by the framework of Industry 4.0 Readiness Degree which observes the degree of adaptation of technologies for each firm (Lucato, Pacchini, Facchini, & Mummolo, 2019).

26. There are three steps to derive the IUA. First, four segments which represent four industrial upgrading activities are drawn and connected at point 0 and separated apart to create a radar chart. Each segment is a vector representing the proportion of firms adapting each industry upgrading activity. In other words, the maximum value for each segment is 100%. Second, the proportion of firms adapting relevant industrial upgrading activities is calculated. Third, the area of a diagram connecting four values of observed proportions for each industrial activity is calculated and compared to the maximum value of the area of a diagram to derive the IUA. Figure 16 illustrates the final output after following the above three steps. Here,

- $a_1 \sim a_4$ = the maximum proportion of firms achieving corresponding industrial upgrading activities
- $x_1 \sim x_4$ = the observed proportion of firms achieving corresponding industrial upgrading activities

Figure 16



Although the area of the observed diagram ($x_1 \sim x_4$) reveals the industrial upgrading adaptiveness, the area of this observed square is divided by the square ($a_1 \sim a_4$) to rescale the IUA in 0% to 100% range. This makes the interpretation of the IUA easier than simply observing the value of the observed trapezoid. Thus, the IUA is represented as:

$$IUA = \frac{Observed\ Adaptiveness}{Maximum\ Adaptiveness} = \frac{Area\ of\ the\ diagram\ (x_1 \sim x_4)}{Area\ of\ the\ square\ (a_1 \sim a_4)}$$

27. The IUA is a snapshot that reveals the industrial upgrading situation. In other words, it is important to note that the IUA does not take into account the maturity of the industrial upgrading. Suppose a country upgraded its industrial activities in the past and firms in this country do not need to upgrade their activities for the next several periods. This country may present a high adaptiveness to the industrial upgrading activities, but the value of IUA will be lower if the firms in this country do not perform any industrial upgrading activities within the time period the data were collected. Therefore, the IUA must be interpreted as the present or recent industrial upgrading status.

28. Using this model of measuring the IUA is beneficial in three ways. First, the IUA clarifies the level of the industrial upgrading adaptiveness among firms by comparing the observed IUA to the maximum value. In other words, this model identifies the distance between the ideal situation where all firms implement industrial upgrading activities and the present

situation. Perhaps one may argue that simply looking at one segment is enough to understand the industrial upgrading situation. However, the area of the diagram would comprehensively reveal the adaptiveness of the industrial upgrading activities that occur in various forms. Second, this model identifies the specific industrial upgrading activity that requires an emphasis. For example, in Figure 16, quality control is the lowest performed activity compared to the other three types of industrial upgrading activities. This suggests that policy focusing on quality control would be significant for this case. Last but not least, the IUA is comparable across categories such as countries, regions, or industries which allows an in-depth analysis of the industrial upgrading.

III – II – II. Data

29. The IUA is measured by using the World Bank's Enterprise Survey. The Enterprise Survey is the firm-level data that captures various characteristics of the firm activities in a specific country. This paper refers to the latest data available for Vietnam which was conducted in 2015. Since the situations surrounding industries rapidly changes, the current situations may not be appropriately reflected from the data that was conducted six years ago. However, there are several merits in using the Enterprise Survey as the primary data source. First, the Enterprise Survey is the only data that comprehensively covers all four types of industrial upgrading activities for each firm in a specific country. Some data covers a specific aspect of industrial upgrading activity. Yet, combining multiple data sources may weaken the consistency of the interpretation. Second, the Enterprise Survey is updated in a certain period. This allows the policy makers and other stakeholders to follow the evolution of the IUA and conduct the time-series analysis which could provide a valuable insight on how the country has been upgrading its industrial activities. Third, the Enterprise Survey covers more than 100 countries across the world with the similar questionnaire. In other words, the IUA derived by using the Enterprise Survey can be compared across countries which allows the policy makers and other stakeholders to clarify the level of IUA of a specific country to that of the world.

30. The manufacturing firms are extracted from the Vietnam Enterprise Survey 2015 to form a dataset necessary to calculate the IUA. The dataset used in this paper has a total sample size of 725 firms. However, the sample size for each industrial upgrading activity varies since not all firms answered the corresponding questions in the Enterprise Survey[3]. In other words, the dataset is unbalanced, and some questions contain missing values which were excluded when computing the adaptiveness for each industrial upgrading activity. In addition, due to the nature of the Enterprise Survey, a firm that experienced multiple industrial upgrading activities appears in each proportion of the relevant industrial upgrading activity.

III – III. Findings and Implications

III – III – I. National Level

31. The IUA of the manufacturing sector in Vietnam is limited. Figure 17 illustrates the IUA and Table 1 shows the value of IUA along with the observed adaptiveness for each industrial upgrading activity. Although some industrial upgrading activities are adapted by nearly 50% of all sample firms, the IUA which considers all four aspects of industrial upgrading activities is merely 11.5%. This suggests that the comprehensive industrial upgrading in Vietnam is inactive and adaptiveness is low compared to its full potential.

32. In detail, manufacturing firms in Vietnam adapt industrial upgrading activities that strengthen the overall production capacity. Technology adoption is the most adapted industrial upgrading activity within the manufacturing sector in Vietnam. Among 719 firms that replied to the question, 357 firms or 49.7% of the responses identified as having introduced a new or upgraded the existing technological facilities in the firm (Table 1). On the other hand, there is less adaptiveness on quality improvement. Among 711 replies, 151 firms or 21.2% of the sample firms revealed their emphasis on quality control (Table 1). These suggest that the manufacturing firms in Vietnam upgrade their industrial activities by installing new

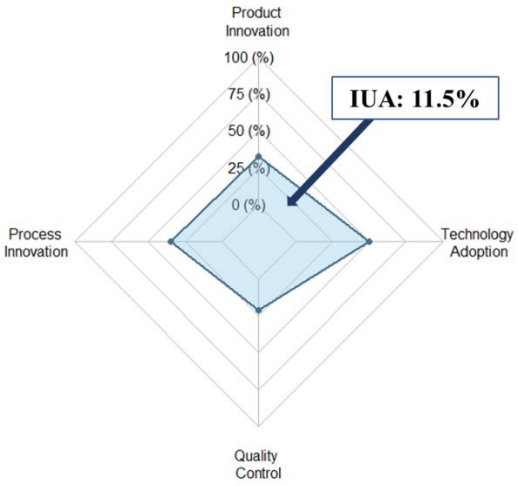
[3] See Appendix 1 for the list of questions referred in the Vietnam Enterprise Survey 2015 to compute the IUA.

technologies and not so much by improving soft elements such as the quality or process.

Table 1: IUA in the Vietnam Manufacturing Sector

Category			Value
Industrial Upgrading Adaptiveness (IUA)			11.5%
Breakdown		***N***	***Ratio***
Product Innovation		717	100.0%
	Yes	238	33.2%
	No	479	66.8%
Technology Adoption		719	100.0%
	Yes	357	49.7%
	No	362	50.3%
Quality Control		711	100.0%
	Yes	151	21.2%
	No	560	78.8%
Process Innovation		719	100.0%
	Yes	250	34.8%
	No	469	65.2%

Figure 17: IUA Diagram



III – III – II. By Region

33. In Vietnam, there is more than twice the difference in IUA by region. Using the information of the regional location of sample firms, the paper calculated the IUA for each region[4]. As a result, the North Central Area and Central Coastal Area had the highest IUA which was 16.8% while that of the South East was the lowest with 7.9% (Table 2). Also, North Central Area and Central Coastal Area revealed the highest adaptiveness for all types of industrial upgrading activities besides the quality control which South East had performed the highest.

34. While the low IUA in the South East region is counterintuitive, the lower IUA does not mean that the firms lack the ability to upgrade their activities. The sample firms in the South East region, one of the most economically developed regions, have the highest average machinery asset and employment size. This lets us assume that the region will have the highest IUA. Yet, the result was opposite and somewhat counterintuitive. However, as explained before, IUA only explains the current industrial upgrading situation. In other words, firms in the South East region may have already upgraded their activities in the past and the upgrading activities were inactive at the time the data were collected. Nevertheless, a further

[4] (1) Red River Delta, (2) North Central Area and Central Coastal Area, (3) South East, and (4) Mekong River Delta are identified in the data. See Appendix 2 for the provinces categorized under each region, Appendix 3 for the distribution of firms by region, and Appendix 4 for the detailed IUA profile.

clarification is necessary to understand the difference in IUA across regions.

35. There are several ways to uncover the reasons behind regional differences in IUA. First, the quality of business climate may play an important role in the regional difference of the IUA. Ideally, the paper will investigate further by analyzing the characteristics such as the business climate or ecosystem for each region to identify the reasons behind this result. For the regional information, the Provincial Competitiveness Index (PCI) which assesses the quality of business climate for all 63 provinces in Vietnam can be used. However, the Enterprise Survey does not locate the firms by provinces, and it was unable to obtain clear implications on how the business climate in each region affects the IUA[5]. Second, the relationship between economic size and innovation activity could be observed. Although industrial upgrading activity is assumed to be active in a region where the economy is large, it may be possible that the firms in suburbs with smaller economies actively upgrade their activities to survive the competition with firms in urban areas. However, we need more detailed data to investigate this.

Table 2: IUA by Region

Region	IUA	Product Innovation	Technology Adaptation	Quality Control	Process Innovation	Average Machinery Asset (Mil. Dong)	Average Employment Size
North Central Area and Central Coastal Area	16.8%	44.0%	60.6%	16.0%	51.5%	19,964	191
Red River Delta	13.0%	39.5%	50.0%	21.1%	35.5%	50,120	134
National Average	*11.5%*	*33.2%*	*49.7%*	*21.1%*	*34.8%*	*855,101*	*217*
Mekong River Delta	8.2%	18.0%	59.1%	18.5%	30.6%	11,467	257
South East	7.9%	26.5%	36.4%	26.7%	23.3%	2,554,352	296

III – III – III. By Industry

36. **There are nearly six times the difference in IUA between industries, and the industrial upgrading in Vietnam is active only in a specific industry.** Among 16 industries[6], the electronics industry had the highest IUA which was 43.8%. The adaptiveness for each industrial upgrading activity in the electronics industry outperforms the national average, and the majority of firms are active in upgrading their activities (Table 3). On the other hand, the

[5] See Appendix 5 for the relationship between the IUA and PCI for each region.
[6] See Appendix 3 for the distribution of firms by industry, and Appendix 4 for the detailed IUA profile.

garment industry had the lowest IUA of 7.4%.

37. Industrial upgrading is crucial for all industries regardless of their comparative advantage. The analysis revealed textiles, food, and garment which have a higher RCA underperformed the national average IUA. Perhaps industries that are already competitive in the international market had already adapted sufficient industrial upgrading activities in the past, and this resulted in their low IUA. However, the world is changing rapidly, and industries can lose their competitiveness easily if they do not put an effort on upgrading their activity. In fact, lower income countries can become more competitive than Vietnam in producing lower value-added products. Thus, it is essential that all industries continuously increase their IUA to sustain Vietnam's economic growth.

Table 3: IUA by Industry

Industry	IUA	Product Innovation	Technology Adaptation	Quality Control	Process Innovation
Electronics	43.8%	66.7%	83.3%	83.3%	33.3%
Chemicals	19.9%	42.9%	50.0%	42.9%	42.9%
Transport machines	16.7%	66.7%	66.7%	0.0%	33.3%
Plastics and rubber	15.7%	35.7%	78.6%	23.1%	28.6%
Leather	15.6%	40.0%	50.0%	22.2%	50.0%
Basic metals	14.9%	45.5%	45.5%	27.3%	36.4%
Fabricated metal products	14.5%	36.9%	59.4%	22.5%	38.0%
Publishing, printing, and recorded media	13.3%	42.9%	50.0%	14.3%	42.9%
Paper	11.6%	22.2%	80.0%	20.0%	30.0%
Food	11.6%	31.9%	49.3%	26.4%	30.3%
Non metallic mineral products	11.5%	34.3%	43.6%	22.1%	38.3%
National Average	*11.5%*	*33.2%*	*49.7%*	*21.1%*	*34.8%*
Textiles	10.6%	40.0%	50.0%	10.0%	35.0%
Furniture	10.4%	47.1%	47.1%	11.8%	23.5%
Wood	8.3%	35.3%	52.9%	0.0%	41.2%
Machinery and equipment	7.8%	22.2%	52.9%	22.2%	17.6%
Garments	7.4%	24.2%	39.6%	16.2%	33.8%

III – III – IV. By Firm Ownership

38. The IUA varies across the firm ownership[7]. Compared to the domestic firms,

[7] Firms are categorized into either (1) domestic, or (2) foreign. Foreign firms have foreign individuals or entities as one of their shareholders. Domestic firms have domestic individuals, entities, or the government though this is marginal as one of their shareholders. See Appendix 3 for the distribution of firms by their ownership and Appendix 4 for the detailed IUA profile.

foreign firms performed higher IUA (Table 4). Yet, domestic firms performed higher IUA than foreign firms in all industrial upgrading activities besides quality control which the foreign firms had a remarkably high adaptiveness. This implies two facts about the foreign firms. First, the foreign firms are more sensitive to the quality of the product rather than upgrading the whole production activities. Second, Vietnam is not considered as the production location for developing new innovative products but as a site to produce quality existing products.

Table 4: IUA by Firm Ownership

Firm Ownership	IUA	Product Innovation	Technology Adaptation	Quality Control	Process Innovation
Foreign	15.4%	27.9%	45.9%	57.1%	26.7%
National Average	*11.5%*	*33.2%*	*49.7%*	*21.1%*	*34.8%*
Domestic	10.8%	33.9%	50.2%	16.4%	35.9%

IV. Determinants of Industrial Upgrading

KEY POINTS:

- *The determinants of industrial upgrading can be categorized into three channels: output side, input side, and the firm capability.*
- *The overall industrial upgrading activity is positively associated with all three channels while those channels differently influence each industrial upgrading activity.*

IV – I. The Industrial Upgrading Ecosystem

39. Industrial upgrading activity is assumed to be active in the ecosystem where the following four key sub-systems function appropriately:

(1) ***Market sub-system:*** This is the core system for industrial upgrading, and firms interact with each other actively under the ecosystem where industrial upgrading is enhanced. Industrial upgrading is a type of reaction by the firms to maximize their profits, and the decision whether to upgrade or not depends on various constraints faced by the firm. Those constraints could relate to the inputs such as the lack of necessary supplies, financial resources, and talents to produce a product that meet the market demand reflected by the buyers and consumers. Also, information asymmetry due to the lack of interaction between

manufacturers and their buyers or consumers could be another form of constraint since firms in such a situation are unable to make appropriate decisions. Therefore, a market system where firms have a strong network would promote industrial upgrading by minimizing those constraints.

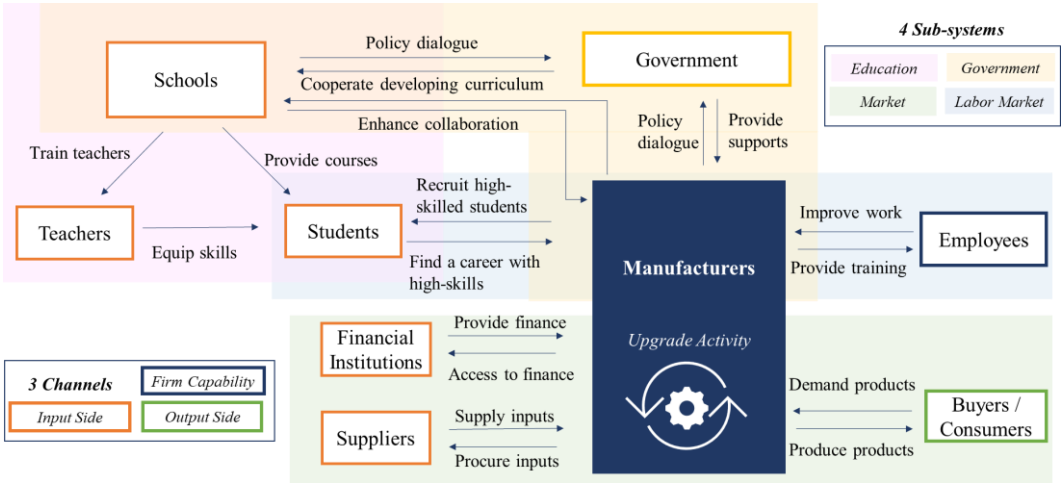
(2) ***Government sub-system:*** The government actively holds a dialogue with both manufacturers and schools and clearly addresses their challenges under the industrial upgrading ecosystem. The government formulates various policies and guidelines which are significant to provide a framework for an ecosystem that promotes industrial upgrading. While the government is not an agent who upgrades the production activities, its policies and guidelines steer industry towards upgrading. For instance, the government provides support or encourages schools to train students with necessary technological skills. In addition, the government commits to the manufacturing companies by providing direct support or incentive measures to promote investments in technologies.

(3) ***Education sub-system:*** In the industrial upgrading ecosystem, schools and firms collaborate actively to equip students with necessary skills in the labor market. Students gain skills by receiving education or vocational training. Also, schools are motivated to understand the skills that are demanded in the labor market since students are assumed to select schools that would provide advantageous skills for their employment. However, schools are unable to access this information unless they have an interaction with the stakeholders in the market sub-system. Thus, it is significantly important that the education sub-system is closely integrated with the market and the labor market sub-systems.

(4) ***Labor market sub-system:*** Labor market in the industrial upgrading ecosystem shares information which motivates workers to upskill and allow firms to access skilled workers. A number of skilled workers can be increased either through the formal education system or internal training. Also, when the workers receive information related to demanded skills, the demand for upskilling is created and transferred to the education sub-system.

40. There are potentially multiple channels that induce firms to adapt industrial upgrading activities through these four sub-systems. Those channels can be classified into the following three categories: (1) *output side* such as consumer preference present in the market sub-system, (2) *input side* including the access to finance, skilled labor and intermediate goods present in market, education, and labor market sub-systems, and (3) *firm capability* reflecting their learning ability or entrepreneurial ability present in the market and labor market sub-systems (Verhoogen, 2020).

Figure 18

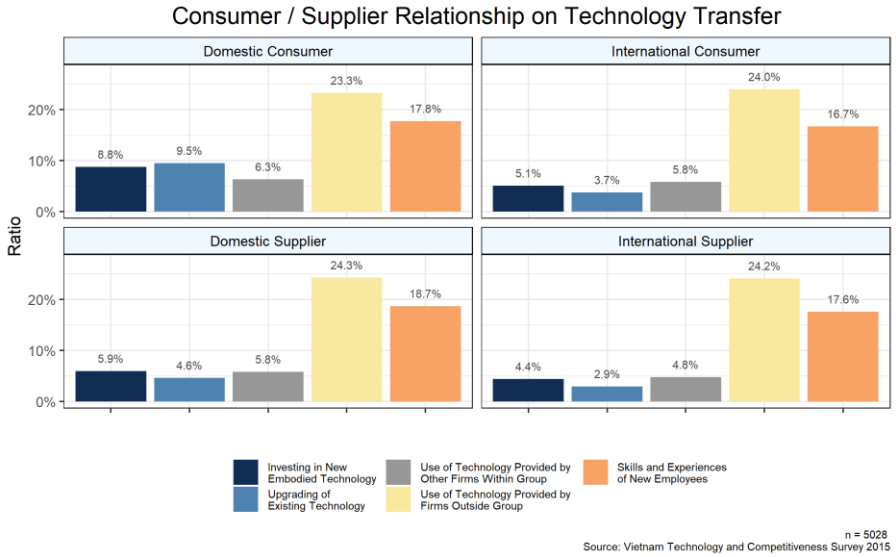


IV – II. Descriptive Analysis

41. Consumer and supplier relations result in the upgrading technology or equipping the employees with new skills. Figure 19 reveals that firms in Vietnam experience technology transfer from their relationship with the domestic or international consumer or supplier[8]. Each box represents the type or source of the relationship. Sample firms choose one or multiple types of technology transfer that resulted from each relationship. For example, 23.3% of surveyed firms mentioned their relationship with domestic consumers resulted in the use of technology provided by firms outside of their group companies. Since some firms did not experience any types of technology transfer, the total percentage in each box does not cumulate to 100%. This reveals that both output and input sides channels for industrial upgrading exist in Vietnam.

[8] See Appendix 1 for the list of questions.

Figure 19



IV – III. Empirical Analysis

IV – III – I. Methodology and the Model

42. The paper also applies regression analysis to identify the correlation between all three channels and the industrial upgrading activities. The primary data source is the surveyed firms in 16 manufacturing industries under the same Enterprise Survey used in the previous section.

43. For the industrial upgrading activities, the IUA Score is measured in addition to the four types introduced in the previous section. The IUA Score is the firm-level IUA. In the Enterprise Survey, firms are asked whether they have adapted the specific industrial upgrading activity or not. In other words, the information available in the data is binary. This allows the IUA at the firm-level to be measured simply by adding the number of industrial upgrading activities that the firm adapted. If the firm has a missing value on any of the four industrial upgrading activities, that firm is excluded from the calculation of the IUA Score in order to restrict the observations to firms that clarified their status on four aspects of industrial upgrading. Therefore, the IUA Score has a range of 0 to 4 where the higher value indicates the higher adaptiveness of industrial upgrading by the corresponding firm.

44. For the output side, two types of data are used. First, the data on the firm's main

targeted market is used to capture the impact of the consumer preferences. The paper analyzes how the firms targeting the international market relate to the industrial upgrading since those firms are assumed to be responsive to the consumer preferences and, thus, upgrade their activities. Second, the paper refers to whether the firm uses technology licensed from a foreign-owned company to analyze how the partnership with foreign firms induces industrial upgrading.

45. For the input side, the data on origin of inputs is examined. Firms with access to the foreign origin supplies are assumed to have broader options of intermediate goods necessary to upgrade their industrial activities. Thus, whether firms use material inputs or supplies of foreign origins is considered to reflect the firm's accessibility to the input side.

46. For firm capability, the data on training is considered. Due to the data limitation, whether firms that provided training to their employees are used as a proxy for their ability and attitude towards skill improvement and learning.

47. The analysis controls for the region where the firm is located and the industry that the firm belongs to. This allows the paper to omit the potential biases on the results generated by the specific regional or industrial characteristics.

48. The paper constructs the following linear probability model based on the above data to identify the determinants of the industrial upgrading activities in Vietnam:

$$\begin{aligned} Y_i = {} & \beta_1 dum\_intl\_market_i + \beta_2 dum\_foreign\_partner_i \\ & + \beta_3 dum\_foreign\_input_i + \beta_4 dum\_train_i \\ & + \alpha_1 region_i + \alpha_2 industry_i + \epsilon_i \end{aligned}$$

Here, Y_i is regressed on the listed dependent variables in Table 5 along with the definition of other variables for firm i and ϵ_i is the error term. Also, the linear probability model is primarily applied for its simplicity of the interpretation. However, both the logistic distribution function (logit) and the cumulative normal distribution function (probit) models were also applied to test the consistency of the result from the linear probability model. For the industrial upgrading score, the ordered logit and the ordered probit models were used to check the result.

Table 5: Variables in the Model

Variables	Definition
1. Dependent	
$Product\_innovation_i$	Dummy variable for achieving the product innovation (1 = Yes, 0 = No)
$Tech\_adaption_i$	Dummy variable for achieving the technology adoption (1 = Yes, 0 = No)
$Quality\_control_i$	Dummy variable for achieving the quality control (1 = Yes, 0 = No)
$Process\_innovation_i$	Dummy variable for achieving the process innovation (1 = Yes, 0 = No)
IUA_score_i	IUA Score (0 – 4)
2. Independent	
(1) Output Side	
$dum\_intl\_market_i$	Dummy variable for international market as the main market (1 = Yes, 0 = No)
$dum\_foreign\_partner_i$	Dummy variable for using technology licensed from a foreign-owned company, excluding software (1 = Yes, 0 = No)
(2) Input Side	
$dum\_foreign\_input_i$	Dummy variable for using material inputs or supplies of foreign origin (1 = Yes, 0 = No)
(3) Firm Capability	
dum_train_i	Dummy variable for providing formal training to any of its employees (1 = Yes, 0 = No)
3. Controls	
$region_i$	Region where the firm is located
$industry_i$	Industry which the firm belongs to

IV – III – II. Data Check[9]

49. A large portion of firms adapt multiple industrial upgrading activities. The distribution of IUA Score demonstrates that nearly 70% of the surveyed firms adapts at least one of the four industrial upgrading activities. Also, nearly 30% of reported firms adapted multiple industrial upgrading activities.

50. The summary statistics of the independent variables reveal several unique characteristics of the surveyed firms in Vietnam. First, the majority of firms are domestic market-oriented with less partnership with the foreign firms. Three in four firms reported the domestic market as their main market, and merely 11.5% of the surveyed firms have the technology licensed from a foreign-owned company. Second, for the input side, nearly half of the firms use material inputs or supplies of foreign origin. Third, most firms do not provide formal training to their employees.

IV – IV. Findings and Implications[10]

51. Each industrial upgrading activity is affected differently by the three channels.

[9] See Appendix 6 for the summary statistics of each variable in regression analysis.
[10] See Appendix 7 and 8 for the detailed regression analysis results.

Both the product innovation and the quality control are strongly influenced by having a network with the foreign companies or using foreign origin supplies compared to the other industrial upgrading activities. These activities were the only dependent variables that had both foreign partnership and foreign origin products variables as positive and statistically significant. Yet, having access to foreign origin products is also important for technology adoption and process innovation. In addition, offering training to the employees is an important element for all four industrial upgrading activities. This suggests that the willingness to learn is a significant characteristic of the firms that achieve industrial upgrading activities.

52. The overall industrial upgrading activity is positively associated with the three channels. Firms exposed to the output side, having access to input side, and with a learning culture are likely to adapt industrial upgrading activity. Training has the largest coefficient which emphasizes the importance of a learning culture for firms to actively adapt industrial upgrading activities.

Table 6: Selected Results of Empirical Analysis

	Dependent variable:				
	Product Innovation	Technology Adoption	Quality Control	Process Innovation	Industrial Upgrading Adaptiveness Score
	OLS	*OLS*	*OLS*	*OLS*	*OLS*
	(1)	(2)	(3)	(4)	(5)
International Market	-0.093*	0.113**	0.098**	-0.081	-0.0001
	(0.048)	(0.051)	(0.042)	(0.050)	(0.118)
Foreign Partnership	0.133**	-0.023	0.273***	0.095	0.496***
	(0.059)	(0.064)	(0.052)	(0.062)	(0.146)
Foreign Origin Inputs	0.122***	0.156***	0.155***	0.086**	0.534***
	(0.040)	(0.043)	(0.035)	(0.042)	(0.099)
Training	0.270***	0.111**	0.174***	0.215***	0.783***
	(0.043)	(0.046)	(0.038)	(0.045)	(0.106)
Constant	0.188	0.473***	0.207	0.215	1.089***
	(0.156)	(0.166)	(0.135)	(0.162)	(0.377)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	610	611	602	611	595
R^2	0.164	0.131	0.220	0.119	0.244

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

53. Yet, the effect of targeting the international market remains unclear. First of all, the international market variable was positive and statistically significant for technology adoption and quality control. This suggests an essential role that a frequent interaction with the international market plays in inducing firms to upgrade their industrial activities. Yet, its slope was negative and statistically significant for product innovation, and negative but statistically insignificant for process innovation and the overall IUA score. This contradicts the assumption that a firm which primarily focuses on the international market potentially possesses a stronger incentive to upgrade their industrial activities to become competitive compared to the domestic firms, and a detailed analysis with relevant data is required.

54. All three channels were also positively related to the industrial upgrading among domestic firms. Yet, foreign firms did not demonstrate a clear positive relationship. Perhaps the industrial upgrading decisions among foreign firms are made by their headquarters, and the determinants of industrial upgrading is different between domestic and foreign firms.

55. The results were qualitatively robust when other variables were also considered in the regression model. The paper checked the robustness of the result by adding one independent variable that reflected the firm's capability of access to finance, and one control variable representing the firm size. The firm was considered to have access to finance if it has a line of credit or loans from a financial institution, and the firm size was represented in two patterns: employment size and machinery asset size. As a result, statistically significant levels changed for some variables and the international market variable which already requires further research changed the slope of coefficient under certain cases. However, the slope of coefficient did not change for other variables and thus the results are qualitatively robust.

56. In conclusion, the results support the argument that having the appropriately functioning four sub-systems is significant to create an ecosystem that promotes industrial upgrading activities. Although the low R^2 value possibly due to the nature of the data suggests the necessity to further investigate the source of industrial upgrading in detail,

three channels demonstrated positive correlation with the industrial upgrading activities. This indicates that four key sub-systems need to function appropriately and create such channels to promote industrial upgrading among firms.

V. Policy Recommendations

KEY POINTS:

- *The industrial upgrading promotion policy should comprehensively target the four sub-systems by fostering interaction among stakeholders to create the ecosystem that bolster firms to upgrade their activities.*

V – I. The Goal of Vietnam Industrial Policy

57. While some service industries such as finance or IT are at the upper end of the industrialization in Vietnam, the government ambitions to uplift all industries including manufacturing sector towards the Fourth Industrial Revolution, or Industry 4.0. The Communist Party of Vietnam has announced in September 2019 that Party General Secretary Nguyen Phu Trong signed Resolution No. 52-NQ/TW of the Central Committee on a number of guidelines and policies to actively participate in the Fourth Industrial Revolution (Vietnam Law & Legal Forum, 2019). Under this resolution, the government aims to make the best use of opportunities brought by Industry 4.0 to step up the renewal of the growth model and economic restructuring. Also, the government envisions Vietnam to be one of the leading centers of manufacturing, smart service, start up and innovation in Asia with high labor productivity by 2045.

58. Industry 4.0 attempts to upgrade industries by mobilizing technologies that emerged from the digital revolution such as Artificial Intelligence (AI) and the Internet of Things (IoT). However, Industry 4.0 does not have a specific definition that is universally agreed because of its relatively new emergence. While the concept of Industry 4.0 first appeared in the industrialization strategy of the German government in 2011, researchers

around the world started to define the concept by identifying various elements that are core to the Industry 4.0 (Tan, Tran Duc Binh, & Nguyen Thi Le Van, 2019). In fact, the research in this area covers a variety of elements (Liao, Deschamps, Loures, & Ramos, 2017). Nevertheless, there is a shared principle that Industry 4.0 is "characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres" (Schwab, 2016) .

59. Vietnamese government decided to set its goal of industrial upgrading to Industry 4.0 after a series of discussions. The first discussion took place at the 4th Plenum of 12th Central Committee on 5 May 2016 (Vu & Anh, 2017). Central Committee Plenums are politically significant events where various policies are discussed and decided by the leaders of the Party. The fact that Industry 4.0 was raised and discussed at this meeting implies a strong political commitment and interest on this issue. After this meeting, the concept of Industry 4.0 was regularly raised and discussed at various high-level meetings.

60. Industry 4.0 is expected to bring a significant economic impact in ASEAN including Vietnam. Technologies associated with Industry 4.0 are expected to improve labor productivity in the manufacturing sector and, thus, generate positive economic outcomes. In ASEAN, Industry 4.0 "has the potential to capture productivity gains worth $216 billion to $627 billion" (Arbulu, Lath, Mancini, Patel, & Tonby, 2018). Furthermore, it could significantly change the structure of current global value chains (Strange & Zucchella, 2017).

61. Industries in Vietnam react positively to Industry 4.0. 79% of the managers in manufacturing companies in Vietnam responded that they are optimistic about the impact of Industry 4.0 (Arbulu et al., 2018). Also, 67% of business executives in 2018 perceived a significant impact of Industry 4.0 on their operations within the next three years (PricewaterhouseCoopers Consulting (Vietnam), 2018). Yet, the industrial upgrading is limited as shown previously, and this paradox where firms recognize the positive potential impacts but do not take steps toward an actual transition is seen globally (Hamley et al., 2018).

62. While Industry 4.0 is set as the specific goal, upgrading the industries in various

stages of industrialization remains to be the main task of industrial policy. Some argue that Industry 4.0 is too ambitious for Vietnam since most of the production level is equivalent to the earlier phase of industrialization (Tan et al., 2019). However, as many countries across the world attempt to increase their competitiveness through digital technologies, it is also important for Vietnam to aim for industrial upgrading and shift towards Industry 4.0. Thus, the discussion should be on what policy interventions are needed to upgrade industries in all stages of industrialization rather than whether Industry 4.0 is realizable or not.

V – II. Policy Recommendations

63. Industrial upgrading promotion policy would benefit all the stakeholders in the ecosystem. The government will be able to fulfill its commitment to sustaining the economic growth of the nation, and gain credibility from industries and citizens for supporting their lives. Industries will be able to expand their activities and have an opportunity to increase their profits. Academic institutions will be able to attract more students and improve the educational quality.

64. Policies that promote industrial upgrading need to comprehensively target four sub-systems and create a whole ecosystem that supports firms to upgrade their industrial activities. As the empirical analysis revealed, both output and input sides and firm capabilities such as a learning culture are crucial for industrial upgrading. Since these determinants relate to different sub-systems, and some overlap to multiple sub-systems, policy should comprehensively focus on all four sub-systems.

65. The Vietnamese government would do well to formulate policies that strengthen the interaction among key stakeholders in the four sub-systems. Under the Resolution No. 52-NQ/TW, the Vietnamese government identifies various prioritized policy areas. Those range from institutional development such as legal reforms to infrastructure development, and human resource development. Without doubt, these policy areas are crucial to promote industrial upgrading activities. For instance, intellectual properties need to be protected to provide firms a safe environment to upgrade their activities. However, the resolution lacks focus on the

impact which interactions among key stakeholders in each sub-system would deliver.

66. The paper proposes following policies to complement the already identified policy areas. In order to support policymakers in Vietnam to assess each recommendation, proposed policies are analyzed from the three dimensions: technical correctness, administrative feasibility, and political supportability. Table 7 summarizes the recommended policies.

(1) Semi-annual business networking fair

- *Theory of Change:* This aims to strengthen both the output and input channels in the market sub-system. The fair functions as a platform for firms to obtain information and knowledge beyond their expertise and enables them to access information related to the most updated market demand such as consumer preferences and the necessary inputs for upgrading. This benefits firms by providing them opportunities to expand their businesses and increase profits. Similar practices are seen in Japan and Taiwan where firms collaborate with other firms to complement the weakness and small size of each firm and attempt to upgrade their production (Ministry of Economy Trade and Industry, 2018). The fair will be held semi-annually to create an active platform. The Vietnam Chamber of Commerce and Industry (VCCI) and the industrial associations would support the arrangements together with the relevant ministries, and the collaboration can be extended to foreign chambers of commerce in Vietnam.
- *Technical Correctness:* The empirical analysis revealed that firms with access to foreign origin inputs are likely to perform a higher industrial upgrading adaptiveness. Also, the consumer and supplier relationship resulted in the technology transfer in Vietnam. This policy supports firms to increase their opportunities to get access to those resources and strengthen their relationship with the other players in the market. Thus, the policy provides a technically correct solution.
- *Administrative Feasibility:* While the policy can be regarded as an extension of the already existing activities of VCCI and industrial organizations, additional human and financial

resources may be required for the fair. This could impose a challenge to the government, VCCI, and industrial associations. Thus, the administrative feasibility is medium.

- *Political Supportability:* VCCI and industrial organizations have a mission to promote their industries. Their active commitment on this mission would increase their credibility from the member firms. Also, this policy benefits not only manufacturers but also suppliers and other key stakeholders in the market sub-system since they would have an opportunity to expand their business. Thus, the political supportability is considered as high.

(2) Annual tripartite policy dialogue

- *Theory of Change:* This policy aims to maintain the favorable ecosystem for industrial upgrading through information sharing among both domestic and foreign firms of various sizes, government, and academic institutions. By continuously updating each stakeholder's knowledge of conditions in each sub-system through dialogues and discussing necessary policies instead of applying a top-down policy formulation approach where the government unilaterally decides a policy, each sub-system will function appropriately and improve the industrial upgrading ecosystem. This platform will also monitor the progress of the agreed actions. A similar approach is also taken in some parts of the EU countries such as France where the platform facilitates the collaboration between policy makers and industry stakeholders (European Commission, 2017).
- *Technical Correctness:* The empirical analysis revealed that both output and input side and firm capabilities are important determinants for the industrial upgrading. In other words, an ecosystem which possesses such channels is crucial for promoting industrial upgrading. Since this policy would sustain a favorable ecosystem structure, it is technically correct.
- *Administrative Feasibility:* This policy requires a representative from each stakeholder to be present. Firms can be represented and selected by VCCI or industrial associations. While the Ministry of Planning and Investment can lead the dialogue, the government agencies responsible for both industrial and education policies should also be presented

since the agenda is multidisciplinary. The academic institution can be selected from universities and/or vocational schools which have experiences collaborating with firms. This process may require a certain time to settle, and unpredicted challenges may rise during this process. Furthermore, creating an appropriate monitoring and evaluation framework may impose challenges among stakeholders. Thus, the administrative feasibility is medium.

- *Political Supportability:* All stakeholders would benefit from holding the tripartite policy dialogue. Firms and academic institutions will be able to let the government realize the necessary support, and the government will be able to formulate policies that will deliver an intended impact. Thus, the political supportability is high.

(3) Tax reduction to foreign firms purchasing supplies from domestic firms

- *Theory of Change:* The goal of this policy is to enhance transferring know-hows and resources essential for firms to upgrading activities by strengthening the linkage between foreign and domestic firms. This policy reduces taxes imposed on products produced by domestic firms when foreign firms purchase them. Foreign firms will be motivated to increase their local procurements to reduce the production cost, and the network between foreign and domestic firms will be strengthened. This network not only allows domestic firms to understand the market demand, but also enhances knowledge and skills transfer which builds firm capacities for industrial upgrading.
- *Technical Correctness:* The empirical analysis revealed that foreign partnership and foreign origin inputs are important factors for industrial upgrading. Thus, an expected linkage built from this policy is technically correct for promoting industrial upgrading.
- *Administrative Feasibility:* There are several administrative difficulties. First, the government needs to identify specific criteria for foreign firms to receive tax incentives. Second, the efficient procedure for how to receive requests from firms and review whether those requests meet the criteria needs to be developed. It will take time to make decisions

on these issues, and thus the administrative feasibility is low.

- *Political Supportability:* The policy would benefit foreign firms. Yet, some domestic firms may oppose providing tax incentives only to foreign firms. Also, some groups within the government may resist a policy which reduces the tax revenue. Thus, political supportability of the policy is medium.

(4) Certify firms offering training program

- *Theory of Change:* This aims to promote a learning culture across firms by motivating firms to provide training to their employees. Firms will receive a certificate if they provide training to their employees. This certificate will be a useful signal for the awarded firm not only to recruit new talent from the labor market by demonstrating its willingness to invest in its employees and perhaps a friendly work environment but also to expand the business by proving its sincere attitude to the work. Thus, firms will be motivated to provide training either through a formal education system or internal program.
- *Technical Correctness:* The empirical analysis revealed that firms offering training to employees are likely to possess a higher industrial upgrading adaptiveness. This suggests that the training is an essential element for industrial upgrading. Thus, enhancing training and creating a learning culture among firms through this mechanism is technically correct.
- *Administrative Feasibility:* The government needs to design appropriate criteria for the certificate. Also, the public awareness of certificates is needed to increase the market value of the awarded firms. While the government is advised to collaborate with key stakeholders, these challenges make the administrative feasibility as medium.
- *Political Supportability:* The policy would benefit not only firms and their employees but also academic institutions as firms are motivated to offer training opportunities to their employees. Thus, the political supportability is high.

(5) Certify skilled labors and reduce tax on firms hiring a certain ratio of those workers

- *Theory of Change:* The goal of this policy is to increase the number of skilled labor forces

through the market mechanism. First, the government issues certificates to people who passed the exam that tests their knowledge and ability of specific skills. Second, firms with a certain ratio of workers with the certificate will receive tax reductions. This motivates firms to hire workers with the certificate. As a result, the value of the certificate increases in the labor market. Workers will perceive a high return in upskilling themselves and receiving the certificate. Consequently, the number of skilled labor increases and bolsters firms to access a skilled labor force necessary to upgrade their activities.

- *Technical Correctness:* The empirical analysis identified firms providing training to employees were positively associated with a higher industrial upgrading adaptiveness. Although this suggests that having trained workers is important for industrial upgrading, the relationship between access to skilled workers in the labor market and industrial upgrading remains unclear due to the data limitation. In fact, simply being able to recruit talents may not result in industrial upgrading if a learning culture is lacking in the firm. Therefore, the technical correctness is medium for this policy.
- *Administrative Feasibility:* The government, in cooperation with the industries and relevant experts, needs to design an appropriate exam to measure the skills level of applicants. Also, the government needs to identify what kind of skills are demanded in the labor market. Otherwise, the certificate will lose its value in the labor market. Perhaps the government could cooperate with the institutions that provide training services to workers in developing this entire certification system. However, the market demand constantly changes, and the identification of demanded skills may not be easy. Thus, this policy has a low administrative feasibility.
- *Political Supportability:* The policy would benefit firms as well as both existing and incoming labor forces. Also, industries providing training services may benefit from the certification system. Yet, some may disagree with the policy as it reduces tax revenues. Thus, the political supportability is medium.

(6) Tax reduction to firms with a certain ratio of workers with foreign education

- *Theory of Change:* The goal of this policy is to promote talents outside Vietnam to enter and retain in Vietnam. By reducing taxes on firms with a certain ratio of workers with foreign education, firms will be motivated to recruit talented workers from outside of Vietnam. On the other hand, those talents can leverage this policy to find an occupation in Vietnam. While this mainly targets Vietnamese talents residing outside the country, it also expects to bring in non-Vietnamese talents who wish to work in Vietnam. These talents would bring new knowledge to the firms which could upgrade their industrial activities.
- *Technical Correctness:* While the empirical analysis revealed the significance of training employees, the relationship between having access to talents and industrial upgrading remains unclear due to the data limitation. Thus, although access to skilled workers is expected to be an important factor for industrial upgrading, the technical correctness of this policy is medium.
- *Administrative Feasibility:* The government needs to identify specific criteria for firms to receive tax reduction. Also, there are challenges in the reviewing process of applications and monitoring the eligibility of accepted firms. This requires detailed administrative structures in not only the central but also the regional level. Thus, the administrative feasibility is low.
- *Political Supportability:* The policy would benefit firms as well as both existing and incoming labor forces. Yet, some groups in the government possibly disagree with the policy as it reduces tax revenues. Also, this closely relates to the immigration policy and the domestic workers may express their concerns on losing their work. Thus, the political supportability is medium.

67. Policy mix is a critical approach to create an ecosystem that promotes industrial upgrading. There is no one single policy that solves every failure in each sub-system. Appropriate policies need to be adapted for each sub-system under an overarching theme. Thus,

the suggestion for the Vietnamese government is to have a larger perspective focusing on creating a desirable ecosystem for industrial upgrading and adapt a policy package that comprehensively addresses obstacles that firms face upon upgrading industrial activities.

68. However, facilitating a dialogue among key stakeholders is prioritized among the recommended policies. Through the semi-annual business networking fair and the annual tripartite policy dialogue, it is crucial to create the base for other policy interventions to appropriately deliver their intended impacts. For example, certificates would not function as a signal unless the stakeholders actively share information. Similarly, tax incentives would not induce firms toward a specific action if the market does not transmit necessary information.

Table 7: The Recommended Policy Package

Policy Recommendation	Targeted channels	Targeted sub-system	Technical Correctness	Administrative Feasibility	Political Supportability	Priority
Semi-annual business networking fair	Output, Input	Market	High	High	High	★★★
Annual tripartite policy dialogue	Output, Input, Firm Capabilities	Market, Government, Education, Labor	High	Medium	High	★★★
Tax incentives on foreign firms purchasing supplies from domestic firms	Output, Input	Market	High	Low	Medium	★☆☆
Certify firms offering training program	Firm Capabilities	Education, Labor	High	Medium	High	★★☆
Certify skilled labors and reduce tax on firms hiring a certain ratio of those workers	Input	Education, Labor	Medium	Low	Medium	☆☆☆
Tax reduction to firms with a certain ratio of workers with foreign education	Input, Firm Capabilities	Labor	Medium	Low	Medium	☆☆☆

69. Partnering with foreign international development agencies or multinational companies could be an option for the Vietnamese government upon implementing the proposed policies. In Vietnam, there are several active bilateral and multilateral international development agencies such as Japan International Cooperation Agency (JICA), United States Agency for International Development (USAID), and the World Bank. The Vietnamese government could utilize and organize the existing partnership programs with these organizations to structure the industrial upgrading ecosystem. Also, some multinational

companies such as Samsung, Panasonic, Toyota Motor, and Intel provide training programs that are designed either by themselves or partnering with academic institutions. The government could leverage these existing assets to implement multiple policies for creating the solid channels that are important for the industrial upgrading ecosystem.

VI. Way Forward

70. The paper identified the current situation and the potential of industrial upgrading activities in the Vietnam manufacturing sector. The paper introduced the concept of measuring the industrial upgrading adaptiveness and revealed the limited adaptiveness in Vietnam despite the recent robust economic growth. The empirical analysis identified essential factors for firms to upgrade industrial activities and provided a comprehensive base for a series of policy recommendations necessary to create the industrial upgrading ecosystem.

71. However, there are several limitations in this paper that potentially calls for future research. First is the data limitation. As explained earlier, the primary data source in this paper is the Enterprise Survey from 2015. Although this is the latest data available for Vietnam, the industrial upgrading situation may have changed since 2015. This could possibly generate different insights for policy recommendations. Also, some responses in the Enterprise Survey are subjective which could alter the characteristics of firms at a certain degree. The low proportion of variance explained in the result of empirical analysis also suggests the need for interviews with firms to better determine the sources of industrial upgrading. Second is the discussion on the impact of industrial upgrading on unskilled workers. As firms upgrade industrial activities, low-skilled workers are potentially replaced by new machineries. In other words, there should be a policy discussion on externalities caused by promoting industrial upgrading. Yet, since the gist of this paper is on uncovering the industrial upgrading situation, its potential and obtaining policy insights for industrial upgrading promotion, this discussion is left for another occasion.

Appendix

Appendix 1: List of Questions Rereferred for the Analysis

Vietnam Technology and Competitiveness Survey 2015

- **Channels of Technology Transfer**

	Question	Answer
1	If your relationships with domestic customers in Vietnam resulted in technology transfer, which form did it take? (Circle all that apply)	1. Investing in new embodied technology (e.g. in goods, machinery, or equipment) 2. Upgrading/modification of existing technology 3. Use of technology provided by other firm within group (e.g. shareholder(s)) 4. Use of technology provided by firms outside group (e.g. suppliers or customers) 5. Skills and experience of new employees
2	If your relationships with international customers outside Vietnam resulted in technology transfer, which form did it take? (Circle all that apply)	1. Investing in new embodied technology (e.g. in goods, machinery, or equipment) 2. Upgrading/modification of existing technology 3. Use of technology provided by other firm within group (e.g. shareholder(s)) 4. Use of technology provided by firms outside group (e.g. suppliers or customers) 5. Skills and experience of new employees
3	If your relationships with domestic suppliers inside Vietnam resulted in technology transfer, which form did it take? (Circle all that apply)	1. Investing in new embodied technology (e.g. in goods, machinery, or equipment) 2. Upgrading/modification of existing technology 3. Use of technology provided by other firm within group (e.g. shareholder(s)) 4. Use of technology provided by firms outside group (e.g. suppliers or customers) 5. Skills and experience of new employees
4	If your relationships with international suppliers outside Vietnam resulted in technology transfer, which form did it take? (Circle all that apply)	1. Investing in new embodied technology (e.g. in goods, machinery, or equipment) 2. Upgrading/modification of existing technology 3. Use of technology provided by other firm within group (e.g. shareholder(s)) 4. Use of technology provided by firms outside group (e.g. suppliers or customers) 5. Skills and experience of new employees

Vietnam Enterprise Survey 2015

- **Dependent Variables (Industrial Upgrading Activities)**

Question		Answer*
Product Innovation	During the last three years, has this establishment introduced new or significantly improved products or services?	1. Yes 2. No -9. Don't know
Technology Adoption	In the last fiscal year, did this establishment purchase any new or used fixed assets, such as machinery, vehicles, equipment, land or buildings?	1. Yes 2. No -9. Don't know
Quality Control	Does this establishment have an internationally-recognized quality certification?	1. Yes 2. No 3.Still in process -9. Don't know
Process Innovation	During the last three years, has this establishment introduced any new or significantly improved methods of manufacturing products or offering services?	1. Yes 2. No -9. Don't know

- **Independent Variables**

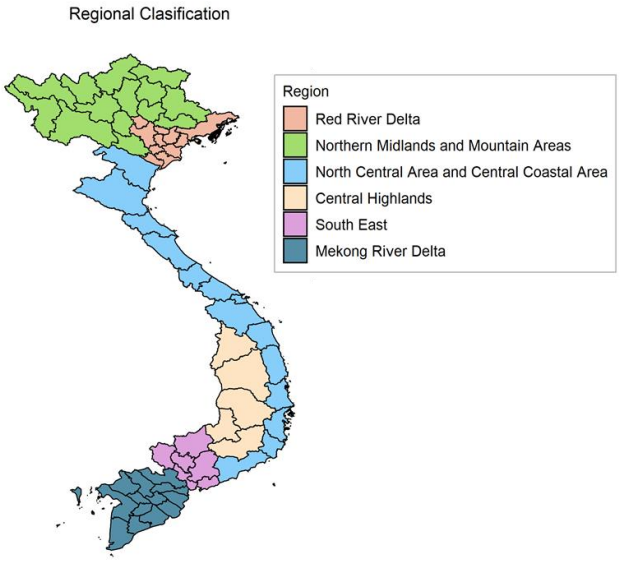
Question		Answer*
Output Side		
Main Market	In the last fiscal year, which of the following as the main market in which this establishment sold its main product? **In the paper, firms that answered 1 and 2 are domestic, 3 is international.*	1. Local 2. National 3. International -9. Don't know
Relationship with foreign companies	Does this establishment at present use technology licensed from a foreign-owned company, excluding office software?	1. Yes 2. No -9. Don't know
Input Side		
Import materials	In the last fiscal year, as a proportion of all material inputs or supplies purchased that year, what percentage of this establishment's material inputs or supplies were: **In the paper, firms that have more than 0% for the foreign origin is considered as using foreign-origin inputs.*	1. Domestic origin: __% 2. Foreign origin: __%
Firm Capability		
Training	During the last three years did this establishment provide formal training to any of its employees specifically for the development and/or introduction of new or significantly improved products or services and processes?	1. Yes 2. No -9. Don't know

** In the paper, "Don't know" and "Does not apply" are counted as NA.*

Appendix 2: Regional Classification and the Data Coverage

ES Coverage	Region	Province
Yes	Red River Delta	Bac Ninh
		Ha Nam
		Ha Noi
		Hai Duong
		Hai Phong
		Hung Yen
		Nam Dinh
		Ninh Binh
		Quang Ninh
		Thai Binh
		Vinh Phuc
No	Northern Midlands and Mountain Areas	Bac Giang
		Bac Kan
		Cao Bang
		Dien Bien
		Ha Giang
		Hoa Binh
		Lai Chau
		Lang Son
		Lao Cai
		Phu Tho
		Son La
		Thai Nguyen
		Tuyen Quang
		Yen Bai
Yes	North Central Area and Central Coastal Area	Binh Dinh
		Binh Thuan
		Da Nang
		Ha Tinh
		Khanh Hoa
		Nghe An
		Ninh Thuan
		Phu Yen
		Quang Binh
		Quang Nam
		Quang Ngai
		Quang Tri
		Thanh Hoa
		Thua Thien Hue

ES Coverage	Region	Province
No	Central Highlands	Dak Lak
		Dak Nong
		Gia Lai
		Kon Tum
		Lam Dong
Yes	South East	Ba Ria - Vung Tau
		Binh Duong
		Binh Phuoc
		Dong Nai
		Ho Chi Minh
		Tay Ninh
Yes	Mekong River Delta	An Giang
		Bac Lieu
		Ben Tre
		Ca Mau
		Can Tho
		Dong Thap
		Hau Giang
		Kien Giang
		Long An
		Soc Trang
		Tien Giang
		Tra Vinh
		Vinh Long



Appendix 3: Summary Statistics of the Data Set

Category	N	Ratio*
Region	725	100.0%
South East	225	31.0%
Red River Delta	216	29.8%
North Central Area and Central Coastal Area	172	23.7%
Mekong River Delta	112	15.4%
Industry	725	100.0%
Garments	150	20.7%
Fabricated metal products	143	19.7%
Food	143	19.7%
Non metallic mineral products	142	19.6%
Textiles	20	2.8%
Machinery and equipment	18	2.5%
Furniture	17	2.3%
Wood	17	2.3%
Plastics and rubber	14	1.9%
Publishing, printing, and recorded media	14	1.9%
Basic metals	11	1.5%
Leather	10	1.4%
Paper	10	1.4%
Chemicals	7	1.0%
Electronics	6	0.8%
Transport machines	3	0.4%
Firm Ownership	725	100.0%
Domestic	639	88.1%
Foreign	86	11.9%

*Some categories do not add up to 100.0% due to the rounding.

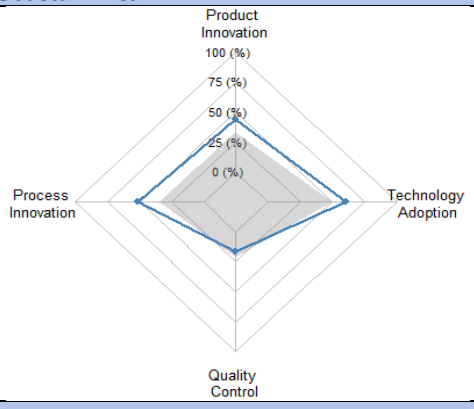
Appendix 4: Detailed Industrial Upgrading Adaptiveness (IUA) Profile

Below are the detailed IUA for each segment. Gray area represents the national average.

Region

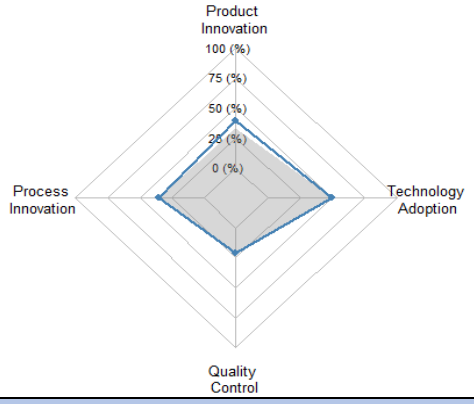
North Central Area and Central Coastal Area

Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		**-**	**16.8%**
Product Innovation	Total	168	44.0%
	Yes	74	
Technology Adoption	Total	170	60.6%
	Yes	103	
Quality Control	Total	169	16.0%
	Yes	27	
Process Innovation	Total	171	51.5%
	Yes	88	



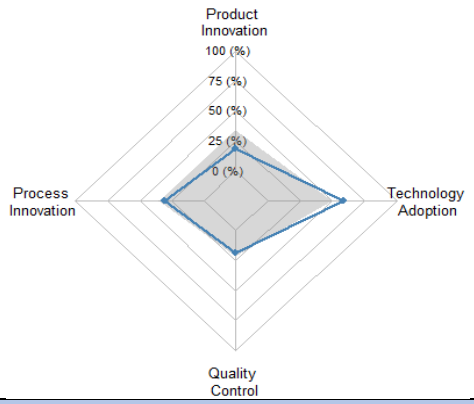
Red River Delta

Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		**-**	**13.0%**
Product Innovation	Total	215	39.5%
	Yes	85	
Technology Adoption	Total	214	50.0%
	Yes	107	
Quality Control	Total	213	21.1%
	Yes	45	
Process Innovation	Total	214	35.5%
	Yes	76	



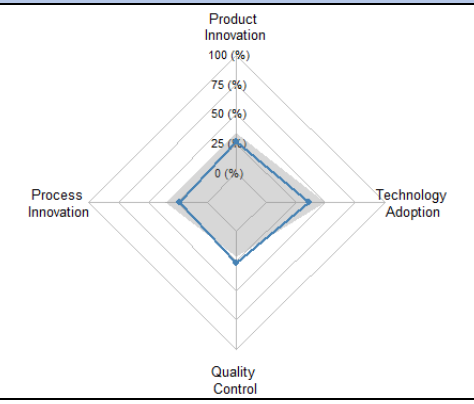
Mekong River Delta

Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		**-**	**8.2%**
Product Innovation	Total	111	18.0%
	Yes	20	
Technology Adoption	Total	110	59.1%
	Yes	65	
Quality Control	Total	108	18.5%
	Yes	20	
Process Innovation	Total	111	30.6%
	Yes	34	



South East

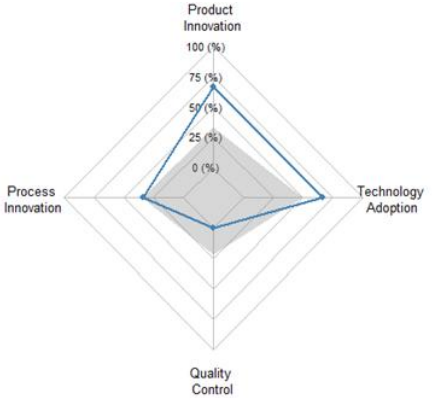
Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		**-**	**7.9%**
Product Innovation	Total	223	26.5%
	Yes	59	
Technology Adoption	Total	225	36.4%
	Yes	82	
Quality Control	Total	221	26.7%
	Yes	59	
Process Innovation	Total	223	23.3%
	Yes	52	



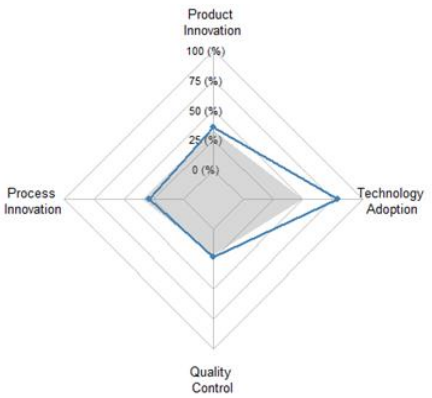
Industry			
Electronics			
Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		-	**43.8%**
Product Innovation	Total	6	66.7%
	Yes	4	
Technology Adoption	Total	6	83.3%
	Yes	5	
Quality Control	Total	6	83.3%
	Yes	5	
Process Innovation	Total	6	33.3%
	Yes	2	

Chemicals			
Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		-	**19.9%**
Product Innovation	Total	7	42.9%
	Yes	3	
Technology Adoption	Total	6	50.0%
	Yes	3	
Quality Control	Total	7	42.9%
	Yes	3	
Process Innovation	Total	7	42.9%
	Yes	3	

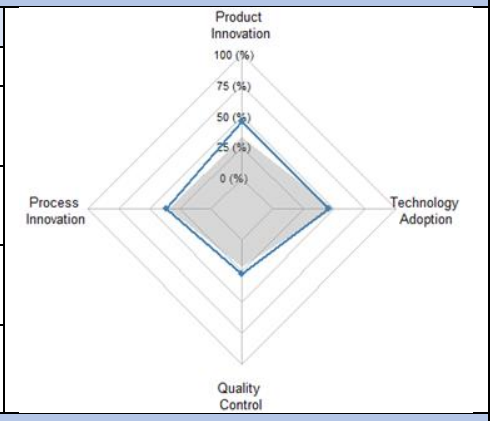
Transport machines			
Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		-	**16.7%**
Product Innovation	Total	3	66.7%
	Yes	2	
Technology Adoption	Total	3	66.7%
	Yes	2	
Quality Control	Total	3	0.0%
	Yes	0	
Process Innovation	Total	3	33.3%
	Yes	1	

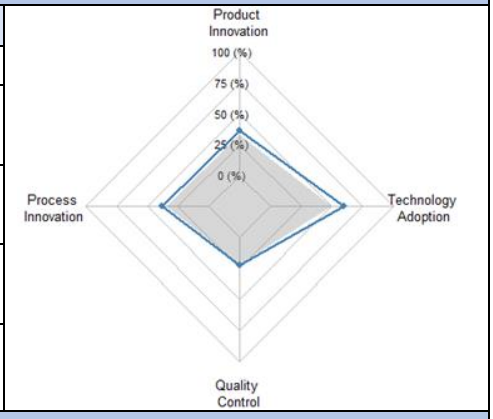


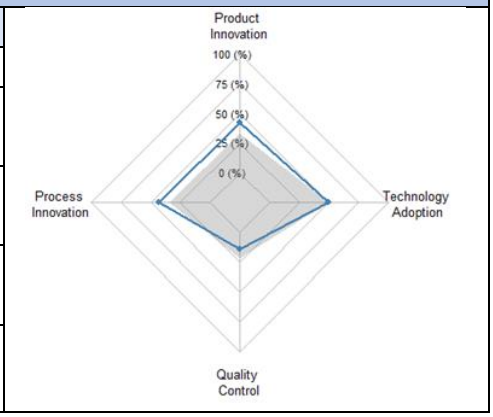
Plastics and rubber			
Category		N	Value
Industrial Upgrading Adaptiveness (IUA)		-	**15.7%**
Product Innovation	Total	14	35.7%
	Yes	5	
Technology Adoption	Total	14	78.6%
	Yes	11	
Quality Control	Total	13	23.1%
	Yes	3	
Process Innovation	Total	14	28.6%
	Yes	4	



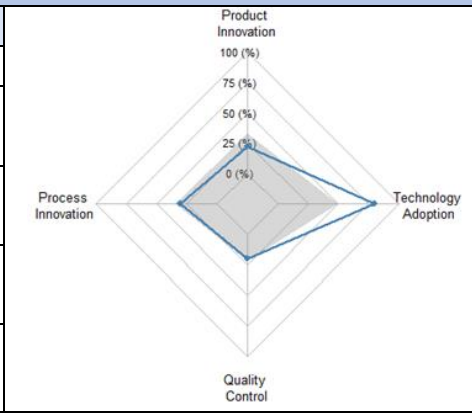
Leather				
Category		N	Value	
Industrial Upgrading Adaptiveness (IUA)		-	**15.6%**	
Product Innovation	Total	10	40.0%	
	Yes	4		
Technology Adoption	Total	10	50.0%	
	Yes	5		
Quality Control	Total	9	22.2%	
	Yes	2		
Process Innovation	Total	10	50.0%	
	Yes	5		

Basic metals				
Category		N	Value	
Industrial Upgrading Adaptiveness (IUA)		-	**14.9%**	
Product Innovation	Total	11	45.5%	
	Yes	5		
Technology Adoption	Total	11	45.5%	
	Yes	5		
Quality Control	Total	11	27.3%	
	Yes	3		
Process Innovation	Total	11	36.4%	
	Yes	4		

Fabricated metal products				
Category		N	Value	
Industrial Upgrading Adaptiveness (IUA)		-	**14.5%**	
Product Innovation	Total	141	36.9%	
	Yes	52		
Technology Adoption	Total	143	59.4%	
	Yes	85		
Quality Control	Total	142	22.5%	
	Yes	32		
Process Innovation	Total	142	38.0%	
	Yes	54		

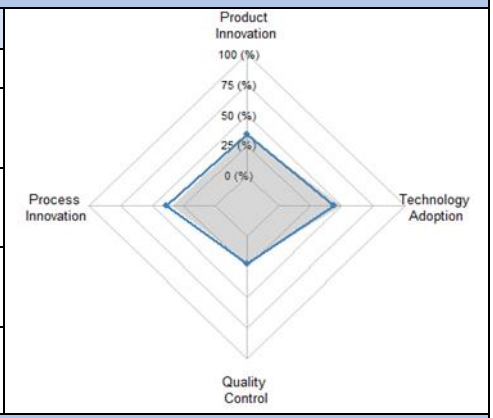
Publishing, printing, and recorded media				
Category		N	Value	
Industrial Upgrading Adaptiveness (IUA)		-	**13.3%**	
Product Innovation	Total	14	42.9%	
	Yes	6		
Technology Adoption	Total	14	50.0%	
	Yes	7		
Quality Control	Total	14	14.3%	
	Yes	2		
Process Innovation	Total	14	42.9%	
	Yes	6		

Paper				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**11.6%**
Product Innovation	Total		9	22.2%
	Yes		2	
Technology Adoption	Total		10	80.0%
	Yes		8	
Quality Control	Total		10	20.0%
	Yes		2	
Process Innovation	Total		10	30.0%
	Yes		3	

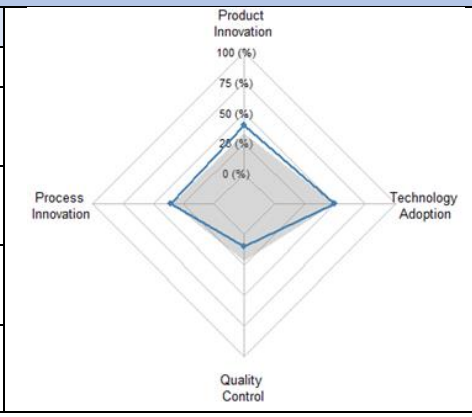


Food				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**11.6%**
Product Innovation	Total		141	31.9%
	Yes		45	
Technology Adoption	Total		142	49.3%
	Yes		70	
Quality Control	Total		140	26.4%
	Yes		37	
Process Innovation	Total		142	30.3%
	Yes		43	

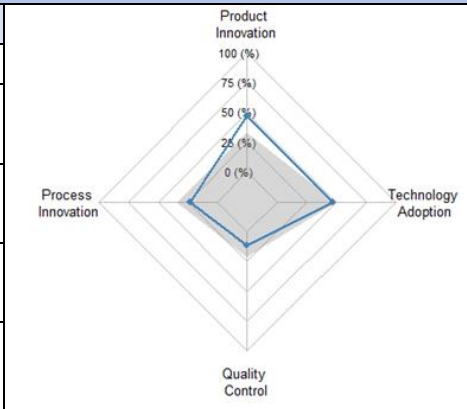
Non metallic mineral products				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**11.5%**
Product Innovation	Total		140	34.3%
	Yes		48	
Technology Adoption	Total		140	43.6%
	Yes		61	
Quality Control	Total		136	22.1%
	Yes		30	
Process Innovation	Total		141	38.3%
	Yes		54	



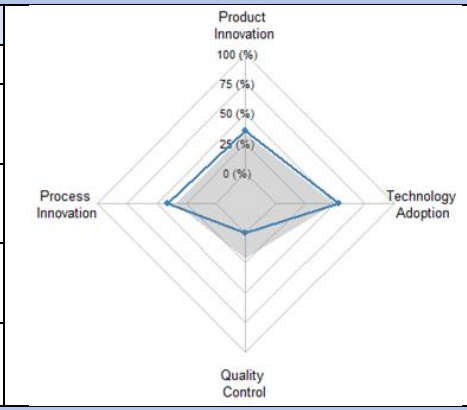
Textiles				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**10.6%**
Product Innovation	Total		20	40.0%
	Yes		8	
Technology Adoption	Total		20	50.0%
	Yes		10	
Quality Control	Total		20	10.0%
	Yes		2	
Process Innovation	Total		20	35.0%
	Yes		7	



Furniture				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			-	**10.4%**
Product Innovation	Total		17	47.1%
	Yes		8	
Technology Adoption	Total		17	47.1%
	Yes		8	
Quality Control	Total		17	11.8%
	Yes		2	
Process Innovation	Total		17	23.5%
	Yes		4	

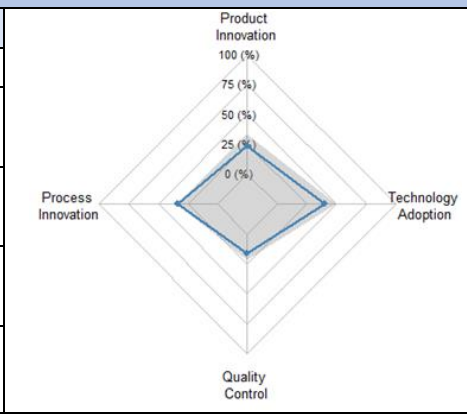


Wood				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			-	**8.3%**
Product Innovation	Total		17	35.3%
	Yes		6	
Technology Adoption	Total		17	52.9%
	Yes		9	
Quality Control	Total		17	0.0%
	Yes		0	
Process Innovation	Total		17	41.2%
	Yes		7	

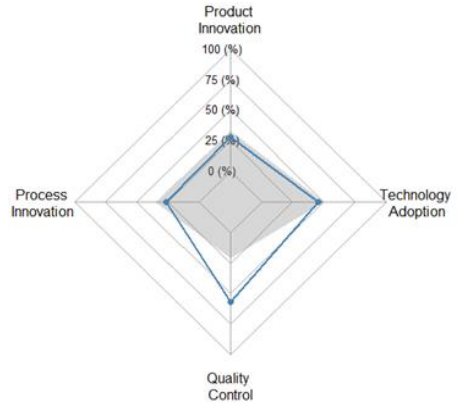


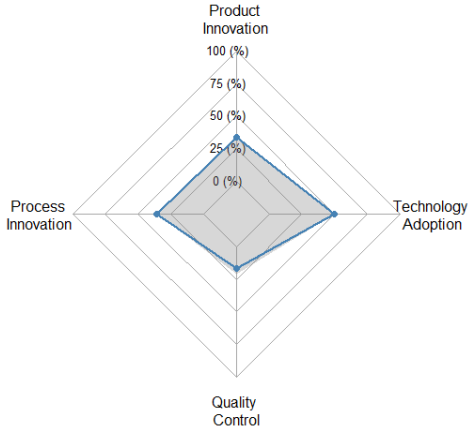
Machinery and equipment				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			-	**7.8%**
Product Innovation	Total		18	22.2%
	Yes		4	
Technology Adoption	Total		17	52.9%
	Yes		9	
Quality Control	Total		18	22.2%
	Yes		4	
Process Innovation	Total		17	17.6%
	Yes		3	

Garments				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			-	**7.4%**
Product Innovation	Total		149	24.2%
	Yes		36	
Technology Adoption	Total		149	39.6%
	Yes		59	
Quality Control	Total		148	16.2%
	Yes		24	
Process Innovation	Total		148	33.8%
	Yes		50	



Firm Ownership				
Foreign				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**15.4%**
Product Innovation		Total	86	27.9%
		Yes	24	
Technology Adoption		Total	85	45.9%
		Yes	39	
Quality Control		Total	84	57.1%
		Yes	48	
Process Innovation		Total	86	26.7%
		Yes	23	
Domestic				
Category			N	Value
Industrial Upgrading Adaptiveness (IUA)			**-**	**10.8%**
Product Innovation		Total	631	33.9%
		Yes	214	
Technology Adoption		Total	634	50.2%
		Yes	318	
Quality Control		Total	627	16.4%
		Yes	103	
Process Innovation		Total	633	35.9%
		Yes	227	





Appendix 5: Relationship Between the IUA and PCI for Each Region

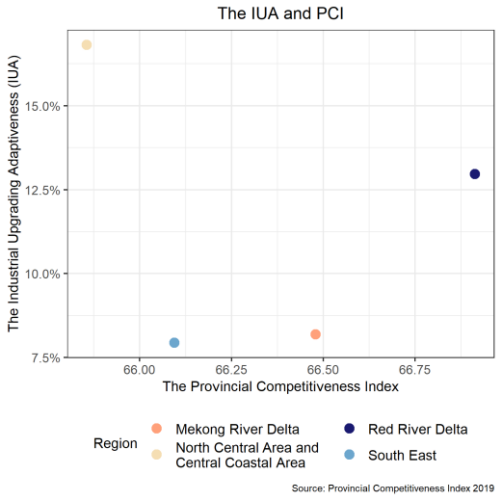
To clarify the relationship between the industrial upgrading adaptiveness (IUA) and the quality of business climate, the paper referred to the Provincial Competitiveness Index (PCI) to extract the characteristics of each region. The PCI quantifies the quality of business climate in each province in Vietnam based on ten aspects. The overall PCI is calculated on the scale of 0 to 100 based on the score of those ten items. The paper grouped 63 provinces into regions and the average PCI for each region was calculated as shown in Table A5.

Table A5: Average PIC Score for Each Region

Category	Central Highlands	Mekong River Delta	North Central Area and Central Coastal Area	Northern Midlands and Mountain Areas	Red River Delta	South East
The Average PCI Score	64.08	66.48	65.86	64.11	66.91	66.09
Entry Costs	7.10	7.16	7.63	7.36	7.38	6.95
Land Access & Tenure	7.09	7.20	6.78	6.42	6.92	7.02
Transparency	6.64	6.69	6.75	6.68	6.62	6.69
Time Costs	6.69	7.92	6.83	6.19	6.81	7.15
Informal Charges	5.95	7.00	6.34	5.72	6.13	6.02
Policy Bias	6.52	6.75	5.88	6.61	6.33	6.25
Proactivity	5.75	6.80	6.33	6.32	6.51	6.00
Business Support Services	6.36	6.24	6.26	5.82	6.36	6.64
Labor Policy	6.28	6.11	6.79	6.74	7.25	6.83
Law & Order	6.05	6.96	6.38	6.95	6.66	6.16

Figure A5 shows the PCI in x-axis and the IUA in y-axis. Each point represents the region where the IUA was identified. From Figure A5, it is unable to observe a clear relationship between the quality of business climate and the IUA. Although a negative slope line can be fitted in the Figure A5, the number of observations is insufficient to conclude that the IUA and the quality of business climate are negatively related. Therefore, a further detailed analysis is required at the provincial level to understand the characteristics of the region with either a high or low IUA.

Figure A5



Appendix 6: Summary Statistics of Variables in Regression Analysis

Dependent Variables	Value	N	Ratio
Product Innovation		717	100.0%
	Yes	238	33.2%
	No	479	66.8%
Technology Adoption		719	100.0%
	Yes	357	49.7%
	No	362	50.3%
Quality Control		711	100.0%
	Yes	151	21.2%
	No	560	78.8%
Process Innovation		719	100.0%
	Yes	250	34.8%
	No	469	65.2%
Industrial Upgrading Adaptiveness Score		700	
	0	216	30.9%
	1	191	27.3%
	2	132	18.9%
	3	131	18.7%
	4	30	4.3%

Independent Variables		Dummy Value	N	Ratio
(1) Output Side				
Domestic Market			625	
	Yes	1	469	75.0%
	No	0	156	25.0%
Foreign Partnership			619	
	Yes	1	71	11.5%
	No	0	548	88.5%
(2) Input Side				
Foreign Origin Input			628	
	Yes	1	286	45.5%
	No	0	342	54.5%
(3) Firm Capability				
Training			716	
	Yes	1	180	25.1%
	No	0	536	74.9%

Appendix 7: Detailed Regression Results

Table A7-1: Regression Result for Product Innovation

	Dependent variable:							
	Product Innovation							
	OLS						*logistic*	*probit*
		Output		Input	Capacity		Combined	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
International Market	-0.030		-0.046			-0.093*	-0.482*	-0.273*
	(0.048)		(0.048)			(0.048)	(0.252)	(0.149)
Foreign Partnership		0.205***	0.210***			0.133**	0.621**	0.379**
		(0.060)	(0.060)			(0.059)	(0.291)	(0.176)
Foreign Origin Inputs				0.158***		0.122***	0.619***	0.368***
				(0.039)		(0.040)	(0.205)	(0.123)
Training					0.317***	0.270***	1.228***	0.747***
					(0.039)	(0.043)	(0.209)	(0.127)
Constant	0.286*	0.309*	0.309*	0.232	0.203	0.188	-1.579**	-0.942**
	(0.163)	(0.161)	(0.161)	(0.160)	(0.141)	(0.156)	(0.756)	(0.459)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	615	615	624	710	610	610	610
R^2	0.064	0.083	0.084	0.093	0.141	0.164		

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Table A7-2: Regression Result for Technology Adoption

	Dependent variable:							
	Technology Adoption							
	OLS						*logistic*	*probit*
		Output		Input	Capacity		Combined	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
International Market	0.176***		0.172***			0.113**	0.520**	0.315**
	(0.050)		(0.050)			(0.051)	(0.235)	(0.142)
Foreign Partnership		0.055	0.034			-0.023	-0.123	-0.077
		(0.064)	(0.063)			(0.064)	(0.287)	(0.175)
Foreign Origin Inputs				0.182***		0.156***	0.709***	0.433***
				(0.040)		(0.043)	(0.197)	(0.120)
Training					0.188***	0.111**	0.516**	0.316**
					(0.043)	(0.046)	(0.212)	(0.129)
Constant	0.542***	0.542***	0.543***	0.489***	0.514***	0.473***	-0.104	-0.061
	(0.168)	(0.170)	(0.168)	(0.167)	(0.153)	(0.166)	(0.733)	(0.451)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	616	616	625	713	611	611	611
R^2	0.098	0.080	0.098	0.113	0.100	0.131		

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Table A7-3: Regression Result for Quality Control

	Dependent variable:							
	Quality Control							
	OLS						*logistic*	*probit*
		Output		Input	Capacity		Combined	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
International Market	0.184***		0.156***			0.098**	0.714**	0.429***
	(0.043)		(0.042)			(0.042)	(0.280)	(0.163)
Foreign Partnership		0.363***	0.345***			0.273***	1.376***	0.826***
		(0.053)	(0.053)			(0.052)	(0.309)	(0.184)
Foreign Origin Inputs				0.232***		0.155***	1.064***	0.619***
				(0.034)		(0.035)	(0.242)	(0.139)
Training					0.224***	0.174***	1.114***	0.649***
					(0.035)	(0.038)	(0.244)	(0.142)
Constant	0.269*	0.306**	0.307**	0.197	0.166	0.207	-1.602**	-0.964**
	(0.143)	(0.140)	(0.139)	(0.140)	(0.125)	(0.135)	(0.807)	(0.482)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	613	607	607	615	703	602	602	602
R^2	0.091	0.134	0.154	0.131	0.107	0.220		

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Table A7-4: Regression Result for Process Innovation

	Dependent variable:							
	Process Innovation							
	OLS						*logistic*	*probit*
		Output		Input	Capacity		Combined	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
International Market	-0.036		-0.048			-0.081	-0.406*	-0.227
	(0.049)		(0.049)			(0.050)	(0.244)	(0.146)
Foreign Partnership		0.149**	0.155**			0.095	0.449	0.272
		(0.061)	(0.062)			(0.062)	(0.287)	(0.175)
Foreign Origin Inputs				0.115***		0.086**	0.422**	0.259**
				(0.040)		(0.042)	(0.202)	(0.122)
Training					0.275***	0.215***	0.942***	0.578***
					(0.040)	(0.045)	(0.204)	(0.125)
Constant	0.290*	0.307*	0.307*	0.248	0.254*	0.215	-1.251	-0.786*
	(0.165)	(0.164)	(0.164)	(0.164)	(0.144)	(0.162)	(0.780)	(0.469)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	621	616	616	625	713	611	611	611
R^2	0.062	0.071	0.073	0.076	0.121	0.119		

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Table A7-5: Regression Result for Industrial Upgrading Adaptiveness Score

	Dependent variable:							
	Industrial Upgrading Adaptiveness Score							
	OLS						*ordered logistic*	*ordered probit*
		Output		Input	Capacity		Combined	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
International Market	0.280**		0.220*			-0.0001	0.075	0.012
	(0.124)		(0.122)			(0.118)	(0.200)	(0.118)
Foreign Partnership		0.791***	0.764***			0.496***	0.789***	0.487***
		(0.153)	(0.154)			(0.146)	(0.252)	(0.145)
Foreign Origin Inputs				0.708***		0.534***	0.909***	0.547***
				(0.097)		(0.099)	(0.172)	(0.100)
Training					1.018***	0.783***	1.308***	0.745***
					(0.101)	(0.106)	(0.186)	(0.107)
Constant	1.392***	1.478***	1.479***	1.167***	1.147***	1.089***		
	(0.413)	(0.405)	(0.404)	(0.399)	(0.354)	(0.377)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	605	600	600	608	694	595	595	595
R^2	0.075	0.109	0.114	0.147	0.191	0.244		

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Appendix 8: Detailed Regression Results (By Firm Ownership)

Table A8-1: Regression Result for Domestic Firms

	Dependent variable:				
	Product Innovation	Technology Adaption	Quality Control	Process Innovation	Industrial Upgrading Adaptiveness Score
	OLS	*OLS*	*OLS*	*OLS*	*OLS*
	(1)	(2)	(3)	(4)	(5)
International Market	-0.061	0.116**	0.058	-0.068	0.001
	(0.054)	(0.058)	(0.045)	(0.056)	(0.133)
Foreign Partnership	0.181**	-0.014	0.230***	0.105	0.537***
	(0.071)	(0.078)	(0.059)	(0.075)	(0.176)
Foreign Origin Inputs	0.126***	0.144***	0.112***	0.093**	0.491***
	(0.044)	(0.047)	(0.036)	(0.046)	(0.107)
Training	0.266***	0.124**	0.170***	0.225***	0.795***
	(0.047)	(0.051)	(0.038)	(0.049)	(0.114)
Constant	0.162	0.639***	0.050	0.155	1.007**
	(0.177)	(0.192)	(0.145)	(0.186)	(0.428)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	527	529	521	528	515
R^2	0.176	0.113	0.163	0.119	0.238

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

Table A8-2: Regression Result for Foreign Firms

	Dependent variable:				
	Product Innovation	Technology Adaption	Quality Control	Process Innovation	Industrial Upgrading Adaptiveness Score
	OLS	*OLS*	*OLS*	*OLS*	*OLS*
	(1)	(2)	(3)	(4)	(5)
International Market	-0.129	0.153	0.159	0.013	0.180
	(0.121)	(0.122)	(0.131)	(0.123)	(0.337)
Foreign Partnership	0.083	-0.016	0.157	0.146	0.362
	(0.115)	(0.116)	(0.124)	(0.117)	(0.319)
Foreign Origin Inputs	0.079	0.458***	0.126	0.088	0.730*
	(0.126)	(0.128)	(0.143)	(0.128)	(0.368)
Training	0.131	0.192	0.092	0.015	0.466
	(0.134)	(0.136)	(0.147)	(0.136)	(0.378)
Constant	0.353	-0.291	0.891**	0.510	1.472
	(0.320)	(0.322)	(0.345)	(0.325)	(0.885)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	83	82	81	83	80
R^2	0.388	0.505	0.425	0.351	0.441

Note: Numbers in parentheses represent the standard error. *p<0.1, **p<0.05, ***p<0.01

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