COMPLEXITY ANALYSIS STUDY OF MALAYSIA'S MANUFACTURING INDUSTRIES

2014 || FINAL REPORT

EPU
ECONOMIC PLANNING UNIT
PRIME MINISTER'S DEPARTMENT, MALAYSIA

UKM
PAKARUNDING

COMPLEXITY ANALYSIS STUDY OF MALAYSIA'S MANUFACTURING INDUSTRIES

2014 || FINAL REPORT

For further information, please contact:

Director General
ECONOMIC PLANNING UNIT
Prime Minister's Department
Block B5 & B6, Complex B
Federal Government Administrative Centre
62502 PUTRAJAYA

www.epu.gov.my

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List of Acronyms

C&P	Chemicals and Plastics
CCHC	Cabinet Committee on Human Capital
CEPII	Centre d'EtudesProspectives et d'InformationsInternationales
CICM	Chemical Industries Council of Malaysia
CREST	Collaborative Research in Engineering, Science & Technology
DoS	Department of Statistics
DSD	Department of Skills Development
E&E	Electrical and Electronics
ECI	Economic Complexity Index
EIR	Entrepreneurship – In – Residence
EPU	Economic Planning Unit
ETP	Economic Transformation Programme
GDP	Gross Domestic Product
GLCs	Government-linked companies
GoM	Government of Malaysia
HS2	Harmonised System Codes, 2 digits
HS4	Harmonised System Codes, 4 digits
ILMIA	Labor Market Information and Analytics
I-O	Input-Output
M&E	Machinery and Equipment
MaGIC	Malaysian Global Innovation and Creativity Center
MEMA	Machinery and Equipment Manufacturers Association of Malaysia
MIDA	Malaysian Investment Development Authority
MNCs	Multinational Companies
MoF	Ministry of Finance
MOHR	The Ministry of Human Resources
MSIC	Malaysia Standard Industrial Classification
NKEAs	National Key Economic Areas
OGI	Opportunity Gain Index
PCI	Product Complexity Index
PEMANDU	Performance Management & Delivery Unit
PI	Precision Instruments
PITRS	Penang Industrial Talent Required Study
PSDC	Penang Skills Development Centre
RCA	Revealed Comparative Advantage
RM	Ringgit Malaysia
SMEs	Small Medium Enterprises
SOEs	State-owned Enterprises
UN COMTRADE	United Nations International Trade Database
VDP	Vendor Development Program

Executive Summary

This report evaluates Malaysia's strategic diversification opportunities in three "priority sectors" identified by the Economic Planning Unit (EPU): Machinery and Equipment (M&E), Chemicals and Plastics (C&P), and Electrical and Electronics (E&E). We employ the Economic Complexity framework, an approach recently developed at Harvard and Massachusetts Institute of Technology (MIT), which emphasises how existing capabilities can be leveraged to develop new products and upgrade a country's export base.

Our analysis documents how, in what we call Malaysia's "first modern industrial transformation", the country went from relying largely on resource-based exports in the 1960s to an impressively more complex and dynamic export composition in the 1990s, especially due to growth in the E&E sector. Along with the upgraded complexity of the economy came remarkable economic growth. These changes, however, have not continued in recent years, and the composition of exports at the end of the 1990s is quite similar to 2012. Shortly after the process of diversification of the economy decelerated, so did growth.

We argue that a "second modern industrial transformation" is needed to revitalise growth, and that it should be guided by three criteria: leveraging existing productive capabilities, increasing economic complexity, and improving access to more attractive diversification opportunities. Using international trade data and metrics representing these criteria we systematically evaluate the potential of Malaysia in currently under-developed clusters. Through filtering United Nation COMTRADE data for products that have a greater economic complexity than Malaysia's average, are feasible for production (measured by their distance from current production capabilities), and present strong opportunity gains, we created a list of 238 products concentrated in the prioritised M&E, C&P, and E&E sectors. This prioritized list of "frontier products" can become the basis of the next wave of diversification.

A detailed review of the frontier opportunities highlights, among others, general- and special-purpose machinery as well as precision instruments in M&E, organic chemicals and pharmaceutical products in C&P, and a few still-underdeveloped high-complexity products in E&E. We complement this analysis with data from the Census of Manufacturing Industries to explore the size, productivity, and other important characteristics of firms in the priority sectors, documenting key observations like the strategic role of international firms and the lack of competitive

scale and capital investment in many frontier products, particularly among local firms.

We conducted detailed case studies on select frontier products identified by the complexity framework to determine the current state of target industries. These case studies include a Growth Diagnostic analysis to identify binding constraints to further investment in frontier products and strategically target policy intervention. The findings of the case studies show that there are constraints related to intermediation and cost of private capital financing; a paucity of skilled labor; and coordination challenges. These findings inform the proposed policy recommendations. These recommendations emphasise the need for a shift in the paradigms that guide policy interventions to a focus on targeted coordination, a network approach to capabilities development and the role of the public sector as catalyst.

Regarding policy, our findings call for a complexity-focused vision of Malaysia's future development in which the latent potential of frontier products in M&E, C&P and E&E play a more decisive role. To achieve this vision we recommend leveraging and augmenting existing capabilities, enhancing strategic coordination, and improving access to risk-tolerant finance in strategic areas. We have also outlined a set of pragmatic implementation mechanisms while remaining flexible to manage the risks that are intrinsically associated with structural transformation.

I. Introduction

This report evaluates the economic transformation opportunities available to Malaysia using the Economic Complexity framework and methods. We concentrate on three "priority sectors" identified by the Economic Planning Unit (EPU): Machinery and Equipment (M&E), Chemicals and Plastics (C&P), and Electrical and Electronics (E&E).

What we have in mind when we refer to "economic transformation" is the strategic diversification of the country's export basket. Recent research on Economic Complexity[1] has produced compelling evidence showing that countries that diversify their economy by adding to their export basket increasingly sophisticated products tend to achieve higher income levels. Our work is based on the premise that achieving this type of diversification should be a central part in Malaysia's policy agenda.

This premise has two important connotations. First, our focus will *not* be on how Malaysia can gain or maintain market positions in industries in which they are already significantly specialised (i.e. growing in what can be referred to as the "intensive margin"). We will look instead at the opportunities space among products that Malaysia is yet to develop significantly (i.e. the opportunities to grow along the "extensive margin").We don't mean to imply that there is no value in fostering exports growth in the intensive margin; on the contrary, we believe that this is an important aspect of any growth strategy. What we are suggesting is that there is great strategic value in developing along the extensive margin, and given how critical diversification can be for growth, the development of new industries cannot be treated as a second-order issue. Strategic diversification of the economy should be a priority in Malaysia's strategy to sustain and enhance economic growth.

The second connotation is that not all types of diversification are equally desirable. On the one hand, some new products will be more valuable than others, either because they increase the knowledge base of the economy or because they open doors to higher-value areas of future diversification. On the other hand, some products will be more "accessible" to Malaysia than others based on the existing natural and human resources, infrastructure, etc. Diversifying strategically implies developing new products that offer a good combination of value and accessibility, that is, products that offer a favorable cost-benefit outlook for the country. This

[1] Most of the relevant recent research in this area is summarised in the "Atlas of Economic Complexity" published by Harvard's Center for International Development (CID) and the MIT Media Lab, available at: http://www.atlas.cid.harvard.edu/.

report presents an effort to map the space of the products still not fully developed in Malaysia in a way that allows us to see more clearly the strategic diversification opportunities.

The use of the Economic Complexity framework implies that the emphasis will be placed on understanding the existing productive capabilities of the country and how they can be leveraged for strategic diversification. This is different from other approaches such as the "value chain" framework. To illustrate, let us think of a country that has developed a successful cluster in forestry and logging. "Moving up the value chain" for such a country may imply adding value to their current output by producing furniture. However, it is not necessarily the case that the capabilities that firms have developed in the logging business give them a comparative advantage in the design and manufacture of furniture. Their know-how, for example, could position them better to enter the market of specialised cutting machinery. In the meanwhile, a country with a strong garments industry (where the design component is central to the business) may have capabilities more suited to develop a successful furniture industry.

The Economic Complexity approach is not mutually exclusive with approaches focused on value chains. Frequently, the best way of leveraging current capabilities for diversification may indeed be moving into products with greater value added within the same industry. But in many cases the best opportunities may lie in related but different value chains. By exploring the potential uses of existing productive capabilities across a larger space of products, the Economic Complexity methods allow us to consider a wider set of opportunities before establishing priorities.

The complexity analysis presented in this report relies heavily on the United Nations international trade database (COMTRADE). This is because, as will become clearer when we detail in Section III, the measures used incorporate information not only of one country and selected products, but of all countries and products for which we have comparable information globally. International Trade Data is the most complete source of international data useful for our purposes.

The methods used and our reliance on trade data set the scope of the analysis. We are able to consider product categories as defined in the classification system used (the 4-digits Harmonised System classification, HS4). This implies that differences across product types and their qualities that are finer than the HS4 categories

escape our radar[2]. It also implies that we do not incorporate information on economic activities in non-traded products and in services.[3]

Another key point regarding the scope of the analysis is that our capabilities-centered approach emphasises the supply-side. When we say that Malaysia has the capabilities to develop, for example, certain types of precision machinery, we mean that looking at the data of many countries worldwide (e.g. under what conditions different products typically emerge) suggests that the country "has what it takes" to export this product in significant quantities. The method does not directly incorporate an analysis of the specific market conditions for each product. This means that the findings of this report should be complemented by demand-side considerations including the competitive environment of industries, market potential, and price dynamics; as well as other relevant factors like resource use, sustainability, environmental impacts, and social impacts.

After identifying products for prioritisation we dig further into the potential constraints facing producers and would be investors. Within E&E, M&E, and C&P, we conduct case studies of two products each from the list of prioritised products. The case study method is complemented by the Growth Diagnostics framework. The Growth Diagnostics framework is based on the idea that while many factors may seem to hold product production back not all these impediments will bind equally. Indeed, resource limits require a prioritisation, which in turn is achieved by asking which of the impediments will, if relaxed, deliver the 'biggest bang for the effort'. The degree to which a constraint is binding is indicated by the change in, say, investment or exports due to a provision of the constrained factor. For example, where lack of skilled labor constrains a product from being developed, we might observe significant wage premia for those who hold the scarce skills. If a particular constraint is relaxed, say a firm brings in foreign skilled labor; this should have a payoff for growth or investment in the prioritised product. If cost of finance is the binding constraint, then a lowering thereof e.g., through a reduction in lending interest rates should have a positive impact on the investment rate and therefore exports of the prioritised product.

[2] The COMTRADE data presented in the harmonised system classification does report exports data at a finer level of aggregation (6-digits or more). However, the reliability and consistency of the data diminish significantly beyond the 4-digits level (i.e. there is a large variation in the quality of the data reported by different countries when the classification of products is very granular). This is why we follow the convention of the Economic Complexity literature and use the HS4 classification.

[3] Ideally we would like to perform this analysis using production data that includes also services and non-traded products. However, to our knowledge there is no internationally comparable production data of this kind available. That said, it is worth mentioning that analyses focused on production data within countries (e.g. across cities or regions) including services and non-traded products have found that many of the empirical facts that are observed across countries and constitute the basis of the economic complexity approach also appear across sub-national geographies, notably the negative relationship between the diversification of cities and regions and the average ubiquity of their industries (The Atlas of Economic Complexity, 2014). This strongly suggests that the mapping of productive capabilities in the tradable sector is not significantly distorted by the absence of services data.

Once a constraint is identified, it is useful to offer evidence to illustrate the manifestations of the missing input. For instance, we must understand how private agents are coping with the lack of the identified input. We need to look at the current industrial landscape to determine key drivers for the successful products. We proceed in this manner for 6 of the 238 products isolated in the complexity analysis.

The remainder of the report is organised in eight sections. Section II discusses the macroeconomic and policy context of this report. Section III presents in more detail the Economic Complexity and Product Space frameworks, the empirical evidence upon which it is constructed, and some of the measures that this framework has produced. Section IV looks at Malaysia's recent development history through the lens of Economic Complexity and the Product Space. Section 0 presents our quantitative assessment of the frontier export opportunities of Malaysia, prioritising among the products that the country still does not export significantly and those best suited for strategic diversification. Section VI uses data from the Malaysian census of manufacturing industries to look at the firms in the priority sectors and provide a clearer picture of their size composition, productivity, and the roles of national and international players. Section VII presents the case study of selected frontier products in which the growth diagnostic framework is applied. Section VIII presents the policy framework for strategic transformation. Section IX concludes.

II. Macroeconomic and Policy Context

By most international standards, the development story of Malaysia has been one of tremendous success. A largely agrarian and resource-based low-income economy in the 1950s, Malaysia today is an upper middle-income country with GDP per capita of $10,500 (current US$)[4]. Less than 2 percent of the Malaysian population lives below the national poverty line and over 95percenthasaccess to key services such as primary education, immunisation, and basic healthcare.[5] The country is consistently ranked high on various international measures of competitiveness and ease of doing business. It is the fourth most "open" economy in the world as measured by average share of exports in GDP[6], and it enjoyed an average GDP growth of 7.2 percent during the 1990sand4.8 percent during the 2000s.

Malaysian exports growth and deceleration

Malaysia's remarkable history of growth and transformation over the past half-century was broadly fueled by two sources. One is Malaysia's traditional sectors, which include oil and gas and tree crops (oil palm, rubber). The other is the electrical and electronics (E&E) sector, which emerged in Malaysia starting with Intel's decision in 1972 to locate its first offshore assembly plant on the island of Penang. Aided by a range of proactive government policies to attract foreign investment, including tax holidays, subsidies, export processing zones, targeted investments and other incentives[7], subsequently Malaysia became home to many of the world's leading electronics manufacturers. In 2012 the sector accounted for18% of GDP and 22% of Malaysia's total exports.[8]

However, the sector's ability to continue to fuel the large share of GDP and export growth is currently in question. With a significant expansion in supply by regional competitors such as China, Thailand and Vietnam and the consequent decrease in prices, profit margins in important sub-sectors (such as semi-conductors) have been shrinking. In addition, the industry has matured and lacks the growth dynamism of younger industries. Moreover, the sector is largely composed of foreign multi-national companies (MNCs) who, despite their long-lived presence in Malaysia, could become foot-loose in the medium run if the attraction to lower-cost

[4] Unless otherwise noted the source of statistics reported in this section are the World Development Indicators, available at http://data.worldbank.org/data-catalog/world-development-indicators (accessed July, 2014).
5 Asian Development Bank, Basic Statistics 2014.
6 On average, exports as a share of GDP stood at 108 percent during the 2000s. In comparison, the average value of exports in GDP during the 2000s was 33 percent for countries in East Asia and Pacific and 31 percent for all upper middle-income countries.
[7] Rasiah, Rajah (1995). *Foreign capital and industrialization in Malaysia*. Macmillan Press: New York, N.Y.
[8] Own calculations using COMTRADE-CEPII data.

manufacturing locations increases. In recent years Malaysia has been increasingly sourcing low-wage workers from abroad in order to preserve its competitiveness in the assembly and lower value added activities in this sector. Driven partly by the slowdown in E&E growth, exports are becoming a less dynamic driver of growth in Malaysia overall. The share of exports in GDP has fallen from 120 percent in 2000 to an average of 78 percent since 2012.

Current challenges

The current state of the E&E sector illustrates the threat of the "middle-income trap" whereby a country is no longer competitive as a low-cost manufacturing location but is still inadequately positioned to be a premier location for the development and manufacture of frontier products.[9] One solution is to move into higher value-added activities such as product development and design. Various government-aided programs in Malaysia have been established to promote precisely such efforts. However even if such upgrading in the E&E sector succeeds, it is not clear that it would be enough to provide sufficient fuel to power the desired GDP growth rates in the economy.

Another challenge that the government has tried to address is the low value added value of local businesses in the economy. MNCs dominate the E&E sector and have an important but smaller presence in other sectors like Chemicals and M&E. In 2011 more than 60 percent of all projects approved by the Malaysian Investment Development Authority (MIDA) were foreign.[10]State-owned companies (SOEs) and Government-linked companies (GLCs) also play a big role in the Malaysian economy, especially in strategic sectors such as oil and gas, transport, telecommunications, finance, and utilities. The contribution of privately owned Malaysian business to GDP and exports is relatively small by comparison. The average local manufacturing firm employed32workers and had annual sales of RM 16.3 million in 2010 compared to an average of 390 workers and sales of RM 218.7 million for foreign manufacturing firms.[11] How domestically owned firms can become more productive and eventually compete in global markets remains one of the main policy questions.

9 Economic Transformation Programme: A Roadmap for Malaysia, Chapter 1. http://etp.pemandu.gov.my/
10 Malaysian Investment Development Authority, http://www.mida.gov.my/home/facts-and-figures/posts/ (accessed August, 2014).
[11] Data from the 2010 Manufacturing Census, DoS.

Government policies and economic transformation

Historically the government has played an active role in steering industrial development in Malaysia. The 10th Malaysia Plan (2010-2015) sets the goal of achieving high-income status by 2020, an aim that will require roughly 6 percent annual growth. One of the key implementing tools has been the Economic Transformation Program (ETP) whose aim is to stimulate projects in 12 national key economic areas (NKEAs) to promote private-sector led growth and deliver higher value added activities. The NKEAs include oil, gas & energy, education, tourism, wholesale & retail trade, E&E, healthcare, palm oil, communications, agriculture, business services, financial services, and Greater Kuala Lumpur / Klang valley development.[12] The ETP has succeeded in attracting incremental investments in a number of important areas of the economy. However, these efforts largely focus on industries that are already among the strongest in the country.

Meanwhile, a clear strategy on how to achieve a more fundamental economic transformation, one that could fuel growth not only incrementally but for the next decade or two, is still incomplete. In other words, the efforts to upgrade the existing economic sectors have not been accompanied by a clear strategy for the development of new and more complex industries in which Malaysia can become a leading producer and exporter. While the country has a well-developed presence in electronics, there are still few internationally competitive firms in other critical sectors such as machinery and chemicals. In comparison to its wealthier neighbors and high-income countries more broadly, Malaysia currently lags behind. The aim of this report is to map the opportunities for transformation and diversification. We hope to add value by identifying the frontier that lies just beyond the scope of Malaysia's current export base but not so far as to be unattainable. Our goal is to contribute to a strategy on what can become new drivers of growth in the Malaysian economy over the next 10 or 20 years. We discuss in the next section the frameworks and methods that we employ.

[12] http://etp.pemandu.gov.my/

III. Economic Complexity and the Product Space

Economic complexity is a novel framework developed over the last decade by a team of researchers at Harvard and MIT led by professors Ricardo Hausmann (Center for International Development, Harvard) and Cesar Hidalgo (Media Lab, MIT). Employing methods from network science, these teams have carefully analyzed the composition of exports of countries around the world, documenting a series of revealing empirical patterns. They also created a series of metrics that have become a very powerful tool to study the patterns of economic diversification and how they relate to growth.

A detailed account of the theory, the main empirical findings and technical definitions of these metrics, can be found in the recently published "Atlas of Economic Complexity".[13] In this chapter we seek to provide a summary overview of this approach and an intuitive explanation of the economic complexity methods employed in our analysis.

RCA and the patterns of international trade

The empirical strategy of this approach starts by distinguishing when a country exports a product "significantly" and when it does not. To do this, it employs the measure known as "Revealed Comparative Advantage" (RCA). It is calculated by dividing the share of the country in the world market *of that product* over the share of the country in total world exports[14]. For example if Malaysia accounts for 40 percent of world trade in crude palm oil and for 1.5 percent of world exports overall, Malaysia will have an RCA = 27 in palm oil. In general, having an RCA larger than one in a product implies that the country is relatively specialised in the production of that good (i.e. it exports that product "significantly"), and having an RCA smaller than 1 implies that the country is less specialised in that good than the world average[15].

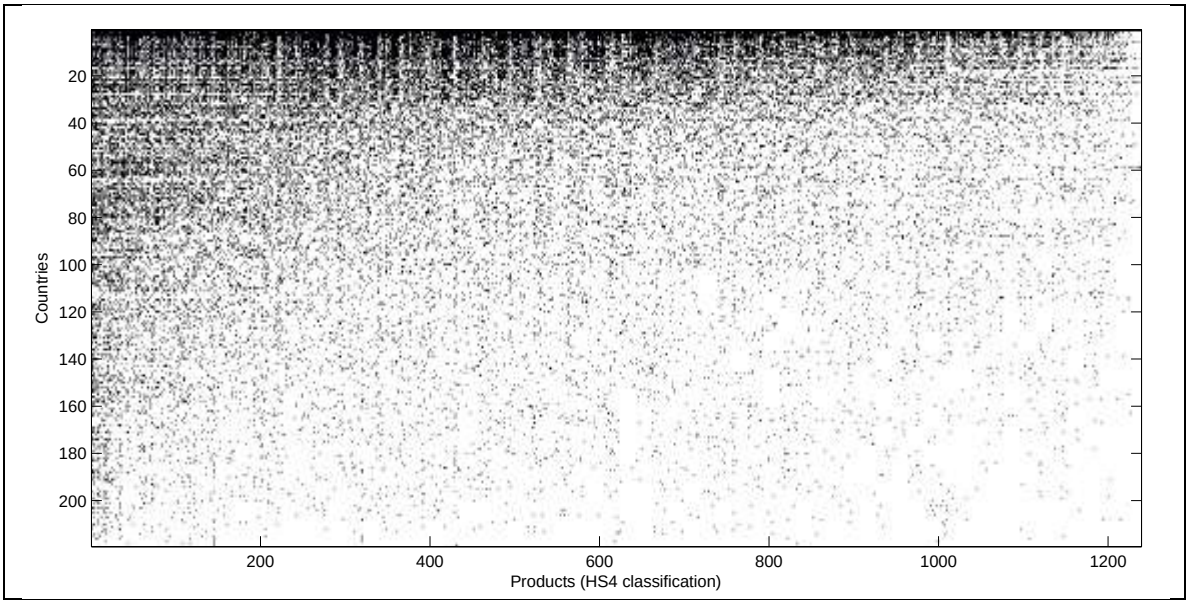
[13] This book and the associated website can be accessed at http://atlas.cid.harvard.edu

[14] Specifically, $RCA_{c,p} = \frac{X_{cp} / \sum_c X_{cp}}{\sum_p X_{cp} / \sum_{c,p} X_{cp}}$ where X denotes exports, *c* indexes countries, and *p* indexes products.

[15] All economic-complexity and product-space measures begin by simplifying country-product export data and turning it into a matrix of zeroes and ones indicating which countries exports which products "significantly" (this is usually known as the Mcp or Matrix Country-Product). The traditional way of doing this simplification is calculating RCA for every country-product pair, and categorizing a country as a significant exporter of a product if it has RCA equal or greater than one in that product. An important limitation of this approach is that if a country has very large exports in some products, other products that have smaller but still significant exports may end up not being counted, because they represent a relatively small share of the country's total exports. This is particularly relevant for Malaysia, where the size of its first-order exports (like semiconductors, palm oil and hydrocarbons) may opaque the visibility of some second-order exports, even if they are big comparing to other countries of similar size. This is why the most recent computations published in the Atlas of Economic Complexity considers that a country exports a product significantly if a)

The Economic Complexity researchers have extensively documented that the matrix linking countries with the products they export significantly (i.e. with RCA) has a clear structure as depicted in Figure 1. This visualisation of the export data matrix places 223 countries in the rows and the 1,241 products in the HS4 classification system in the columns, and sorts them according to the amount of products that countries export with RCA and the amount of countries that export each product with RCA. A black cell denotes that a country has RCA in the corresponding product and a white cell that it does not.

Figure 1: The Country-Products Matrix, 2012



Source: COMTRADE/CEPII data, own calculations

Figure 1 shows that while some countries export almost every product (they are diversified) others export only a few. Conversely, some products are exported by almost all countries (they are ubiquitous) while others are exported by only a few. This evidence is at least partially at odds with the dominant theories of international trade that predict that countries will tend to specialise in the production of certain goods based on their comparative advantage which can stem either from i) their factor endowments such as natural resources, human, and physical capital (Heckscher-Ohlin advantage) or ii) their productivity in certain activities (Ricardian advantage). While it is true that global trade patterns are consistent with both factor endowments and productivity playing an important role in shaping a country's

the country has RCA>=1 in that product, or b) the share of the country in the world market *of that product* is at least twice as large as the share of the country in the world population. This is the approach we have adopted for the computation of all the complexity measures included in the report.

export patterns, we do not nearly observe the large degree of specialisation that these theories predict.

Perhaps the most surprising empirical fact represented in Figure 1, is that there is a clear negative relationship between the diversity of a country's exports (how many products it exports) and the average ubiquity of its products (how many other countries export these products). Specifically, diversified countries tend to export goods that are on average rare – i.e. exported by few other countries. In contrast, undiversified countries export goods that are very common or ubiquitous. This implies that instead of specialising, countries tend to diversify as they advance in their development. Rather than abandoning certain industries in favor of others, they tend to add to their export basket new and more advanced products.

Productive capabilities and economic complexity

What can explain the observed patterns? Hausmann, Hidalgo and their co-authors propose a theory whereby what countries can produce and export reflects their underlying productive capabilities. Countries have capabilities that can be used to make goods. Different products require different capabilities – more complex products require many sophisticated capabilities while simple products require few. In this model of the world, countries with many capabilities are able to produce and export many different products including those that are very complex, i.e. that require many different capabilities. These are the diversified countries whose exports are rare on average. Countries with few capabilities are able to produce and export only a few simple products. These are the undiversified countries whose exports are ubiquitous on average.

Using network science methods, Hausmann, Hidalgo, and co-authors have constructed measures of the capabilities intensity or economic complexity of countries and products. The Economic Complexity Index (ECI) is a measure developed for each country by looking at how diversified its exports are, and adjusting their diversity based on how ubiquitous or rare the products in its export basket are, how diversified other countries that export the same products are, how ubiquitous or rare the exports of these countries are, and so on. In a similar fashion, the Product Complexity Index (PCI) measures how ubiquitous a product is, and adjusts this measure according to how diversified countries that export that product

are, how rare or ubiquitous other products that these countries export are, and so on.[16] Both of these measures are expressed in standard deviations from the mean.

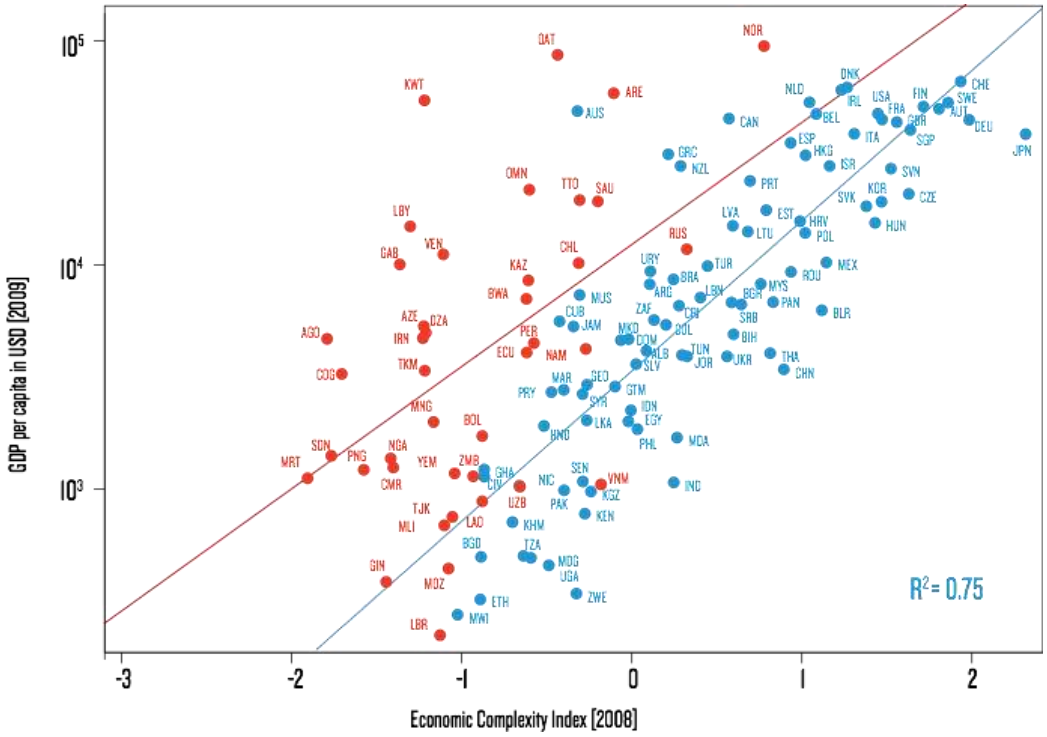
Complexity, development, and growth

One remarkable finding is that ECI is highly correlated with GDP per capita levels. Higher income countries tend to have higher economic complexity, and in those that do not their income is usually highly reliant on resource-based activities. Although the ECI uses data only on which countries export which products significantly (i.e. a matrix of zeros and ones) and no information about other country characteristics, it is able to explain 75 percent of the variation in GDP levels across countries for which natural resources represent less than 10% of their GDP, as shown in Figure 2 taken from the Atlas of Economic Complexity.

Economic complexity is also very connected to growth. The difference between the income levels predicted by the ECI and the actual income levels of the country at a given point in time (i.e. the vertical distance to the regression line in Figure 2) is a good predictor of subsequent GDP per-capita growth. Thus countries that are currently less wealthy than one would expect given their level of economic complexity tend to catch up and those that are wealthier than their complexity would suggest tend to subsequently grow more slowly. In statistical regressions that compare the performance ECI with that of other known determinants of growth such as education, institutions, and the quality of the business environment, the economic complexity emerges as the single strongest predictor of GDP growth among these variables.

[16] As mentioned before, the formal mathematical definition of these and all other complexity measures used in this report can be found in the publicly available Atlas of Economic Complexity. The reader looking for specific guidelines for computation should refer to this publication and to the material of the technical training offered by the consulting team to EPU and partner institutions on September 3rd and 4th, 2014.

Figure 2: Economic Complexity and Income Per Capita



Source: Atlas of Economic Complexity, 2011

The Product Space

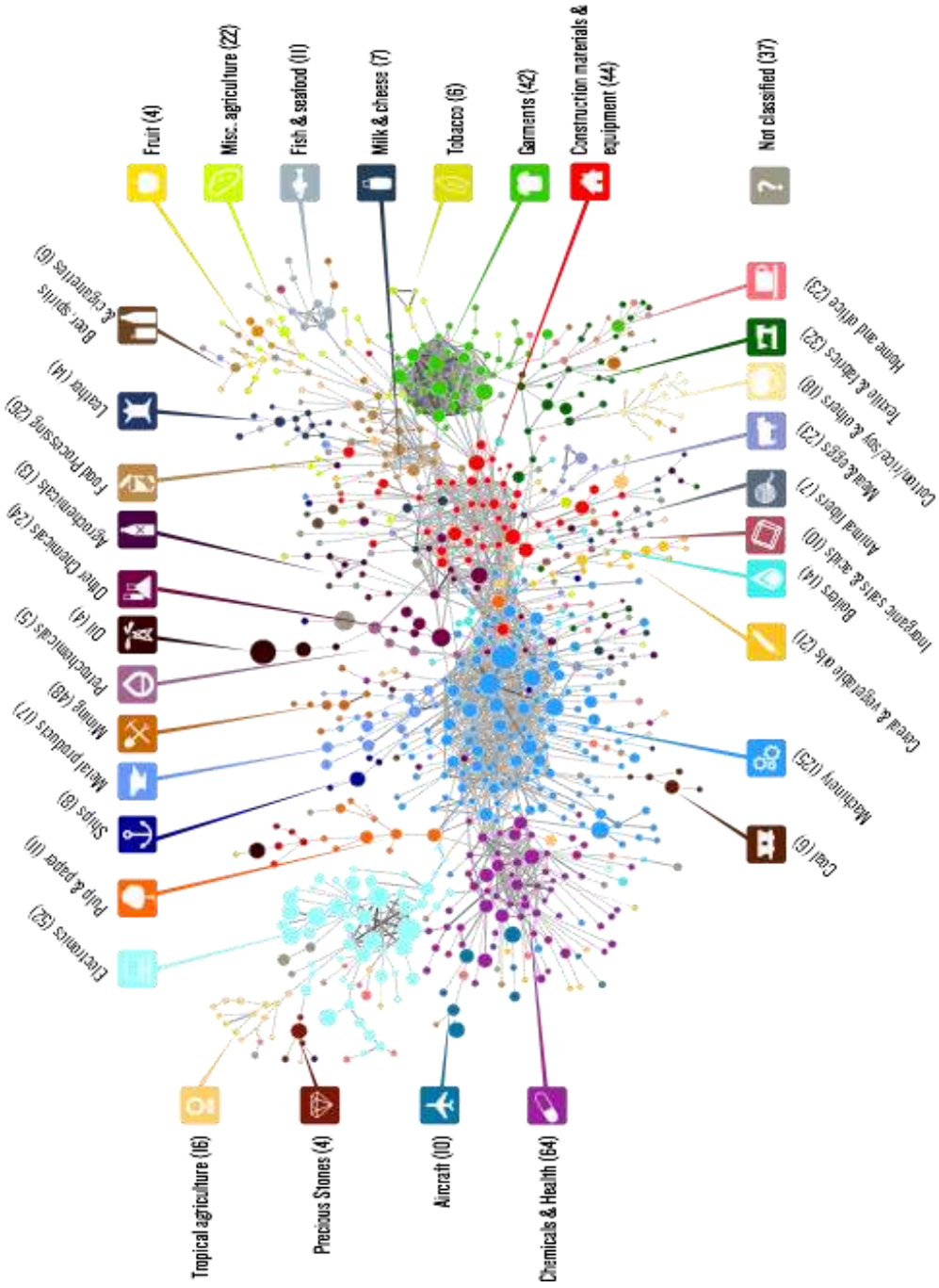
If having high levels of economic complexity is so connected to development levels and growth, a natural question to ask is how do countries become more diversified and achieve higher levels of economic complexity? In answering this question, Hausmann, Hidalgo and co-authors have made another fundamental contribution to our understanding on how a country's export composition relates to development. The key idea is that in the process of structural transformation needed to upgrade the complexity of their export baskets, countries tend to use their existing capabilities to move into new products that are related or nearby. In other words, they tend to develop products that require capabilities that are similar to those they already have. How close or distant any two products are can be inferred by looking at how many countries make both at the same time. If most countries that export product A also export product B we can infer that the capabilities required for these two products are similar and hence these products are related. If, however, products A and B almost never co-appear, we can infer that capabilities that they require are different.

Hausmann, Hidalgo, and co-authors use a network visualisation to illustrate the technological relatedness across all product categories. This network, (reproduced in Figure 3)[17] is known as the "product space" and is entirely based on the empirical connections found in the international trade data. The nodes represent products and the links connect pairs of products that are closely related as suggested by the exports patterns (i.e. have a high likelihood that any country jointly exports both). As it is apparent in the graph some products lie in densely interconnected clusters, suggesting that they share related capabilities with many other products. Others are peripheral and relatively isolated in the product space, suggesting that the capabilities used in these products translate less well into others. Overall we can observe a well-interconnected core in the product space, which includes machinery, chemicals, and other highly inter-linked sectors. Resource-based products such as oil and tree crops are located in more peripheral areas of the product space.

We can superimpose any country's exports basket onto the product space and visualise the position of their current export basket. Performing this exercise, Hausmann, Hidalgo and co-authors find that richer countries tend to occupy much of the product space, especially the highly interconnected clusters at the core, while poorer countries tend to be located at the periphery. Most importantly, they find that over time, countries tend to move into products that are highly connected to their already existing products. Thus a country's position in the product space today is informative of its future opportunities for growth and diversification, and it is valuable to think about the historical evolution of a country's exports through this lens. This is what we do in the next section for the case of Malaysia.

[17] This figure portrays the product space as introduced in the 2011 version of the Atlas of Economic Complexity, using the SITC4 product classification. Note that this differs from the HS4 classification employed in our analysis. In the remainder of the report our visualisations of the product space are based on HS4 categories.

Figure 3: The Product Space



Source: Atlas of Economic Complexity, 2011

IV. Malaysia's Economy through the Lens of Economic Complexity

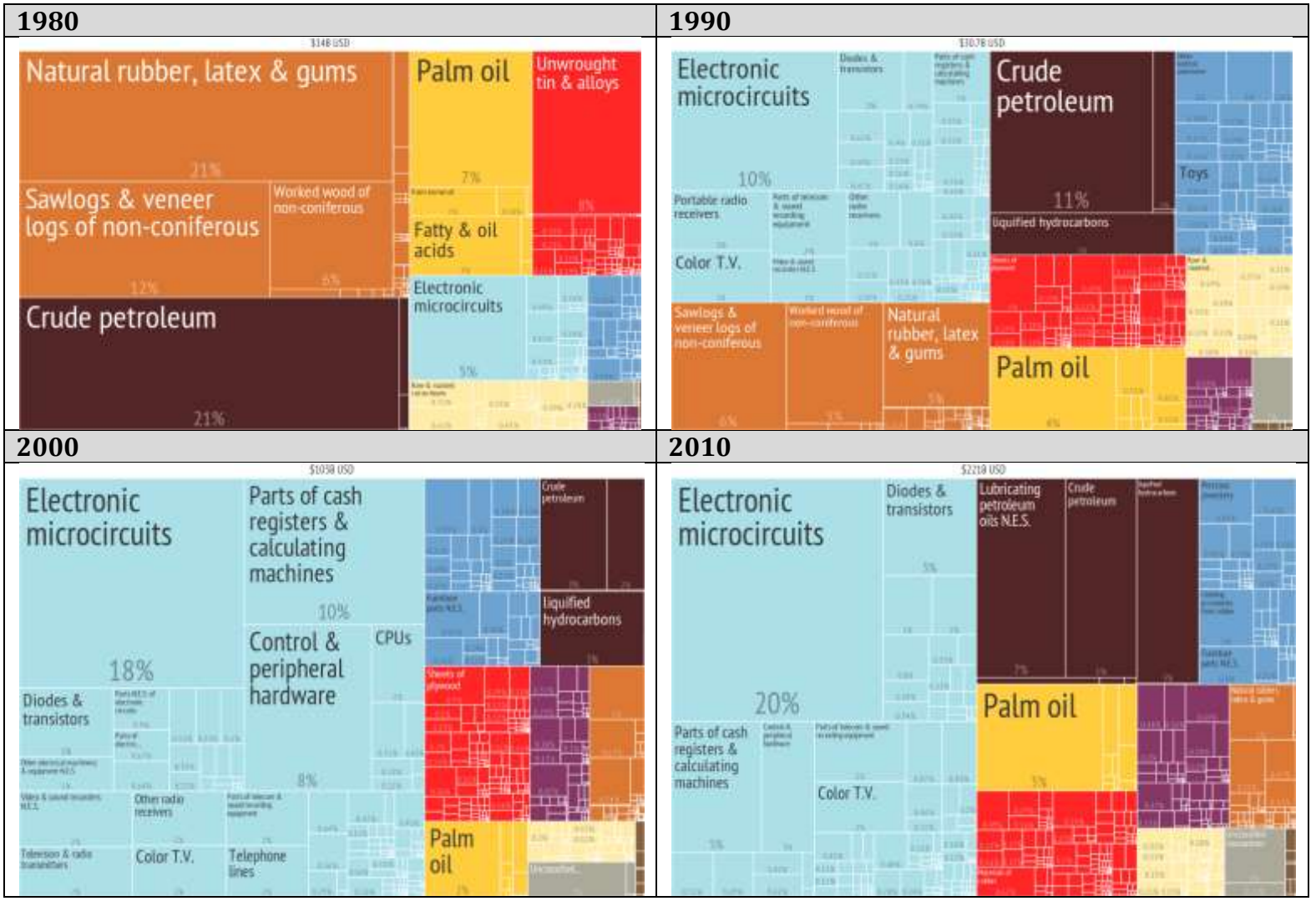
Historical evolution of exports

At the beginning of what could be termed its "first modern industrial transformation", Malaysia was a largely resource-based economy. Prior to the arrival of the electronics cluster the dominant sectors were basic food manufacturing, rubber, and metals, which cumulatively accounted for over 60 percent of manufacturing output and more than 80 percent of manufacturing exports in the late 1960s.[18] Perhaps surprisingly, amid such a base of relatively basic industries, a competitive electronics sector began to emerge in the 1970s.

By 1980, exports of petroleum, rubber, wood, palm oil, and related products still accounted for roughly three quarters of Malaysia's exports but the E&E sector was also contributing roughly 10 percent in total export value (Figure 4). The following decade, 1980-1990, saw a significant transformation. In a time when the value of exports roughly doubled from about US$ 15 billion to roughly US$30 billion, the value of E&E sector exports grew roughly six times making it the largest exporter in Malaysia. The next decade saw another tripling in the value of total exports, much of it driven by growth in E&E. In 2000, E&E accounted for roughly 70 percent of Malaysia's exports. Finally, the last decade saw a slowdown in both total exports growth and the rate of growth in of E&E. Exports doubled, but this time the E&E categories above grew by only 50% in total. Meanwhile, much of the growth in total exports was driven by a commodity boom in oil and gas and to some extent in related chemicals. Comparing Malaysia's exports in 1990 and 2010 side-by-side we observe a very similar pattern. No significant transformation of Malaysia's export mix occurred post-1990.

[18]Rasiah, Rajah (1995). *Foreign Capital and Industrialisation in Malaysia*. Macmillan Press: New York.

Figure 4: Malaysia's Exports by Product Category, 1980-2010



Source: Atlas of Economic Complexity: http://www.atlas.cid.harvard.edu. SITC4 level data from United Nations COMTRADE

Historical evolution of economic complexity and implied capabilities

While looking at the evolution of total export volumes is revealing, it is not a very precise measure of the evolution of a country's capabilities for several reasons. One is that total export volumes reflect not only structural changes in the product mix but also exogenous changes in goods prices. For example, if the world experiences a commodity price boom it may appear that certain countries such as Malaysia are becoming more specialised in resource-based exports although there has been no true change in the industrial structure of the country. Using RCA in our computation is a way of addressing this issue, since RCA scales a country's exports in a product by total world exports in the same product. Thus if a country's exports in a good (e.g. petroleum) increase at the same rate as the world exports in the same good, the RCA will not register any change in the country's level of specialisation in that good.

A second feature of exports data is that they record the full value of an exported good, but only part of that may be local value added. Thus for example, in 2012 Malaysia exported US$11 billion of "electronic integrated circuits" but it is likely that only 10-15 percent of this is Malaysian value added.[19] This issue is not unique to Malaysia. Asian input-output (I-O) tables suggest that Singapore, Taiwan, and South Korea have 24 percent, 12 percent, and 35 percent average value added, respectively, in the same industry. This gives rise to the following common and well-justified concern among local policymakers – while it is true that products like semiconductors are very sophisticated (technologically speaking), can we really say that Malaysia has a complex economy because it exports a lot of semiconductors if most of the higher-value links of this value chain are not located in Malaysia?

Fortunately, our method addresses this concern directly. First, the Product Space analysis looks only at whether the country has RCA or not on a product, reducing the weight of very large export values in the analysis. Second, the economic complexity measures takes into account simultaneously the characteristics of all products in which the country has RCA, of all other exporters of the same products, of all products in which those exporters have *RCA* and so on, as discussed in Section III. For example, the list of countries that exported significantly the product category HS4 8541 (which includes semiconductors) in 2012 include not only rich and highly industrialized nations, but also countries like Philippines, Thailand, India, Indonesia and Vietnam. This suggests that the capabilities required to export semiconductors are not necessarily as sophisticated as the technological characteristics of the

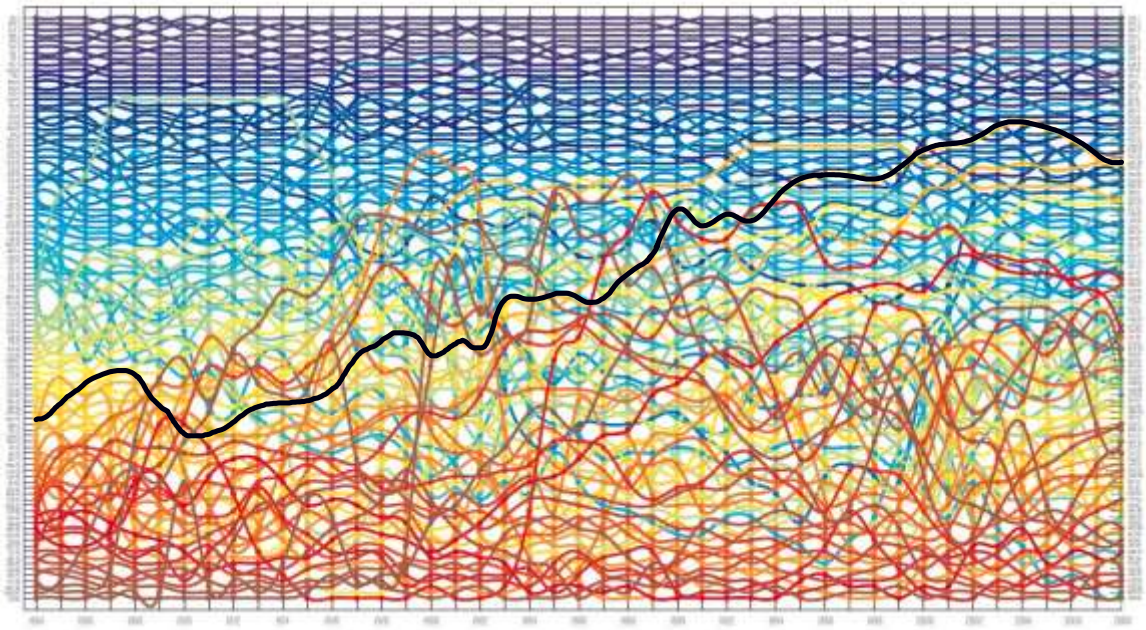
[19] According to data provided in the 2005 Asian Input-Output table (available from http://www.ide.go.jp/English/Data/Io/index.html), the share of Malaysian value added in industry category 051 "Semiconductors and integrated circuits" was 11 percent in 2005.

product may suggest. But this is not a low-complexity product either. The HS4 8541 product category is ranked 247 among 1,239 products by PCI. Relatively few countries are able to export semiconductors significantly even in the low-value activities of the production chain, because it requires reliable infrastructure, precision manufacturing expertise, local suppliers of high-quality parts, etc.

How does the Economic Complexity of Malaysia look when compared with other countries? As previously discussed, we use the ECI as an indicator of how many capabilities a country has relative to all other countries in the world. Because it is a standardised measure, as some countries climb up on the index, others have to climb down. Figure 5 illustrates over a long period of time (1964-2008) the evolution of the ECI in 128 countries. We see that overall the complexity rankings have been relatively persistent over the past few decades. Most countries that were on top of the complexity index in the 1960s remain there today, and many that were on the bottom are still there. A few countries, however, have made remarkable transformations and one of them is Malaysia (highlighted in black). Ranked in place 70 in 1964 in terms of its economic complexity, Malaysia climbed 44 positions and was ranked 26th in 2008. Only Thailand achieved a similar degree of economic transformation during this same period.

However we also see that most of the large gains were made earlier in Malaysia's transformation process, most notably during the 1980s and 90s. In the most recent decade, Malaysia's position in the ECI rankings has been more stable. While lower-ranked economies of Indonesia, Philippines, Thailand and China have been catching up, Malaysia has been stagnant, even slightly declining in its relative regional position.

Figure 5: The Evolution of Economic Complexity in 128 Countries, 1964-2008



Source: Atlas of Economic Complexity

Historical evolution in the product space

While the ECI summarises a country's overall complexity, the product space allows us to see a more detailed picture of where a country's capabilities lie, whether in strategic, densely interconnected areas of the product space or in more peripheral ones. In the product space visualisations that refer to specific countries, we highlight only those products in which the country has RCA > 1. By examining the product space at different points in time we can observe how a country's productive structure evolves –what new products it develops and what products it abandons. Figure 6 presents Malaysia in the product space in 1995 and 2012[20].

Starting from the far right of Malaysia's product space we can see the cluster of tree crop exports, which contain rubber, palm oil, and related products. These products were part of Malaysia's export basket historically and are still present today. Just below tree crops we see the densely interconnected garments cluster that since 1995 Malaysia has largely abandoned although it continues to export significantly certain woven fabrics. Further left we see products that Malaysia exports significantly in processed foodstuffs (bright green nodes). These have increased

[20] In these visualisations, as well as in those presented, the size of each node is proportional to the product's share in the worlds exports.

notably since 1995 and current exports include products made of tobacco, cocoa, and other oils and extracts. Malaysia had a strong presence in wood-based products which are mostly used in construction both in 1995 and in 2012. But the relative importance of these products in total world trade has shrunk (as can be seen by their smaller node size).

Petroleum products and certain related chemicals (top right corner of product space) have a stronger presence in 2012 but these products are located in the periphery of the product space, with relatively few linkages to other products. Since 1995 Malaysia has also developed a significantly stronger presence in certain metal products including wires and tubes made of zinc, copper, iron, and aluminum. These products (colored in dark brown) are scattered throughout the product space.

Turning to the densely interconnected core of the product space – which includes mostly machinery and transport but also certain E&E products – we see that Malaysia succeeded in making only a few "jumps" into new products since 1995. Not surprisingly these are products related to its existing capabilities. For example, Malaysia developed RCA in two products in the center of the product space related to electrical switchboards and a number of products made of materials related to rubber, including specialised pipes, tubes, and sheets. However, to a large extent this core part of the product space remains empty.

Further left in the product space we see the densely interconnected but more peripheral E&E cluster in which Malaysia had a wide-reaching presence in both 1995 and 2012. Note the share of some E&E products in world trade has shrunk especially for the more peripheral products such as sound recorders, storage disks and tapes. Other categories have largely held their share, among them telephone sets, data processing machines, and integrated circuits.

One success story in Malaysia's product space is its diversification into a number of new products in the precision instruments category (colored in grey). These new products lie in high proximity to the E&E sector, which suggests that Malaysia was indeed in a privileged position to expand in this direction given its capabilities in E&E. Such "nearby" products include oscilloscopes, spectrum analyzers and other instruments and apparatus for measuring or checking electrical quantities, optical fibers and optical fiber bundles, lenses, prisms, mirrors and other optical elements. Malaysia also jumped into a number of more distant new products in this category, located in strategic areas of the product space. Examples of such products are

automatic regulating or controlling instruments and instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases.

Looking at the chemicals sector, of which some products are clustered at the top left corner of the product space while others are scattered, we see that Malaysia has made some advances into the more core products in this area. For example, Malaysia developed RCA in various inks, photographic plates and film, heterocyclic compounds and a number of chemicals, which are relatively central on the cluster. Malaysia also developed a number of chemicals products in other parts of the product space, notably various alcohols, acids, and derivatives. Despite these advances, many opportunities remain untapped in this sector.

While Malaysia developed RCA in certain new products, it also lost RCA in a number of other areas of the product space. Most apparent is the exit from the garments sector, which we mentioned before. However, looking closely we also see that Malaysia also abandoned or reduced its presence significantly in other products. One such group represents relatively unsophisticated goods, such as ceramic ornaments and household articles, wooden frames and other decorative wood articles. The second group of products are more advanced, and include mostly products related to transportation, including electric motors, electrical transporters, and seats, floating vessels, fluid containers and certain types of aircraft. Today Malaysia exports only three transport products with RCA > 1 (tug boats, bike parts, work trucks, etc.).

Overall we see that Malaysia has made a number of successful advances into new and more sophisticated areas of the product space (e.g. precision instruments, certain chemicals, certain metal products) and has abandoned a few relatively unsophisticated areas of the product space (garments, simple ceramic and wooden products). The advances were often made in directions that are consistent with Malaysia leveraging its existing capabilities to move into products that were nearby. However, while it made incremental progress, Malaysia over the past 17 years did not succeed in achieving a more radical transformation as it had in prior decades. Likely because its starting position was one in which the most strategic areas in the core of the product space (especially the machinery sector) were largely empty, the ability of Malaysia to easily move into the core of the product space was also limited. Hence Malaysia's product space today remains strongest in largely peripheral areas (tree crops, petroleum, metals) and in the E&E cluster, but is sparse in some key strategic areas.

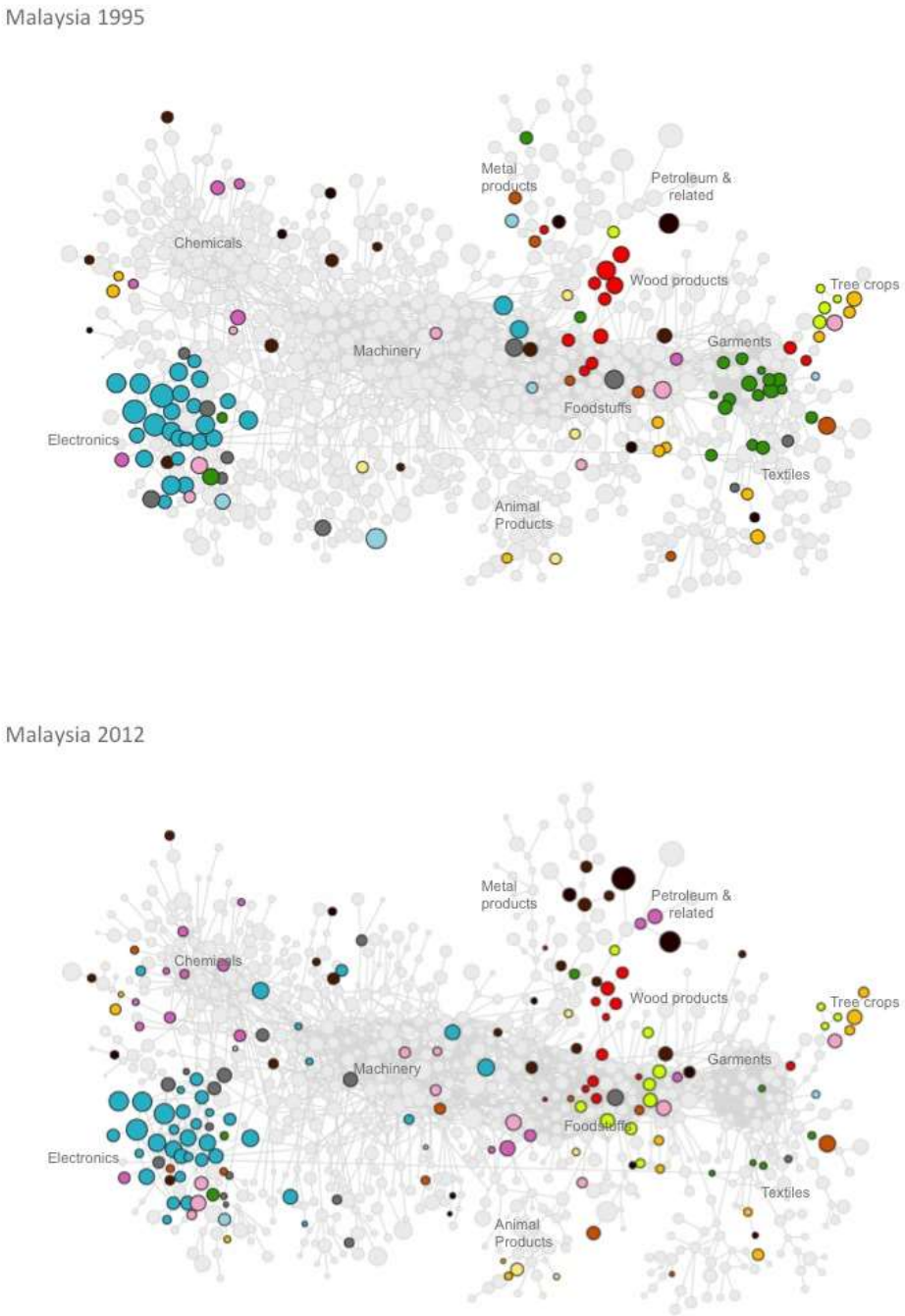
Compare this evolution to that of South Korea whose product space is shown in Figure 7, starting from a presence in garments and textiles that was even stronger than Malaysia's, Korea abandoned a large fraction of this sector. Unlike Malaysia, Korea did not have any notable presence in either foodstuffs or wood based products either in 1995 or in 2012. In metals and minerals, Korea had a strong presence already in 1995, which only grew stronger by 2012. Korea is particularly specialised in a series of products made of iron (rolled iron, wire, bars, blocks, structures, containers, pipes, etc.).

Looking at the more central core of the product space, we see that already in 1995 Korea had a stronger presence in machinery and transport equipment than Malaysia does today. In 1995, Korea exported significantly cars, ships, railway cars, buses and other specialised machinery. It also exported various other industrial machines (cranes, lifting machinery, boilers, transformers, textile machinery) and household equipment (refrigerators, washing machines, etc.). Looking at 2012, we see that Korea not only expanded its presence in machinery but moved from the more peripheral to the more central parts, adding to its exports machine tools, various machine parts, and engines, among others.

In E&E, Korea abandoned a number of peripheral products (sound and video recording equipment, radio receivers, and calculators) but maintained and grew the better-interconnected products (e.g. telephones, integrated circuits, semiconductors). Korea also grew its presence in the chemicals sector especially in certain centrally located products – petroleum resins, polymers, polyamides, silicone, synthetic rubber, etc.

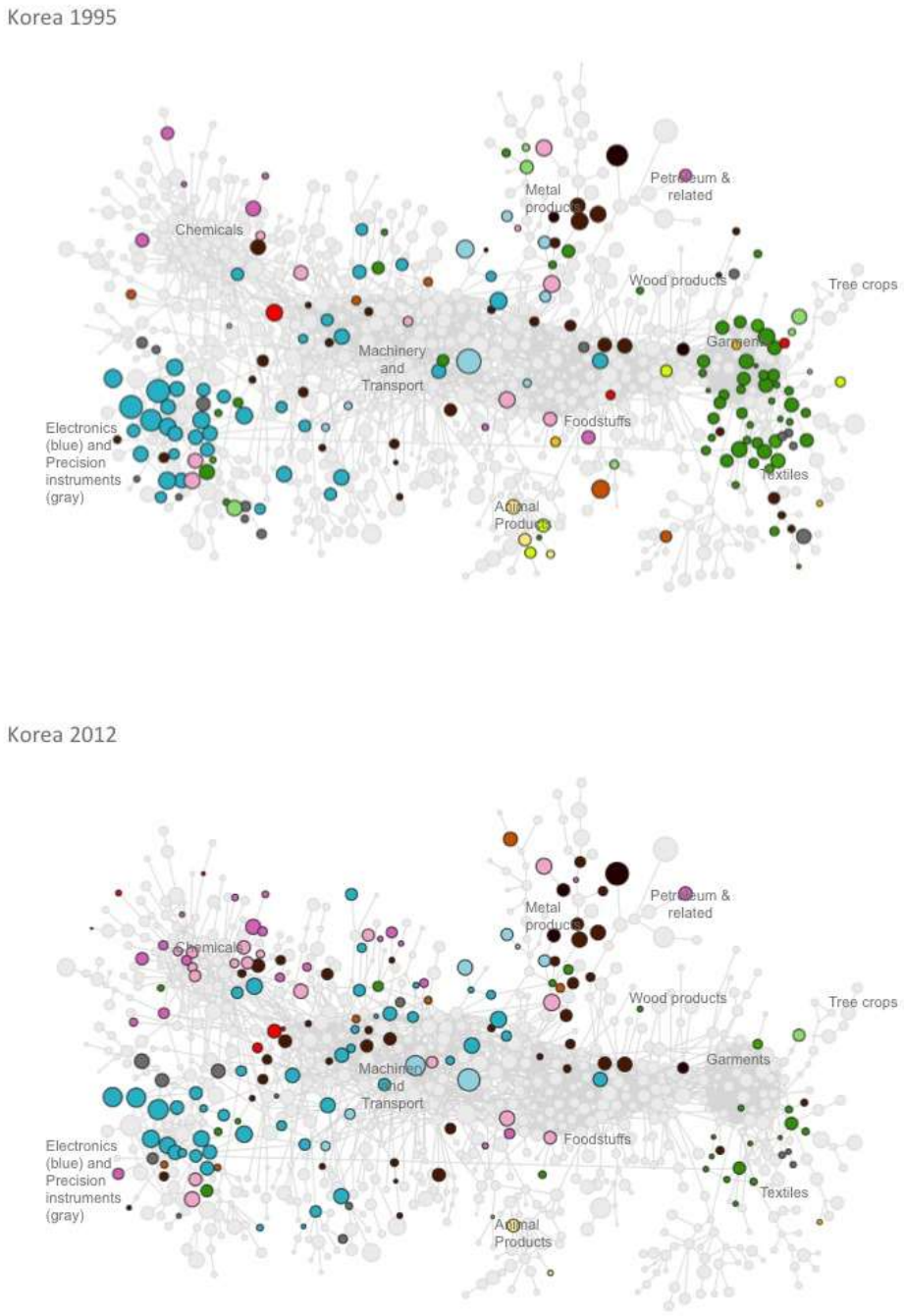
Overall, we see that Korea's transformation in the period 1995-2012 appears to have been more strategic than that of Malaysia. While there are many factors that contribute to this outcome, we argue that Korea's more diverse and central starting position in the product space made this type of diversification more feasible.

Figure 6: Malaysia in the Product Space, 1995 and 2012



Source: Observatory of Economic Complexity

Figure 7: South Korea in the Product Space, 1995 and 2012



Source: Observatory of Economic Complexity

Current opportunities in the product space

We have already discussed the evidence for the view that, as countries move up the income ladder, we see a natural process whereby they tend to diversify into more sophisticated and strategic parts of the product space, specifically the machinery, chemicals, and electronics sectors. As we saw in the prior section, Malaysia succeeded in transforming its economy during the 1980s by moving into the electronics sector. However its diversification into the other core areas has been more limited. Figure 8 (left column) compares Malaysia to various countries in its region. For each country the length of the bar corresponds to the *number* of different products exported with RCA. We see that countries that are richer than Malaysia have indeed achieved greater RCA in these strategic sectors.

Specifically, in E&E Malaysia is ranked 4th among the 14 countries in terms of the share of all products in the E&E sectors in which it has RCA.[21] In 2012 it exported significantly 73 percent of all the products in this category. On the other hand in M&E where Malaysia exports with RCA only 18 percent of all products it is ranked 7th in its region. Similarly, it is ranked 7th in Chemicals where it exports with RCA 19 percent of all products.

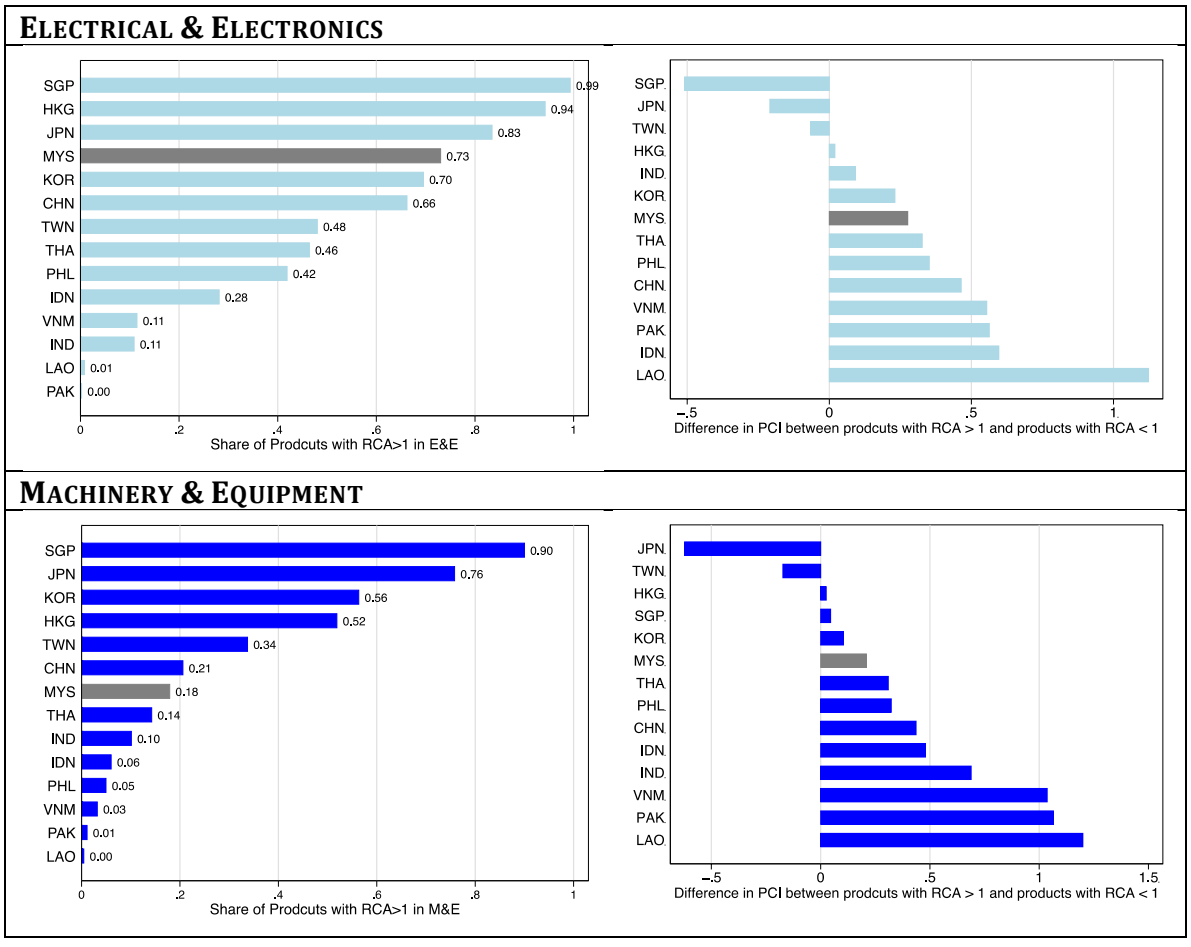
However, given its current starting-point Malaysia is very well positioned to move into strategic products in these sectors. This can be seen in the right half of Figure 8, which graphs in each of the three priority sectors the difference in the average complexity of the products that a country already exports with RCA and of those that it does not. A negative difference, like what Singapore, Japan, and Taiwan have in E&E and Chemicals, means that the products which these countries do not export with RCA are on average less complex than the ones that they do. In other words, these countries have already moved into the most lucrative parts of the product space and have abandoned the least complex products. At this point, diversifying further would lower their average complexity. From such a position, these countries are playing a different game – one of expanding the technological frontier rather than catching up to it, inventing new products rather than learning to make products that are already invented.

The situation of Malaysia is different. In each of the three priority sectors, the average complexity of the products that Malaysia currently exports with RCA is lower than the complexity of the products that it does not. However, the difference

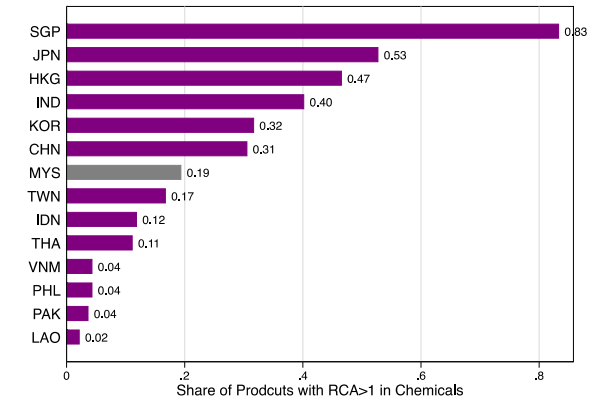
[21] Note, here "share" refers to the count of products in which a country has RCA overall the count of all products in that sector, not to be confused with "market share."

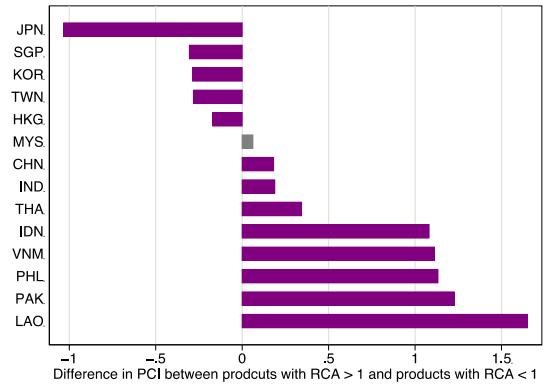
is not very large. This represents an opportunity because it means that the more complex products are nearby Malaysia's current capabilities. In contrast consider countries like Laos, Pakistan, Indonesia and Vietnam. The products that they currently export are significantly less complex than the ones they do not. These countries are further from the knowledge frontier and would find diversifying into these more lucrative parts of the product space more difficult than Malaysia. The next section takes a closer look at the specific opportunities that Malaysia has in the priority sectors. In order to do this, we will introduce a couple of new measure that will allow us to better map these opportunities.

Figure 8: Presence and Distance From Products in E&E, M&E, and Chemicals for Malaysia and Comparison Groups, Year 2012



Chemicals





Note: Authors' calculations based on HS4 trade data from CEPII and economic complexity variables

V. Frontier Export Opportunities

Methodology

In the prior section, we highlighted the strategic importance of three sectors – E&E, M&E, and Chemicals – at a very broad level. Each of these sectors houses a variety of clusters and products, some of which are more lucrative and strategic than others. Where do Malaysia's current capabilities lie? What other products are nearby and would further strategic diversification? In this section we take a closer look at the data – at the HS4 product level – in order to answer these questions. In order to identify truly "new" opportunities for diversification, we consider only those products in which Malaysia does not already have RCA and ask which of them embody the most promising potential.

In order to identify such products, we will utilise three measures from the Economic Complexity framework: the PCI, Distance and Opportunity Gain. Recall that the PCI measures how "complex" a product is, and is usually interpreted as a proxy of the number of productive capabilities that the product requires. If a country begins exporting significantly a product that has a PCI higher than its current ECI, it will increase the average complexity of its export basket. In the exercise that follows, our first step is to filter out all products that have lower complexity than Malaysia's current ECI and only consider opportunities in products that would increase Malaysia's current complexity.

In a second filter, we utilise the metric Distance, which measures how close or far a country is from a new product given its current position in the product space. We can calculate the proximity between any two products as the minimum conditional probability that a country that exports one also exports the other[22]. The product space maps the strongest among these bilateral proximities. A country's distance from a given product, for example "A", is calculated by summing the proximities to product A from all products in which the country does not have RCA and dividing that by the sum of the proximities to A from all products.[23] Metaphorically, if between each pair of products there exists a path, Distance is the share of all the possible paths to a product that the country does not have access to (weighted by how long or short these paths are). The more paths a country can access to reach a given product and the shorter these paths are, the lesser a country's Distance to that product is.

In a third filter, we introduce the measure called Opportunity Gain. It is calculated as the change in Opportunity Value coming from developing RCA in a new product, where Opportunity Value is a measure that summarises the value of a county's strategic position in the product space (how near or far it is from complex products).[24] The idea is that a new product can be strategically valuable if it "opens doors" for future diversification and economic upgrading – i.e. if it decreases the distance to other strategic products. Products that allow a country to access parts of the product space with multiple connections might prove pivotal in the long-term diversification process. Opportunity gain is a measure designed to capture how much a new product will add to a country's future diversification opportunities, i.e. to what extent developing a specific new product will improve the country's position in the product space.[25]

Optimally, a country would diversify into new products that have the highest complexity, shortest distance, and highest opportunity gain. However, often there exists a trade-off between these three desired properties. For most countries, the products that have highest complexity are also farthest away in terms of distance. Similarly, the products that deliver the highest opportunity gain also tend to lie at

[22] Note that although the names are related, "Distance" and "Proximity" are two very different measures. The first relates the country as a whole (i.e. considering all its exports basket) to an specific product. The second relates a pair of products only.

[23] Mathematically the distance of country *c* to product *p* is calculated as $d_{cp} = \frac{\sum_{p'}(1-M_{cp'})\phi_{pp'}}{\sum_{p'}\phi_{pp'}}$ where *p'* represents all products excluding *p*, $M_{cp'}$ is an indicator that equals 1 is a country exports a products with RCA>1, and $\phi_{pp'}$ represents the bilateral proximity between any two products *p* and *p'*.

[24] Formally, the opportunity value of country *c* at a point in time is calculated as $OV_c = \sum_p (1 - d_{cp})(1 - M_{cp})PCI_p$ where d_{cp} is the distance of country c to product p and $M_{cp'}$ is an indicator that equals 1 is a country exports a products with RCA>1.

25 Formally, it is calculating by subtracting the country's current Opportunity Gain score from the Opportunity Gain score calculated after adding the new product (with RCA) to the current export basket.

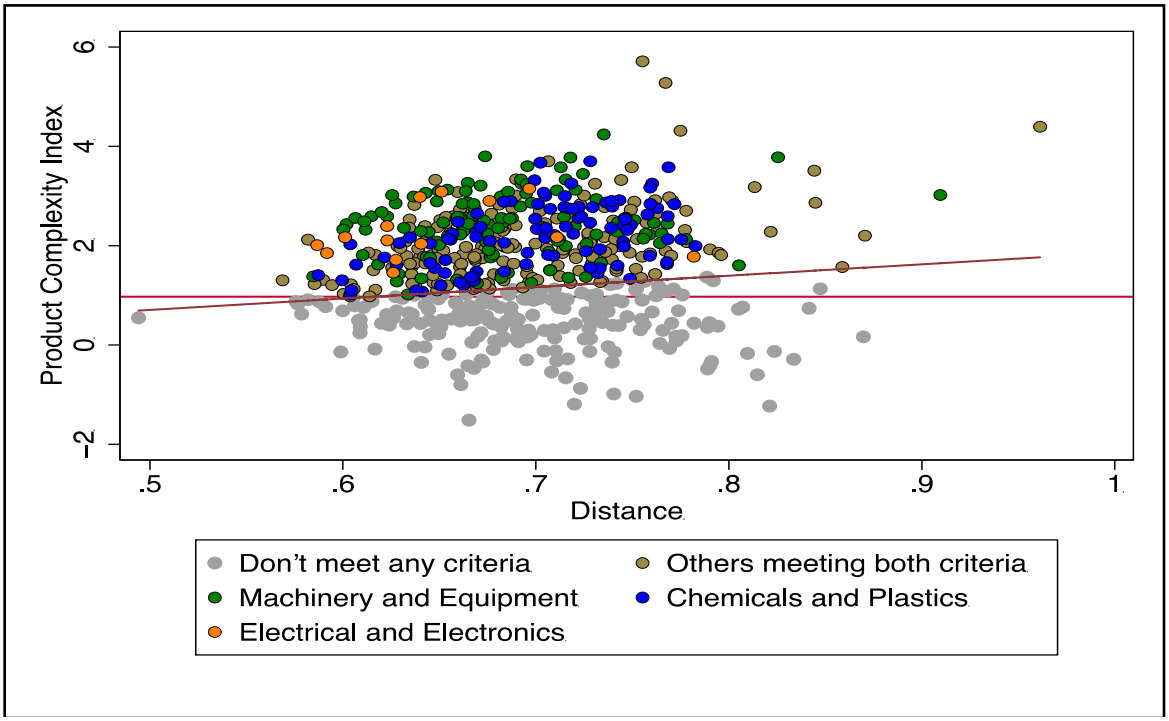
greater distances. Because we cannot achieve all three desired properties at once, we identify the products that for any given distance have the highest complexity and greatest opportunity gain.

Think of distance as a cost that needs to be overcome in order for a new product to emerge, i.e. the number of missing capabilities that need to be developed. Products at larger distances are not impossible to reach, but they do require more up-front investment in new capabilities. Meanwhile, we can think of complexity and opportunity gain as the strategic benefits gained from developing a new product. The aim of our methodology is to ensure that we recommend products at high distances only if the strategic benefits are worth the costs. Malaysia's historical experience offers a good example of a diversification strategy that successfully balanced this tradeoff. In the early 1970s, electronics were located at a significant distance from the capabilities of Malaysia. At that time, developing this sector was not the most natural, or "nearby" diversification opportunity. According to Intel's accounts, their first officers set up shop in largely empty land. Major investments in specific new capabilities (incentives, training, infrastructure, regulation, etc.) were required to develop this sector. However, the strategic benefits have been felt for decades as the initial investments propelled a wave of diversification into nearby industries.

Figure 9 graphically illustrates the first and second filters. It graphs by PCI and distance all products in which Malaysia does not have RCA (all in the year 2012). We can graphically see the tradeoff – the products that are more complex tend to be more distant (i.e. the graph has positive slope). We formalise this by drawing a regression line, which can be interpreted as the average PCI at any given level of distance[26]. We also draw a horizontal line at Malaysia's current level of ECI. The first filter takes out all products that lie below Malaysia's ECI. The second filter takes out all products that have below-average PCI at any given level of distance. This exercise identifies 430 products that Malaysia has not developed significantly yet, which are all above Malaysia' current complexity and which have a favorable distance-complexity tradeoff.

[26] In practice the filters used were stricter than the simple regression line. At a given distance, a product was prioritised if it had a value equivalent to the regression line plus 0.15 or higher. The same was true in the Opportunity Gain filter. Using the less strict filter would have meant prioritising almost half of the products in the HS4 classification, making in harder to detect the most valuable opportunities.

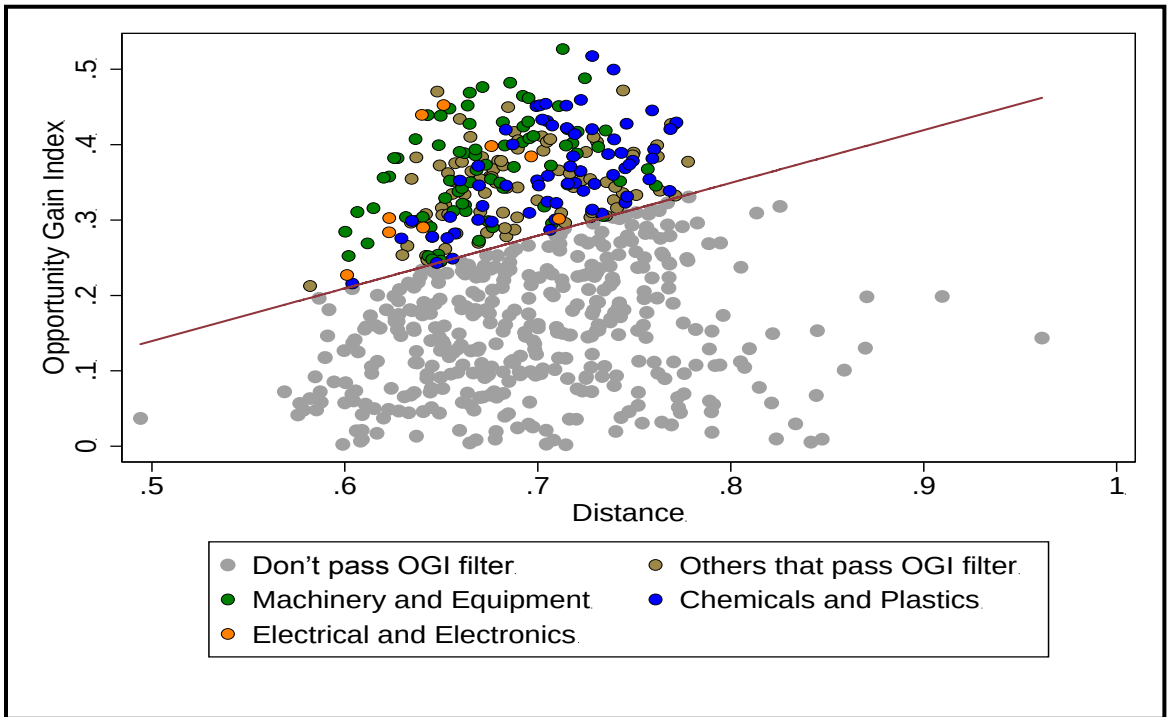
Figure 9: Products Selected by the ECI and Distance-Product Complexity Filter



Source: COMTRADE/CEPII, data own calculations

Next we apply the Distance-Opportunity Gain filter. Figure 10 graphs all products in which Malaysia does not already have RCA, this time by Opportunity gain and Distance. Again we graphically see the trade-off. Products that have larger Opportunity gain tend to be more distant. We formalise this with a regression line, which can be interpreted as the average Opportunity gain at any given level of distance. The third filter takes out all products that lie below it – i.e. the products that have below-average opportunity gain at any level of Distance.

Figure 10: Products Selected by the Distance-Opportunity Gain Filter



Source: COMTRADE/CEPII data, own calculations

Finally, we show the three filters together in Figure 11. The products that are highlighted in color are those that at the same time pass all of our filters:

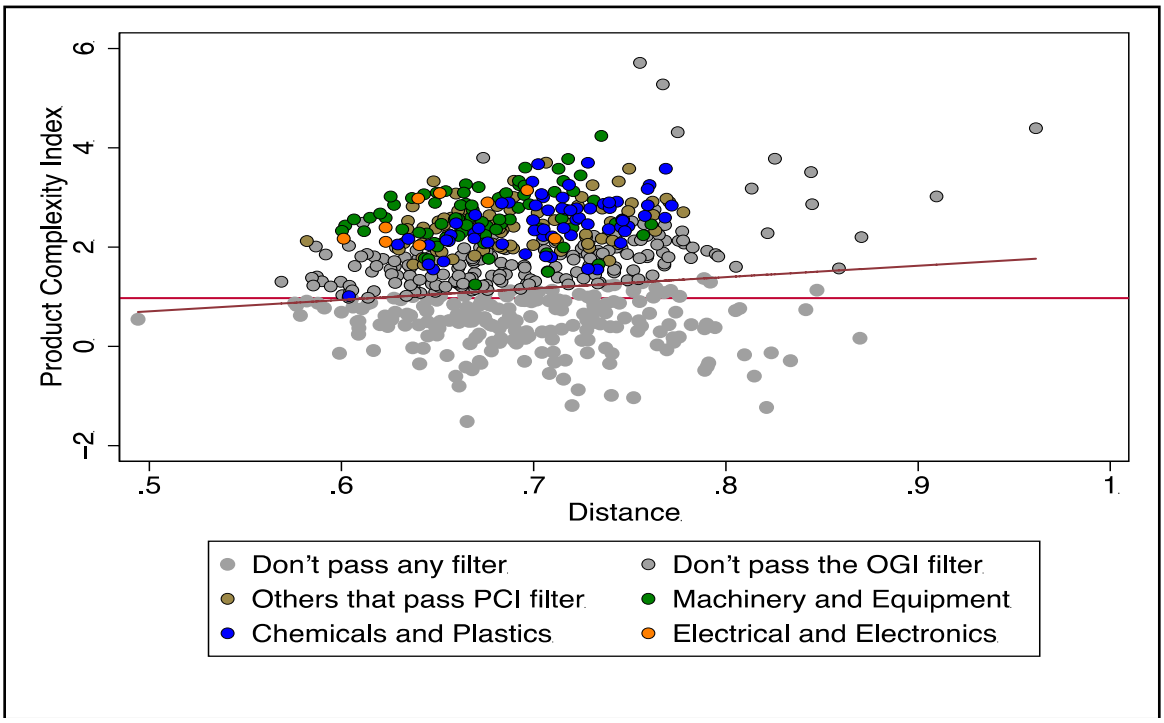
1) Malaysia does not already export them significantly;

2) They have a PCI higher than Malaysia's current ECI;

3) They have above-average PCI at their level of Distance; and

4) They have above-average Opportunity gain at their level of Distance. There are 238 such products and they represent the most strategic opportunities for diversification according to the economic complexity measures.

Figure 11: Products That Pass All Filters (ECI, Distance-PCI, and Distance-Opportunity Gain)



Source: COMTRADE/CEPII data, own calculations

Frontier Opportunities in the Product Space

Table 1 groups the prioritised products by sector and shows summary statistics for each. The largest number of the strategic products that the filters identify falls in M&E to which we have also added Precision Instruments (PI) with a total of 77 products).[27] The second largest number of new products is in C&P, with 66 products. The filters identified only 9 new products in E&E but the reason is that Malaysia already has RCA in most of the products that fall in this category. Interestingly, the complexity filters naturally prioritise the same sectors that the Government of Malaysia (GoM) has chosen to focus on in their current policy agenda. In addition to a total of 151 products in the "priority sectors", the filters also identify a total of 87 products in other sectors including metals, textiles, products made of stone, glass, and wood, vegetable products and foodstuffs, among others. Although these sectors are in general less strategic than the priority sectors, the filters have selected the most complex and strategic products among them.

[27] Note that we are using short-form sector labels when referring to the different HS2 categories. For a more detailed description of what is contained in each of the HS2 categories please refer to the website of the United Nations: http://comtrade.un.org/db/mr/rfCommoditiesList.aspx?px=H0&cc=

Table 1: Summary Statistics of Selected Products Aggregated By Sector

HS2 group(s)	Name	(1) Number of products selected	(2) Products already exported with RCA>1*	(3) Total products in the category	(4) Avg. Current RCA	(5) Avg. distance of selected products	(6) Avg. PCI of selected products	(7) Avg opp.gain of selected products	(8) Avg.15-yrs growth in Malaysia of selected products**	(9) Avg.15-yrs growth worldwide of selected products
Priority sectors										
84, 86-92	Machinery and Equipment	76	55	179	0.22	0.67	2.63	0.37	6.2%	5.6%
28-40	Chemicals and Plastics	66	73	219	0.14	0.71	2.49	0.36	9.9%	6.9%
85	Electrical and Electronics	9	34	48	0.28	0.65	2.55	0.34	5.9%	6.2%
Total / Average		**151**	**162**	**446**	**0.19**	**0.69**	**2.57**	**0.36**	**7.8%**	**6.2%**
Other sectors										
72-83	Metals	39	61	157	0.17	0.69	2.49	0.36	11.5%	7.3%
50-63	Textiles	15	31	149	0.11	0.70	2.40	0.35	3.8%	2.5%
68-71	Stone / Glass	12	27	67	0.19	0.69	2.41	0.34	6.6%	5.3%
93-97	Miscellaneous	8	10	45	0.05	0.69	2.62	0.35	2.6%	7.0%
44-49	Wood & Wood Products	7	29	68	0.16	0.70	2.36	0.33	9.8%	2.1%
06-15	Vegetable Products	3	23	101	0.01	0.70	2.31	0.34	n.a.	6.5%
16-24	Foodstuffs	1	19	56	0.02	0.67	1.93	0.28	n.a.	10.2%
64-67	Footwear / Headgear	1	2	20	0.32	0.64	2.07	0.31	n.a.	8.2%
25-27	Mineral Products	1	19	65	-	0.67	1.83	0.27	n.a.	6.2%
Total / Average		**87**	**221**	**728**	**0.14**	**0.69**	**2.44**	**0.35**	**4.5%**	**5.8%**

Source: Authors' calculations using economic complexity variables and international trade data from CEPII for 2012

Notes: * Column (2) "Products already exported with RCA>1" counts all products where either Malaysia has RCA>1 or Malaysia's share in global exports is at least twice as Malaysia's share in global population. As described in footnote15, this is the definition that we employed in the calculation of all complexity variables in this report.

** Column (8) "Avg.15-yrs growth in Malaysia of selected products" is only shown for industries with more than three product observations, otherwise labeled n.a. 15-year growth rates are calculated for the period 1997-2012.

Column 4 shows that Malaysia indeed is not a significant exporter of the selected products, with average RCA of 0.19 across all the priority sectors. To a first approximation, these are "new" products for Malaysia. The average distance variable in Column 5 shows that amid the priority sectors, C&P products are most distant and the E&E products least distant from Malaysia's current productive capabilities. This is not surprising given the greater extent of existing capabilities in E&E, many of which can be more easily redeployed in machinery and equipment industries than in chemicals. According to an interview with one manufacturer of advanced special purpose machinery, the presence of the local engineers working in the E&E sector and of specialised local input providers were key for the success of their business.

Column 6 shows that all of the identified products are complex, with average PCI of 2.57, well above Malaysia's average PCI of 0.97. But here again we see some variation across the three sectors, with the selected M&E products being most and the C&P least complex. Opportunity gains are largest by moving into M&E, followed by C&P and finally E&E as can be seen in Column 7. This is the case both because Malaysia currently has a relatively low presence in M&E and because, as we saw before, this sector is particularly central in the product space. Also this sector includes precision instruments, which have a very high average complexity and the highest opportunity gain among the identified sectors.

Finally, in Columns 8 and 9 we present the average growth of exports in the identified product categories over the past 15 years in Malaysia and for the world. While this is not a complexity measure per se it also captures to what extent the capabilities required to become a meaningful exporter exist in Malaysia. If Malaysia provides the right ecosystem for the production of certain products, it is likely that there are some firms already active at this frontier and this filter is meant to identify how well they have performed. Indeed, the growth data suggests that although Malaysia is still a relatively small exporter in these products, firms that are exporting the frontier products in M&E and C&P have been outperforming the global market average growth thus gaining market share! This is a very comforting fact because it suggests that the possibility of scaling up these industries to the point where they can become more significant drivers of exports and economic growth lies within reach.

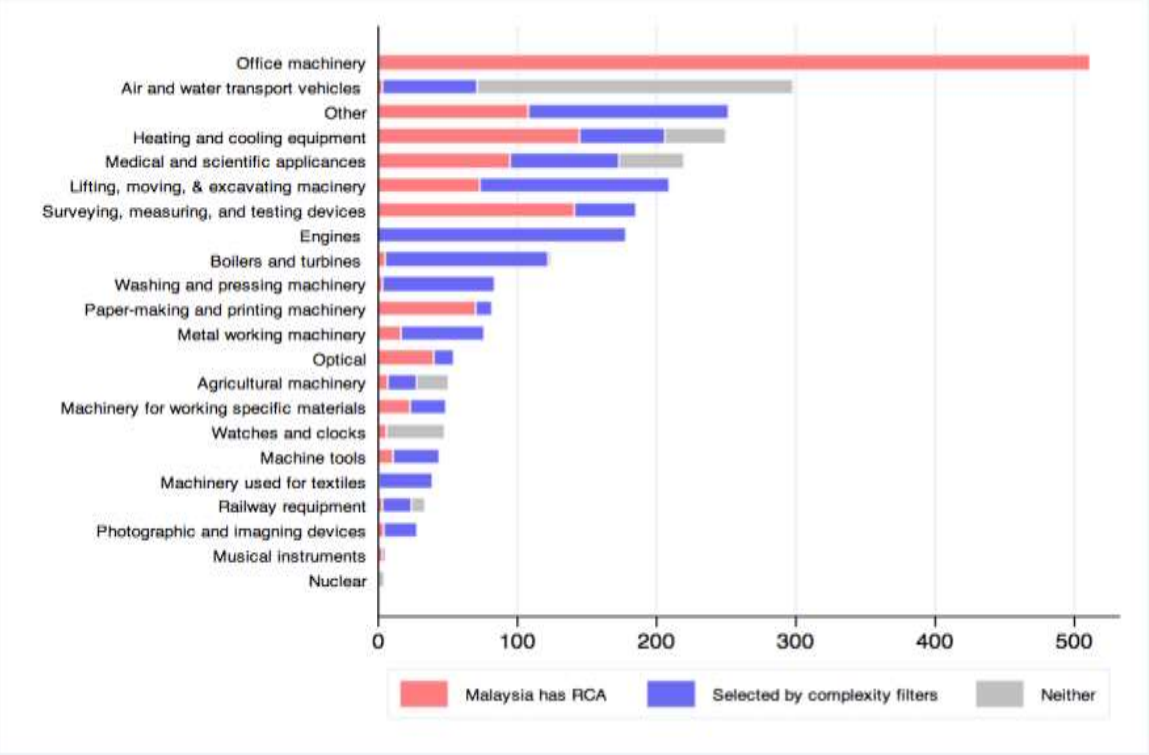
Appendix I includes a full listing of all of the selected products, showing their complexity, distance, opportunity gain, and realised growth. The benefit of having the four criteria for each product is that decision makers can use them to inform

their strategies. Since it can be difficult to see the "big picture" at this relatively fine level of detail, we have also grouped the products into more aggregate clusters.[28] The goal is to illustrate for each cluster a more complete picture of how far Malaysia has come already and what further opportunities lay ahead.

Current and Frontier Opportunities in M&E and Precision Instruments

In this part of the analysis we look at the various product clusters in M&E and Precision Instruments. Figure 12 shows the clusters ranked by the volume that each commands in world exports. Motor vehicles and parts is the largest cluster in M&E, accounting for over US$ 1,200 billion of exports worldwide in 2012. Its sheer size makes this industry an extreme outlier so we have excluded it from Figure 12 and will discuss it separately. The next largest cluster and the first one shown is office machinery, which accounted for more than US$530 billion of world exports in 2012.

Figure 12: Global Market Export Volumes in M&E and Precision Instruments (US$ Billion), 2012



Source: Authors' calculations using trade data from CEPII

[28] In the case of C&P these groupings correspond one-to-one to HS2 level codes. In the case of M&E and E&E, we find that the HS2 level codes are too aggregate to be informative. Appendix I shows what HS4 level products fall in each cluster.

In each cluster the red shaded area corresponds to the world market size of the products that Malaysia currently exports with RCA.[29] The blue area corresponds to the world market size of the products selected by the complexity filters and the grey area the world market size of the products that are neither exported with RCA nor selected by the filters – i.e. the products that are either insufficiently complex, insufficiently strategic, or too distant given Malaysia's current position in the product space. Appendix I shows side-by-side the three groups of products by cluster and allow us to see a more complete picture of the complexity, strategic value and growth dynamics of products that Malaysia exports significantly, of those that represent attractive opportunities, and of those that do not.

Let us now take a more detailed look at the patterns that emerge. **Transport equipment**, which includes motor vehicles, air- and water transport vehicles, and railway equipment is the largest category in M&E in terms of global export value. Malaysia is currently not a significant exporter in this cluster, exporting only parts of bikes and work trucks, tug boats, and shipping containers with RCA. Based on the complexity filters this sector is generally not among the most readily accessible to Malaysia, although there are certain products that have attractive tradeoffs.

In **motor vehicles,** the complexity filters identify **car parts** (HS 8708) as the most nearby diversification opportunity. In 2012, Malaysia exported over US$800 million of car parts, mostly to countries in its region. Encouragingly, the average export volume growth of exports of car parts over the past 15 years was close to 16 percent in Malaysia, compared to 6 percent in the world. The filters also highlight cars (HS 8703) as an attractive diversification opportunity but export volumes of cars in Malaysia have grown at only 0.2 percent over the past 15 years, well below the global average of 6.2 percent. Although the economic complexity methodology imply that Malaysia is well positioned in terms of its productive capabilities to export cars, we see that other factors also determine a country's ability to be a successful exporter, such as competitive dynamics and global market trends. Overall the largest number of products in the motor vehicles cluster falls in the "neither" category – they are too distant given their strategic value to Malaysia.

Similarly, the **air and water transportation** cluster does not present ready-made opportunities for diversification in Malaysia. In fact, the filters select only one product in this category, namely **parts of airplanes or helicopters** (HS 8803) as offering an attractive cost-benefit tradeoff. Still this product is quite distant from

[29] To clarify, the red area does not correspond to Malaysia's total exports of these products but rather the sum of all countries' exports of these products, i.e. the size of the world market.

Malaysia's current capabilities (ranked 168th most distant among the 238 products). **Railway equipment** on the other offers more accessible opportunities specifically in **railway track fixtures** (HS 8608), **locomotive parts** (HS 8607), and **railway coaches** (HS 8603, 8605). Among these, self-propelled railway coaches have registered fastest recent growth in Malaysia and are most sophisticated, but also most distant. Meanwhile, **railway locomotives** (HS 8601, 8602) were not selected because they have relatively low complexity and high distance to Malaysia.

The next largest export category in M&E and precision instruments is **office machinery.** Malaysia current exports with RCA *all* the products in the cluster hence there are no further opportunities to diversify. If Malaysia's path resembles that followed by other countries, it may over time abandon certain less complex products such as **typewriters** (HS 8469) and specialise in the more complex ones such as **computer hardware** (HS 8471) and **computer accessories and parts** (HS 8473) which together account for 98 percent of this cluster's world exports. The challenge that Malaysia faces in this cluster is competition from lower-cost manufacturing locations. Although Malaysia has been gaining market share in computer accessories, it has been losing market share in computers as more standardised computer manufacture and assembly activities are shifting to lower-cost locations. The lower PCI of computers relative to computer accessories suggests that indeed more countries are gaining the capabilities to export computers.

Next, we consider opportunities in **general purpose machinery**, which includes heating and cooling equipment, lifting, moving & excavating machinery, engines, boilers and turbines, and machine tools, and "other" machinery. Here Malaysia currently exports very little with RCA but the implied capabilities suggest that developing this sector would be strategic. In **heating and cooling equipment** Malaysia is currently quite diversified with RCA in four of the seven products. From the missing products the complexity filters include only one (pumps for liquids) but exclude the other two (refrigerators and industrial furnaces) because of their low PCI and opportunity gain. However in the remaining general-purpose machinery sector all but one product is selected by the complexity criteria.

Specifically, all products in **lifting, moving, and excavating machinery** pass the filters. These include loading and unloading machinery, pulley tackle and hoists, other moving and excavating machinery, among others. In **engines** all products also pass the complexity filters. Although Malaysia does not have RCA in any product in this cluster yet, **other engines and motors** (HS 8412) and **compression-ignition**

internal combustion piston engines (HS 8408) have grown at 29 and 14 percent over the past fifteen years, respectively. In **boilers and turbines**, where Malaysia currently has RCA in one product (Steam or other vapor generating boilers, HS 8402) all products pass the filters. By far the largest of these products, both in Malaysian and in world exports is Turbojets, turbo propellers and other gas turbines (HS 8411). The **machine tools** cluster, where Malaysia currently has RCA in **machine tools for working metals** (HS 8462), also offers attractive diversification opportunities into all the remaining products according to complexity criteria.

In the **"other"** category, all products pass the complexity filters. Products that appear particularly attractive given their overall ranking on distance, complexity opportunity gain and average growth are **tools for hand working, pneumatic, hydraulic motors** (HS 8467), **compression-ignition internal combustion piston engines** (HS 8408), and **appliances for thermostatically controlled valves** (HS 8481).

Turning to various **specific-purpose machinery,** the outlook is very similarly positive. With the exception of a few machines used in agriculture, leather processing and nuclear reactors, all of the products that Malaysia does not already export with RCA pass the complexity filters. Many of the machines selected are used in sectors in which Malaysia has strong capabilities, for example machinery for working rubber or plastics, various machines for processing of textiles (but not leather), metal working machinery, and paper making and processing machinery. With current exports of just under US$4 billion specific purpose machinery is still small in Malaysia's total exports but it grew 9.2 percent on average over the past fifteen years, compared to 4.0 percent in the world suggesting that this is a space where Malaysia has been gaining market share. Products that appear particularly attractive given their overall ranking on distance, complexity opportunity gain, and average growth are **parts and accessories for metal working machines** (HS 8466), **other machinery for making paper pulp, paper or paperboard** (HS 8441), and **machinery for working rubber or plastics** (HS 8477).

In **precision instruments** Malaysia's largest export volumes relate to instruments used for testing of E&E products, e.g. **oscilloscopes, spectrum analyzers and apparatus for checking electrical quantities** (HS 9030). This sector is directly leveraging Malaysia's capabilities in E&E and precision manufacturing. Malaysia also has RCA in several other **surveying, measuring, and testing devices** although the absolute export volumes of these products are lower. However the growth rates in this sector, both in Malaysia and the world market, are high. Looking ahead, the

complexity filters identify all but one of the remaining products in **surveying, measuring, and testing devices** as good diversification opportunities. **Instruments and apparatus for physical or chemical analysis** (HS 9027) are particularly attractive given their overall ranking, recent history of growth in Malaysia and size of the world market.

In **medical and scientific appliances**, Malaysia currently has RCA in only two products, microscopes and certain medical instruments. The complexity filters have selected all but one of the remaining products as strategic and valuable for Malaysia. Most of these products have indeed been seeing high growth rates both in Malaysia and in world markets, although total export volumes are still relatively low suggesting that there is significant room to grow both on the intensive and extensive margin. **Apparatus based on the use of X-rays or of alpha, beta or gamma radiations** (HS 9022) looks particularly promising. It currently accounts for US$150 million of exports for Malaysia, growing at an average annual rate of 27 percent on average compared to 8 percent in the world.

In **photographic and imaging devices**, Malaysia currently has RCA in all products, notably photographic cameras, image projectors, video cameras and photocopiers. The only remaining product in which it does not have RCA is **equipment for photographic laboratories** (HS 9010); it accounts for by far the largest export value in this cluster (US$23 billion) and highest PCI among all of the selected products. This product represents a good diversification opportunity according to the complexity filters.

In **optics**, Malaysia has RCA in the two most attractive products in this cluster, as measured by world market size: Lenses, prisms, mirrors and other optical elements and **optical fibers** (HS 9001). The remaining three products also offer good diversification opportunities but their world markets are significantly smaller.

Watches and clocks in general do not present a strategic growth opportunity largely based on their distance. In addition, many of the products have registered negative growth over the last 15 years, not only in Malaysia but in the world overall.

Similarly, the production of **musical instruments** is not strategic for Malaysia. Only one product meets the complexity filters.

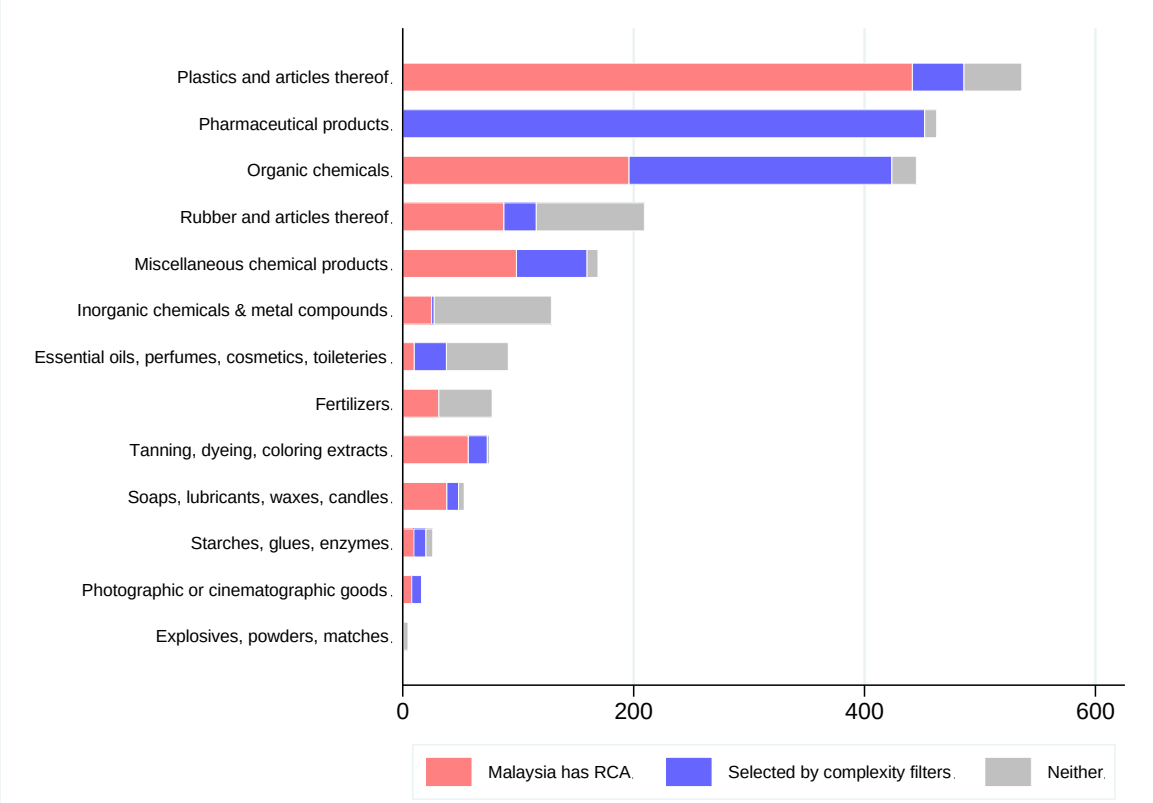
Current and Frontier Opportunities in Chemicals and Plastics

As can be seen in Figure 13, the largest clusters in **chemicals and plastics** are plastics, pharmaceutical products, and organic chemicals, each with a world market in excess of US$400 billion. Malaysia today has a broad presence in plastics and a relatively good presence in organic chemicals, rubber products, miscellaneous chemicals, tanning and dying substances, and soap, lubricants and waxes. Malaysia has a narrower presence in pharmaceutical products, inorganic chemicals, perfumes, and toiletries, among others.

Turning to opportunities for diversification, in **plastics** Malaysia already exports a broad range of products and predominantly those that have the largest world markets: ethylene polymers, plastic plates and sheets, packaging plastics, and various other products. The 14 plastics products in which Malaysia has RCA account cumulatively for close to US$500 million of exports and have performed well, growing 15 percent on average in Malaysia compared to 9 percent in the world. The complexity filters have selected an additional 7 products. Among these, **silicones** (HS 3910) are most complex and **petroleum resins** (HS 3911) most strategic. Five additional plastics products, including plastic household products and builders' ware, were not selected due to their low complexity.

The large world trade volume in **pharmaceuticals** includes more than US$330 billion of world trade in packaged medicaments. Although Malaysia does not currently export any pharmaceutical product with RCA, the complexity filters have identified **packaged medicaments** (HS 3004) as a strategic diversification opportunity. Indeed, Malaysia does appear to have the relevant capabilities because it exported over US$187 million of packaged medicaments in 2012, predominantly to other Asian and to African markets. Despite the availability of basic capabilities in Malaysia, this sector has underperformed the average rate of growth of the world market. This suggests that factors other the productive capabilities might be holding back greater export potential in this sector.

Figure 13: Global Market Export Volumes in C&P (US$ Billion), 2012



Source: Authors' calculations using trade data from CEPII

Organic chemicals is a sector where Malaysia has already been developing capabilities and which has further opportunities for diversification. Malaysia currently has RCA in 11 of the 42 products in the cluster and these products have grown 27 percent on average over the last 15 years, compared to 8 percent in the world. The complexity filters have highlighted an additional 24 products, all of which are sufficiently complex and strategic given their distance. The performance of these products over the last 15 years is mixed – some have grown at high double digits rates (e.g. other organic compounds, nucleic acids and their salts, compounds with other nitrogen function) and others have taken off at a slower rate or even lost volume. Seven products in this cluster were not selected, either because they are insufficiently complex or too distant.

In **rubber products**, Malaysia today exports 13 out of the 17 products with RCA with the largest export volumes accounted by US$2.8 billion of **natural rubber exports** (HS 4001) and close to US$3.5 billion of apparel made of rubber, notably **rubber gloves** (HS 4015). With a few exceptions, the existing rubber products are not overly complex but they have seen healthy export growth of 10 percent on

average, with some products (e.g. compounded rubber, HS 4005) growing well in excess of that. The diversification opportunities in this sector are limited, however. The complexity filters selected only one out of the remaining four products, **synthetic rubber** (HS 4002). The other three products are either insufficiently complex (rubber tubers, tubes) or insufficiently strategic (conveyor belts) given the distance.

Miscellaneous chemicals feature various opportunities for diversification. Malaysia already has RCA in six products in this cluster, including some of the largest by world market size: **chemical elements used in electronics wafers** (HS 3818), **fatty acids and acid oils from refining** (HS 3823), and **insecticides, rodenticides, fungicides, herbicides** (HS 3808). The complexity filters have identified an additional 11 products, all of which have been growing at healthy rates in Malaysia. Six additional products were deemed insufficiently complex and have not been selected.

The **inorganic chemicals** cluster features 51 different products. Malaysia today has a narrow presence in this cluster with the exception of four products; the complexity filters do not select it as one that is very strategic for Malaysia. Similarly **fertilizers** are not strategic for Malaysia largely due to their low complexity.

The **tanning, dying, and coloring** cluster features 15 products and Malaysia already has RCA in 11. Three of the six remaining products represent good diversification opportunities and three do not because of their low complexity. Overall future growth in this cluster may come from growing Malaysia's exports in existing products (growing the intensive margin) rather than in diversifying (growing the extensive margin). Indeed the products in which Malaysia has RCA have registered average growth of 16 percent on average over the past 15 years, compared to 6 percent in the world.

In **soaps and related products**, Malaysia has developed a presence with RCA in three out of the seven products, including cleaning products, soaps, and waxes. These products have been growing at healthy rates but they are not very complex, with an Average PCI of 0.3. The complexity filters have identified two products – **lubricating products** (HS 3403) and **model and dental pastes and waxes** (HS 3407) –as potentially strategic due to their higher complexity. **Polishes and candles** were not selected due to their low complexity. **Essential oils, perfumes, cosmetics, and toiletries** do not offer many diversification opportunities. Only **beauty or make-up preparations** (HS 3304) in which Malaysia already exports

over US$106 million and which have growth exports at an average of 14 percent over the last 15 years were selected by the filters.

The smaller clusters of **starches, glues, and enzymes and Photographic and cinematographic goods** each offer three incremental opportunities for strategic diversification.

Current and Frontier Opportunities in Electrical and Electronics

By far the largest cluster in E&E is **semiconductors and electric circuits** with over US$700 million of exports in Malaysia and over US$24 billion of exports in the world. Malaysia today has RCA in 10 out of the 12 products in this cluster. While Malaysia's exports across the different products have grown at an average rate of 4 percent over the last 15 years compared to 5 percent in the word, its exports in electronic integrated circuits, which is the single largest product in the cluster, have lagged behind, falling by 1 percent relative to a 4 percent global market growth. Given Malaysia's already broad presence in this cluster, it offers only one strategic opportunity for diversification: **electric filament** (HS 8539). One more product that Malaysia does not already have RCA in, Apparatus protecting electrical circuits for > 1k volts (HS 8535), did not meet the complexity filters because it is the least complex in the cluster.

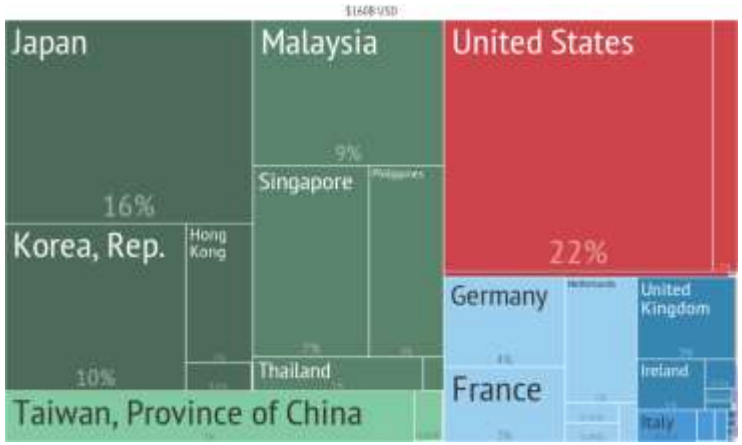
The challenge for Malaysia in semiconductors and electric circuits is very different than the challenge in some less developed clusters. Namely the challenge in E&E is to maintain or grow its market share in a space that has been growing relatively slowly and has lots of supply coming from China and Taiwan who have increased their cumulative global market share in this cluster from 8 percent to 36 percent over the last 15 years (Figure 14). A second challenge is to develop the capabilities to be a producer and exporter of new and potentially less price-competitive products in this cluster.

As in semiconductors, Malaysia has a broad presence in **telephones, sound, and video devices**. The largest product category in this cluster is **telephones** (HS 8517), accounting for US$205 billion of exports in the world and over US$8 billion in Malaysia. Over the last 15 years Malaysia has gained some market share in telephones as exports have grown 12 percent on average compared to 10 percent in the world. However, in the next two largest products, namely **parts of radios, telephones and TVs** (HS 8529) and **video recording apparatus** (HS 8521), Malaysia has lagged behind world market growth.

One challenge that we can observe in this cluster stems from the quickly changing nature of technology: while some products are growing, others are becoming obsolescent. For example, **dictating machines** (HS 8520), **parts of video and sound equipment** (HS 8522), and **sound recording apparatus** (HS 8519) have seen the volume of their world exports shrink in the last 15 years. As we saw in Korea's product space, it abandoned some low-performing E&E products. Malaysia on the other hand is currently present in almost all products, including those that are becoming obsolescent. A second challenge that Malaysia faces in this cluster, as in semiconductors, is maintaining or growing its market share in a changing competitive environment.

Figure 14: Who exported Electronic integrated circuits?

1997



2012

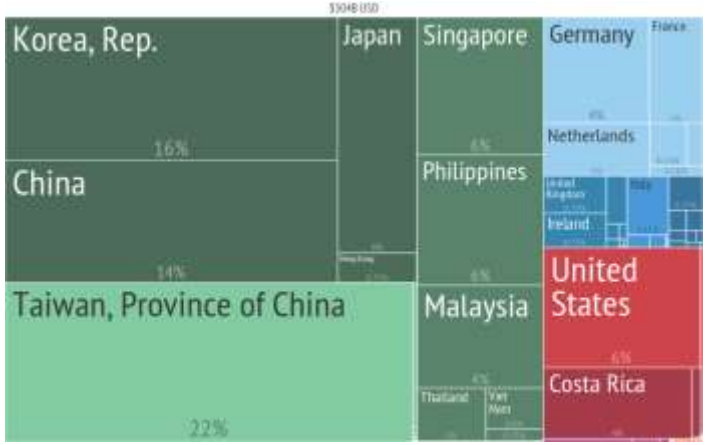
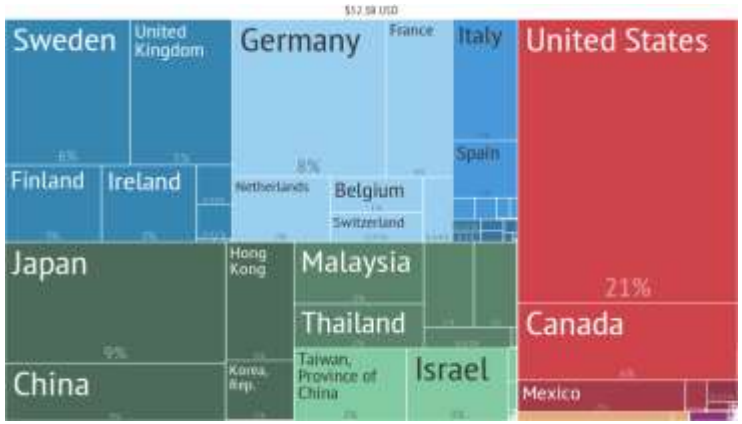
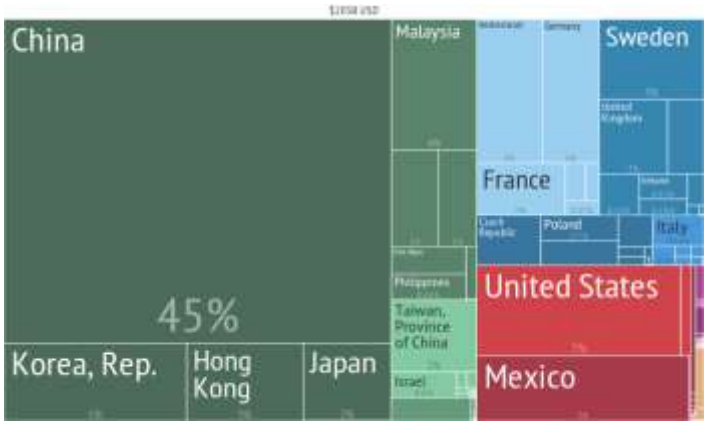


Figure 15: Who exported telephones?

1997



2012



Source: Atlas of Economic Complexity: http://www.atlas.cid.harvard.edu. HS4 level data from CEPII

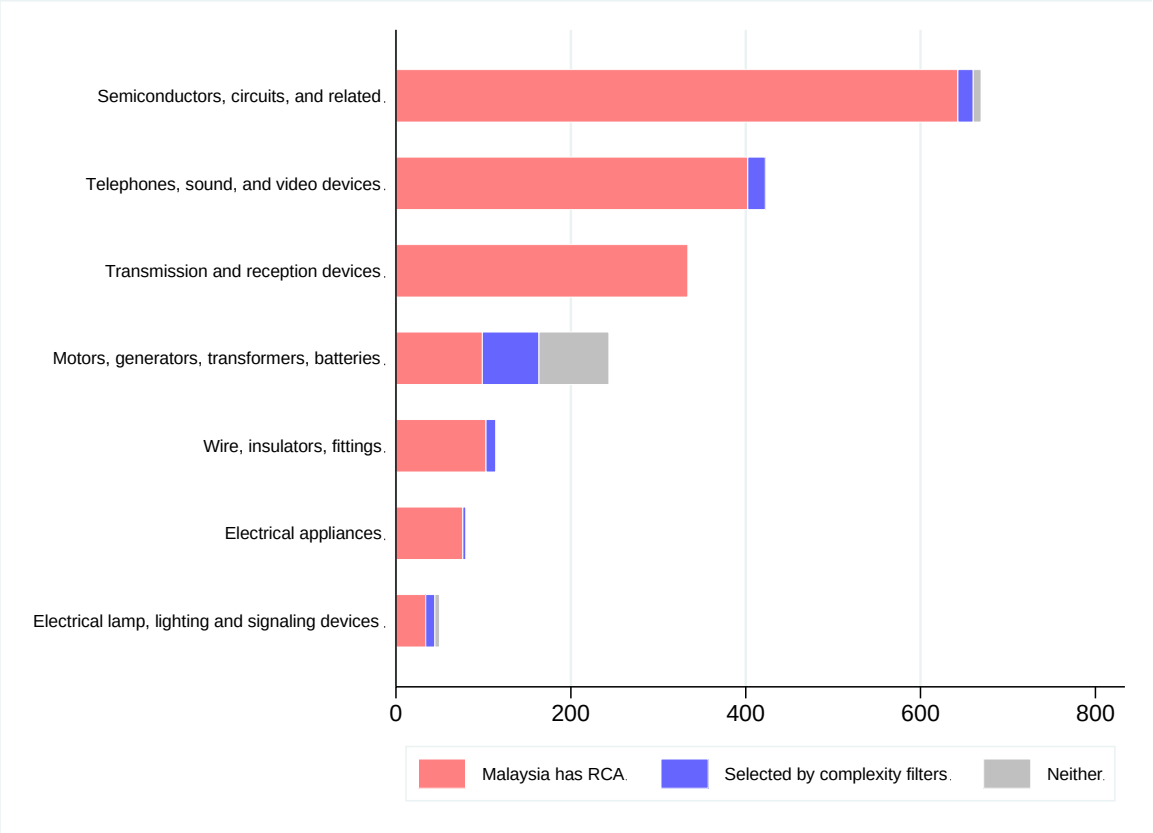
In particular, Malaysia may need to adjust its strategy to reflect a world where production has increasingly shifted from the U.S. and Europe to one where China has emerged as the single most dominant supplier in the global value chain for these manufactured products (Figure 15).

Transmission and reception devices are also a mature cluster in Malaysia. Since it exports all products with RCA there is not room for further diversification. In terms of the intensive margin, Malaysia has performed relatively well. It has outperformed world market growth in the largest and most dynamic product category in this cluster: **Transmission apparatus for radio, telephone and TV** (HS 8525).

The next largest cluster in the E&E market is **motors, generators, and transformers**. Here, Malaysia has a weaker presence with RCA in 4 out of the 9 products, including **electrical transformers** (HS 8504), which is the largest product in the category. As before, Malaysia's growth performance in these products is mixed, underperforming world growth in some products (e.g. transformers) and outperforming in others (e.g. electromagnets). In terms of the available opportunities, the complexity filters identify three of the remaining five products as strategic, specifically **parts for use with electric generators or converters** (HS 8503), **electrical ignition or starting equipment** (HS 8511) and **electric generating sets and rotary converters** (HS 8502). These products have indeed been growing over 15 percent on average in Malaysia. The remaining two products did not pass the filters because of their lower complexity and higher distance.

In **electrical wires and insulators**, Malaysia has RCA in two out of the four products, among them **optical fiber cables** (HS 8544) which accounts for a US$ 101 billion global export market and US$954 million of exports for Malaysia. The complexity filters identify both of the remaining, albeit smaller products as potential diversification opportunities. They are **insulating fittings for electrical machines, appliances or equipment** (HS 8547) and **carbon electrodes or other articles of graphite or carbon used for electrical purposes** (HS 8545). In **electrical appliances**, Malaysia has RCA in all the products except shavers, which the complexity variables select as strategic because of its high PCI. Finally, **electrical lamp, lighting and signaling devices** feature one new strategic product for Malaysia, which is **Electric laser or other light or photon beam** (HS 8515)

Figure 16: Global Market Export Volumes in E&E (US$ Billion), 2012



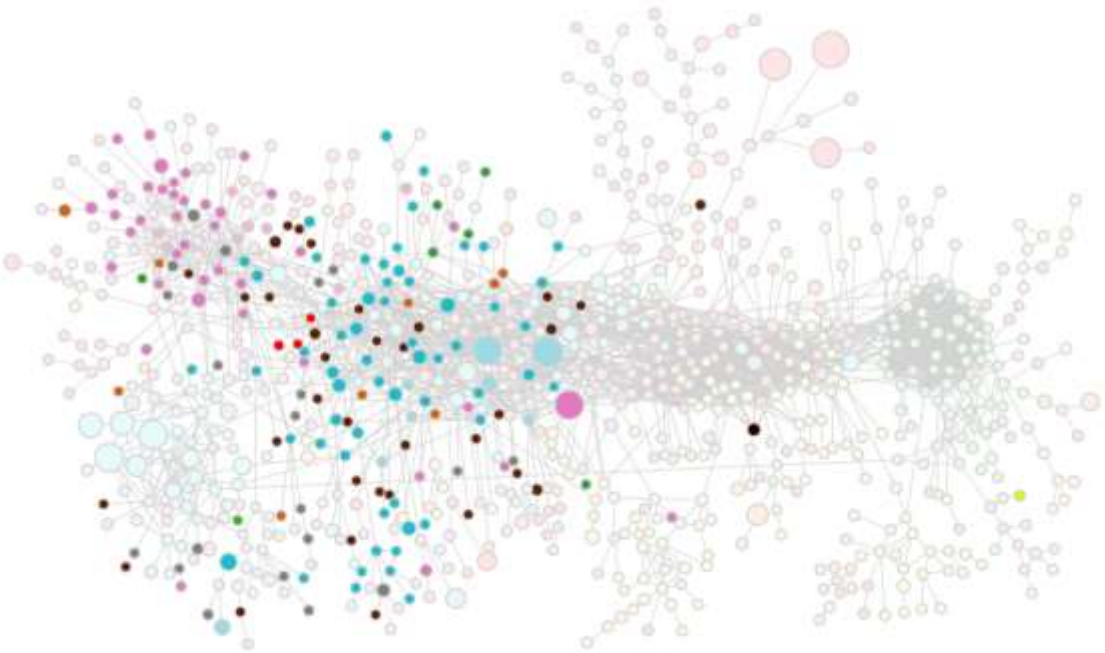
Source: Authors' calculations using trade data from CEPII

Taking stock

The analysis in this section describes a rich set of opportunities for strategic diversification. We have shown that the priority sectors contain a number of under-developed products that offer Malaysia the opportunity to increase the complexity of its economy and to improve its position in the product space. This can be seen more clearly in Figure 17, which shows the position in the product space of the 238 products that pass the complexity filters. Most of these products are highly interconnected. This means that they employ capabilities that are required to make many other products. Many of the 238 products are located in the manufacturing core of the product space, an area of the product space that advanced economies have populated. Additionally, most of these products are concentrated on the left side of the core of the product space, closer to the industries in which Malaysia is already well positioned, namely the E&E sector. In sum, not only do the frontier products serve the goals of increasing complexity and opening diversification

opportunities, but they also leverage the capabilities that Malaysia has developed since its first modern industrial transformation.

Figure 17: Position of Prioritised Frontier Products in The Product Space



Source: Authors' calculations

VI. Malaysian Firms in the Priority Sectors

In the prior chapter, we looked at where Malaysia's capabilities currently lie and pointed out the strategic future directions in the priority manufacturing sectors. In this part of the analysis, we consider what the industrial structure and firm productivity look like in these clusters today. To do so, we use data from the 2010 Malaysian Census of Manufacturing Industries that features information on roughly 40,000 different establishments in Malaysia.[30] Our primary goal is to gain more insight about the firms active in what we have referred to as the "frontier" – i.e. the products and industries that are relatively underdeveloped today but provide attractive opportunities for strategic diversification. This section will examine the participation of firms in these product categories and the constraints they face in manufacturing such products.

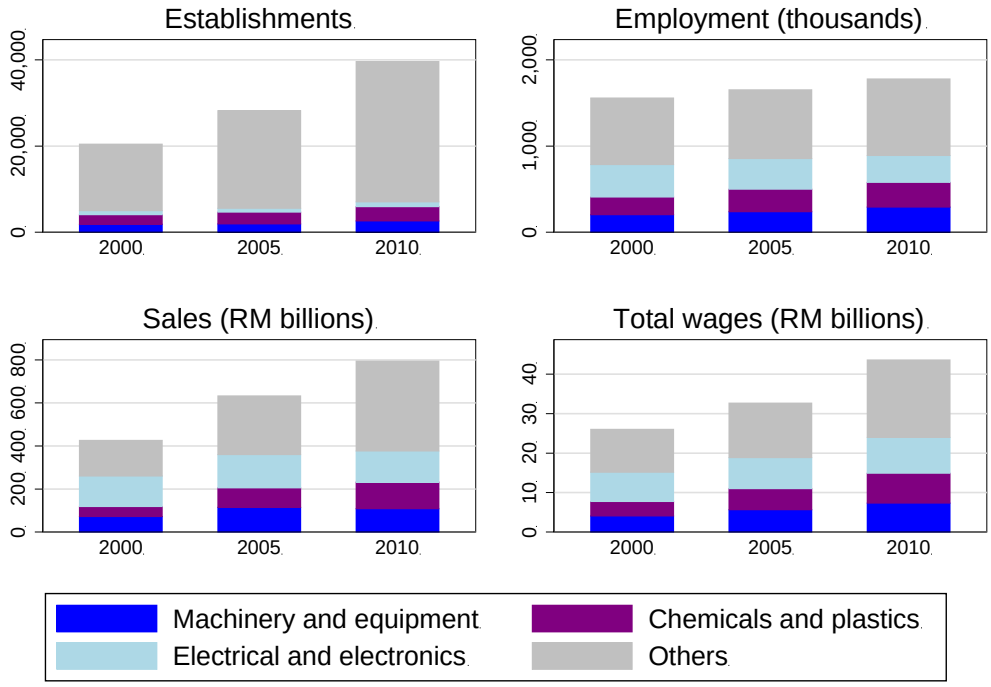
Before we turn to the firms, we first explore more broadly the extent of what we have termed "priority sectors" in Malaysian manufacturing. Figure 18illustrates i) the share of M&E, C&P, and E&E in all manufacturing establishments; ii) their share in the total number of workers; iii) their share in all manufacturing sales; and iv) their share of total wages paid to workers. It is powerful to see that, although these sectors house less than 20 percent of all manufacturing firms, they account for roughly half of all manufacturing employment and sales, and more than half of all manufacturing sector wages. This points to the fact that firms in these sectors tend to be larger and more productive and that the workers in these sectors earn higher wages compared to other manufacturing sectors. Thus the priority sectors are particularly relevant to Malaysia not only because they house the most complex and strategic products but also because of their existing scale in Malaysian manufacturing and employment.

Next, we zoom in on each sector and consider the firms in the individual clusters. Note that the "clusters" as we term them here correspond to the 3-digit Malaysia Standard Industrial Classification (MSIC) 2008 codes. While often the cluster names will be similar to the cluster names we discussed in the prior section of this report, it is important to note that they do not map one-to-one to each other because of differences in the international and local classification systems. Secondly while we are showing here the aggregate activities of these firms, given data limitations we are unable to show how much of their activities relates to production for exports versus production for the domestic market, nor which firms export and which do

[30] Strictly speaking the unit of observation in the Census of Manufacturing is an establishment rather than a firm. This means that a firm could appear in the data more than once if it has multiple establishments. However, for simplicity in this chapter we will refer to each observation of an establishment as a "firm."

not. Finally, the money values in this section are not comparable to the prior section as the census data is reported in Ringgit Malaysia (RM) and the trade data in U.S. dollars.

Figure 18: Manufacturing in Malaysia by Industry Group, 2010



Source: Manufacturing Census, DoS

Firms in M&E and Precision Instruments

The prior chapter argued that Malaysia has significant productive capabilities in office machinery and increasingly in precision instruments. We also argued that Malaysia has a still relatively weak position but meaningful capabilities to access other strategic parts of the M&E space, like general- and special purpose machinery. In particular, Malaysia has high potential to produce machines used in sectors in which it is already strong: rubber and plastics, oil and gas, agriculture, E&E, among others. This type of diversification would allow Malaysia to leverage the capabilities and know-how that it already possesses as it further develops its machinery industries. We have also argued that it is strategic for Malaysia to continue to deepen and broaden its presence in precision instruments, as these products tend to be complex and strategic and also leverage its existing capabilities.

Next, we look to the census data in order to gain more appreciation for the firms active in these sectors and the opportunities and constraints that they may face. Table 2 shows selected descriptive statistics of firms in M&E, separately for domestic- and foreign-owned firms.

Table 2: Summary Statistics of Firms in M&E, 2010

Description	Total sales	% foreign	Number of establishments		Avg. establishment sales		Avg. workers / establishment		Avg. productivity (sales / workers)		Avg. knowledge workers		Avg. investment (capex / sales)	
			Domestic	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*
Manufacture of computers and peripheral equipment	29,791,934	91%	60	24	46,357	1,130,123	361	1,761	131	1,325	25%	30%	2%	7%
Manufacture of motor vehicles	21,643,980	17%	34	3	621,407	1,207,727	732	855	289	893	20%	20%	2%	3%
Manufacture of general-purpose machinery	13,289,403	66%	568	44	9,534	200,705	40	401	197	412	25%	23%	3%	3%
Manufacture of parts and accessories for motor vehicles	10,199,177	40%	349	26	21,701	157,738	88	420	224	475	25%	23%	3%	9%
Building of ships and boats	7,733,531	1%	259	4	47,225	20,751	67	166	297	126	18%	17%	5%	4%
Manufacture of special-purpose machinery	6,157,837	36%	622	46	7,855	50,863	37	162	157	305	22%	31%	4%	6%
Manufacture of transport equipment n.e.c.	4,761,033	52%	81	8	28,998	357,023	103	495	143	510	21%	22%	3%	3%
Manufacture of optical instruments and photographic equipment	2,955,469	100%	3	7	4,777	420,162	21	1,905	153	196	87%	16%	10%	4%
Manufacture of measuring, testing, navigating and contro equipment; watches and clocks	2,446,525	84%	45	13	9,581	158,715	44	613	205	193	30%	26%	1%	12%
Manufacture of air and spacecraft and related machinery	1,530,438	78%	11	2	14,286	595,470	139	688	104	946	56%	70%	4%	1%
Manufacture of irradiation, electromedical and electrotherapeutic equipment	1,489,632	90%	13	5	11,279	268,600	76	1,643	145	130	17%	20%	1%	12%
Manufacture of magnetic and optical media	962,375	96%	3	2	13,376	461,124	76	421	193	963	25%	52%	0%	14%
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	939,216	4%	97	2	12,694	18,980	44	118	174	118	11%	43%	3%	3%

Source: Authors' calculations using the 2010 Malaysian Census of Manufacturing Industries, DoS
Notes: All values are in RM 000's

As was the case when we looked at total M&E exports, the **office machinery** cluster clearly comes out on top with total sales of close to RM 30 billion. In many ways this cluster is less representative of the M&E sector and rather similar to the E&E sector. It features 24 large foreign establishments, which account for more than 90 percent of sales. Their productivity as measured by sales per worker is among the highest in Malaysian manufacturing. It also features 60 Malaysian-owned establishments but these operate at a much lower scale and productivity. Similar to the case of E&E, the challenge in this cluster is not to develop the productive capabilities to diversify into new areas, but rather to deepen and to add more value to existing activities. In some cases the challenge also is to abandon products that are becoming obsolescent and move into new products that appear on the technological frontier. A positive sign in the firm-level data is that the investment by the foreign firms is relatively high (7 percent on average) which suggests that despite competitive pressures they continue to view Malaysia as an attractive location.

The second largest set of industries in M&E relate to **transportation equipment**, most notably **motor vehicles** and their parts and bodies. The prior chapter argued that while Malaysia is not a significant exporter of motor vehicles, it is nearby in terms of its productive capabilities. The census data indeed shows a richer landscape of firms manufacturing cars and car parts with more than 500 establishments and total sales of RM 33 billion. We also saw in the export data that Malaysia has seen limited dynamism in cars. Car parts were closer in the product space and likely more commercially viable. However the capabilities that exist in this cluster are extensive and they could potentially be leveraged to produce other related machinery. For example other lifting, handling, loading or unloading machinery, a cluster that was selected by the complexity filters has one of the highest proximities to cars in the product space.

The remaining transportation clusters – **water, air and rail transport** – are underdeveloped both in Malaysian exports and in Malaysian manufacturing. The building of ships and boats, a largely domestically owned industry, features over 260 small establishments with total sales of RM 7.7 billion. As we saw in the prior chapter some of them (likely the larger firms) do export tugboats. It would be interesting to probe further what capabilities these firms are employing and to what extent the manufacturing is taking place in Malaysia. In the manufacture of **aircraft and related machinery** there are only 13 active firms but the two foreign firms account for the large share of activity. We saw that aircraft parts did pass the complexity filters but that the majority of the other air transport products is beyond the reach of Malaysia's current capabilities. In **rail** the complexity filters identified a

number of opportunities but surprisingly there appears to be little or no such activity today (some such activities may be visible only at finer levels of industry classification).

Turning to the two sectors that the complexity filters highlighted as offering the largest number of strategic diversification opportunities–**general-and special purpose machinery**–the census data reveal that there are more than 600 establishments active in each of these clusters. Given their low export footprint it is perhaps surprising to see that these clusters account for by far the largest number of M&E establishments, with total sales of close to RM 20 billion and more than 70,000 workers.

What could explain this apparent inconsistency? The key lies in considering the productivity of these firms. We see from Table 2that the Malaysian-owned firms in these clusters are on average among the smallest (in terms of sales per establishment) and least productive (in terms of sales per worker) in the M&E sector. This does not imply that there is not a meaningful number of very productive Malaysian firms. Indeed, looking at Figure 19 which maps the productivity of Malaysian and foreign-owned firms in these clusters, we see that there are a number of firms whose productivities and scale come close to and in some cases even exceed those of the foreign firms. However, there is also a fat tail of many small, relatively unproductive firms.

A fact from international trade theory is that due to the large fixed costs involved in exporting (finding foreign markets and partners, upgrading technology, gaining product certification, etc.) in general only the most productive firms in any country export.[31] For such firms the profits that they can earn abroad are sufficient to offset the initial fixed costs of becoming an exporter. Less productive firms do not export because their foreign sales would be insufficient to compensate for the fixed costs of exporting. Thus we can imagine that along the distribution describing the productivity of firms there exists a cutoff productivity and only those firms with productivity above this cutoff export, while those below sell only in the domestic market.

This also implies that for the firms with productivities just below the exporting cutoff, upgrading their technology or lowering their fixed costs of exporting can

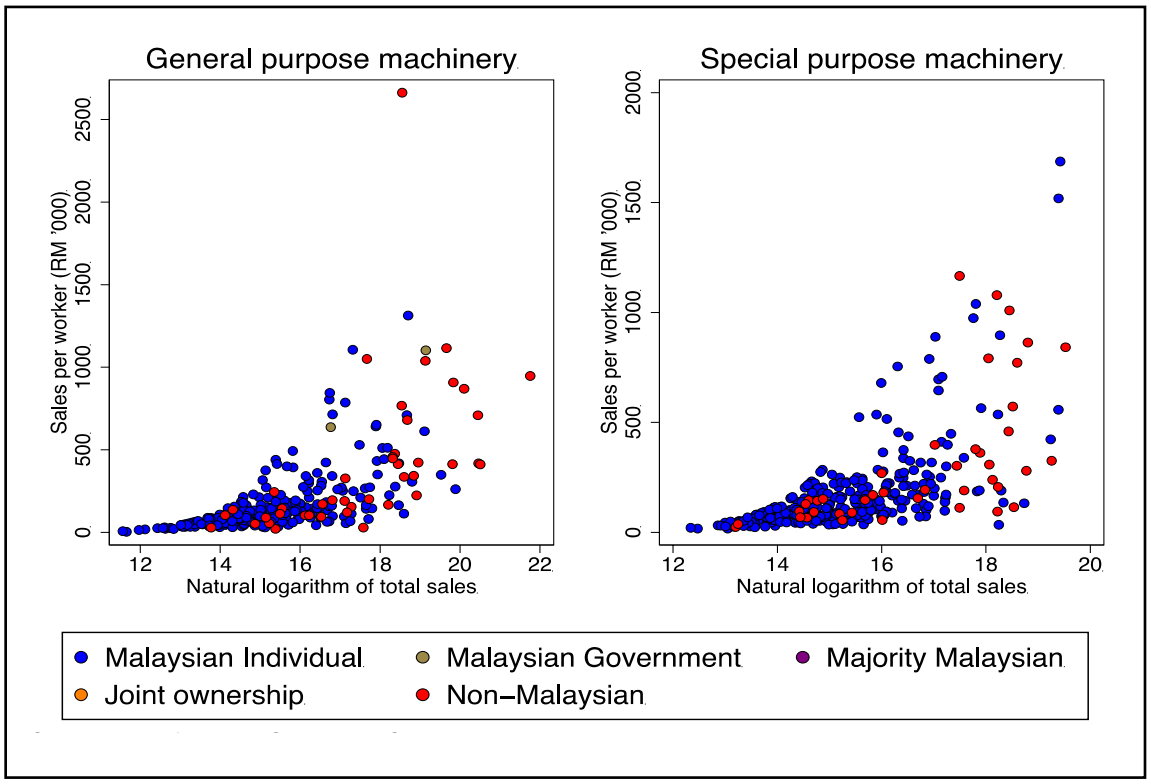
[31] For the benchmark model describing this result see Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-1725. A lot of subsequent research has found empirical evidence for this model, including Bustos, P., "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms," *American Economic Review* 101: 304-340, 2011 and Manova, K., "Credit Constraints, Heterogeneous Firms, and International Trade," *Review of Economic Studies* 80: 711-744.

yield a lot of incremental benefit because it would increase their productivity enough to move them from being domestic-only producers to becoming active as exporters. This increases the size of the demand they face and incentivises further productivity upgrading. Thus, the presence of many mid- and lower-productivity firms in general and specific purpose machinery firms suggests that Malaysia is not missing the basic capabilities to make such products, i.e. there is no need to "jump-start" the industry from scratch. Rather it suggests that if manufacturing firms (especially those at a medium-level of productivity) are able to increase their productivity, Malaysia could see a meaningful increase in its RCA in these areas of M&E.

However, looking at investment levels, M&E firms in this space are investing only 3-5 percent of annual sales. Based on interview evidence, it appears that mid-sized M&E companies face a constraint accessing capital needed for investment in newer and better machinery. The nature of the capital-intensive business model is typically such that capital investment requirements are high and the cash return to equity is low, at least in the short to medium run (profits frequently need to be re-invested during the growth phase). At the same time, there are few financing sources available that have preferences consistent with this type of risk profile (i.e. that prioritise the growth on the company's value over the cash returns). This leaves midsized M&E companies capital constrained and needing to rely on scarce internal cash flow or family ties for investment. As a result, they have relatively old capital stock and substitute towards more labor-intensive production, both of which leads to lower productivity and lower growth.

A second observation is that, compared to the better-developed sectors in Malaysia, the establishments of foreign firms in general-and special-purpose machinery are also smaller and less productive. For these firms capital constraints may not be relevant given that they can access international or home market financing. It would be important to understand what are the gaps they face in the Malaysian ecosystem (whether specific types of high skilled labor, land, input providers, etc.) and what specific incentives would enable them to locate their larger and more capital-intensive manufacturing activities in Malaysia.

Figure 19: Size and Productivity of Malaysian Firms in General- and Special-Purpose Machinery by Ownership Type, 2010



Source: Manufacturing Census, DoS. Includes all establishments with 10 workers or more in 2010

We saw in the prior chapter that **precision instruments**, which includes optics and photographic equipment, measuring and testing instruments, and medical devices, are an under-developed but a high-potential, high-growth sector. The product space analysis revealed that Malaysia is very well positioned to take advantage of the opportunities in this sector. In particular, there is significant room to grow both on the intensive and extensive margin in measuring and testing instruments and in medical devices. These sectors are likely to continue to see fast growth, spurred by the ageing world population and the growth of the "Internet of things" which will rely on a great number of sensors, measuring, checking, and automatic regulating instruments.

The census data reveals that as of 2010 the sector is currently small in Malaysian manufacturing, with total sales of less than RM 8 billion across the various clusters.[32] It features only 64 domestic and 27 foreign firms. Foreign firms account

[32] Note that the export data showed more than US$8 billion of exports across the various categories of precision instruments, which suggests that there is a difference between the product classification of MSIC and HS in this cluster.

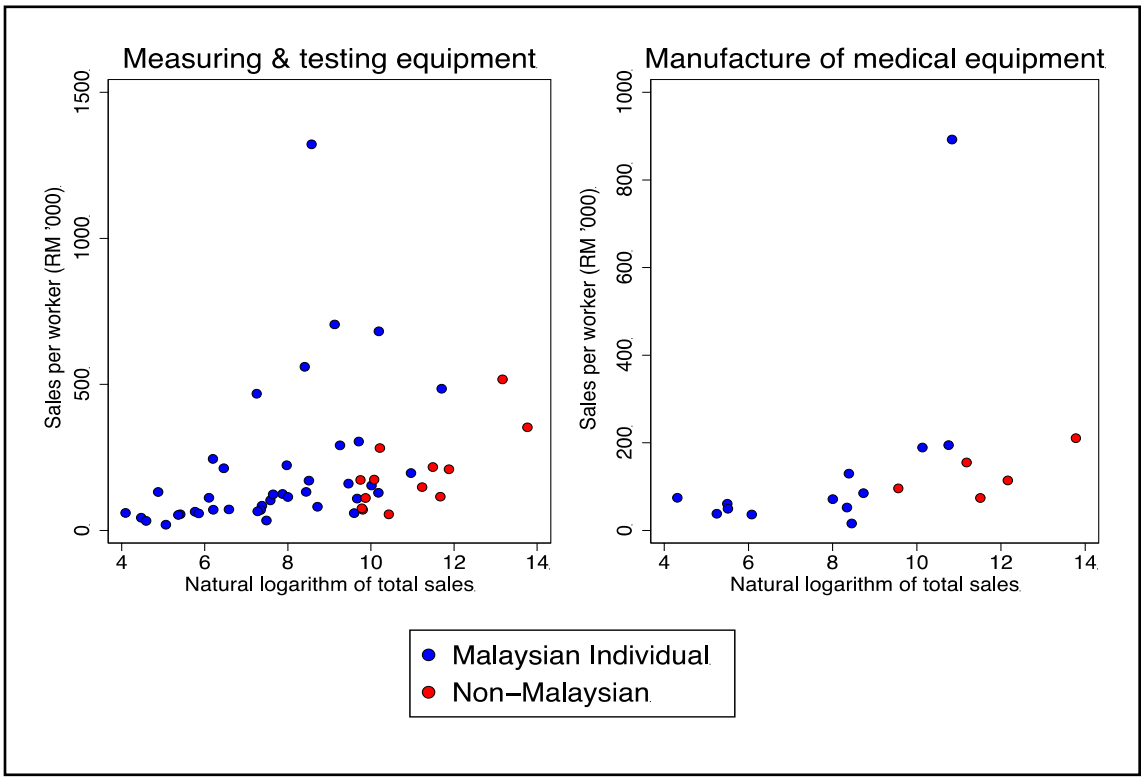
for the great share of sales, ranging from 100 percent in optical instruments and photographic equipment to 84 percent in measuring and testing instruments.

However, in contrast to other sectors that feature significant foreign presence, the foreign firms in precision machinery have relatively low labor productivity.[33] Indeed, across the different clusters Malaysian firms are as or even more productive than the foreign firms. Figure 20 illustrates this by mapping the size and productivities of the 45 domestic and 13 foreign firms active in the manufacture of surveying and testing instruments and the 13 domestic and 5 foreign firms active in medical devices. We see that in both clusters, the foreign firms are larger but not necessarily more productive. In each cluster, there are a number of star performers among the Malaysian firms.

The low productivity of the foreign firms seems to be explained by the labor-intensive nature of their activities. Specifically, looking at the average number of employees at the foreign firms we see that they frequently employ upwards of 1,000 workers at each establishment. This suggests that they are basing in Malaysia relatively labor-intensive, low-productivity manufacturing activities. The fact that they have a very low share of knowledge workers also lends support to this view. On the positive side, the foreign firms did have very high levels of investment in these clusters– 12 percent each in measuring and testing instruments and in medical devices. This is in line with the high growth rates that we observed in Malaysian and the world exports in these clusters. It would be important to understand whether foreign firms are beginning to shift to higher-productivity and more capital-intensive production processes to Malaysia and if not, what would incentivise them to do so.

[33] One exception is the "manufacture of magnetic and optical media" which will be discussed separately.

Figure 20: Size and Productivity of Malaysian Firms in Precision Instruments by Ownership Type, 2010



Source: Manufacturing Census, DoS

On the other hand, despite their good performance and productivity levels, the domestics firms do not seem to be taking advantage of the growth opportunities by investing in this sector. With the exception of optical and photographic equipment, domestic firms were investing no more than 1 percent of sales in 2012. It would be very important to probe what constraints are holding back greater investment by domestic firms and what kinds of incentives could address these constraints.

Finally, we see a small cluster of "Manufacture of magnetic and optical media" which includes blank disks, hard drives, and storage devices. In this cluster, there are currently only 2 foreign and 3 domestic firms active. However, the foreign firms here employ less low-skilled labor and more knowledge-intensive workers. This is also reflected in much higher average labor productivity. Moreover, foreign firms invested 14 percent of sales in this area in 2010, which suggests that they are seeing profitable growth opportunities. It would be important to better understand the incremental growth opportunities in this space.

Firms in Chemicals and Plastics

In the prior chapter, we highlighted Malaysia's strong export presence in plastics and rubber and a lesser but meaningful presence in organic and miscellaneous chemicals, tans and dyes, and soaps. The main avenues for future diversification were pointed out in increasing Malaysia's presence in these clusters, and in particular in organic and miscellaneous chemicals. The product space analysis also pointed out pharmaceuticals as an area in which Malaysia has productive capabilities, although it has very few exports to date.

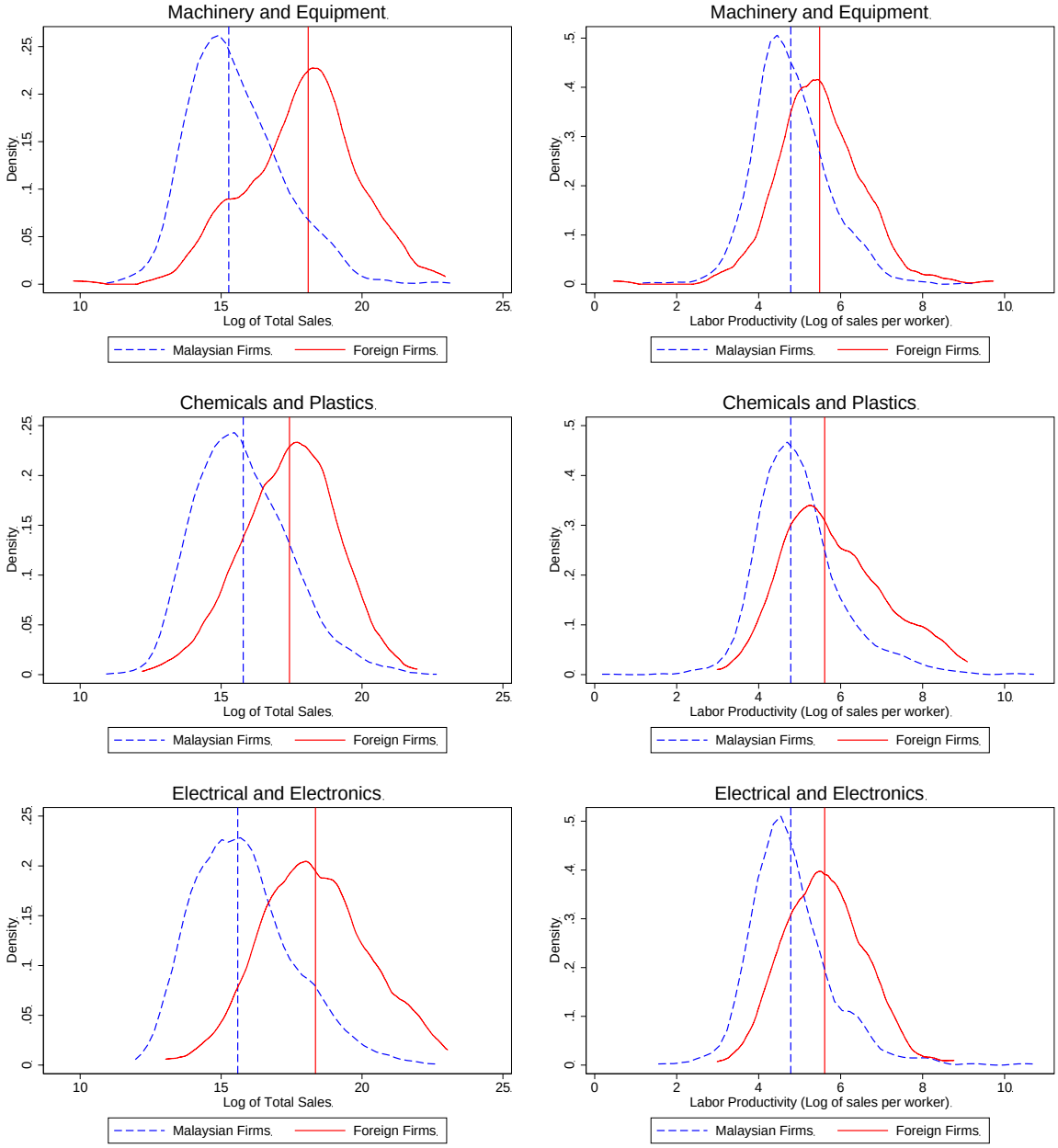
The firm level data points to a number of meaningful strengths in this sector. In contrast to M&E and E&E this sector is majority Malaysian-owned. Foreign firms play an important role but their share in total sales is lower. Figure 21 plots the distribution of firm sales and productivities for each of the sectors. We see that in each sector the foreign firm's distribution is shifted to the right of the domestic firms, which means that across all the sectors foreign firms tend to be bigger and more productive. In the case of C&P, the disparity in average firm size is somewhat more muted.

Table 3 shows descriptive statistics for firms in C&P. The largest cluster is **basic chemicals** with over RM 55 billion of sales and 376 domestic and 56 foreign firms. This cluster features some of the largest Malaysian firms and both the foreign and the domestic firms have by far the highest average labor productivities recorded in Malaysian manufacturing. This is likely related to the high capital intensity and high share of knowledge workers active in this cluster. Second in size is **rubber products** with total sales of RM 31 billion. The Malaysian firms in rubber also have relatively high productivities. But as we can see from the lower share of knowledge workers, production is less complex compared to basic chemicals. **Plastics manufacturing** features over 1,300 firms but both domestic and foreign firms tend to be very small. They are also significantly less productive, suggesting that that this activity is more labor intensive. Similar to rubber products, plastic products manufacturing firms also have a low share of knowledge workers.

The **pharmaceutical cluster** is very small and underdeveloped with only RM 2 billon of sales. It houses 196 Malaysian firms with average sales of less than RM 9 million per firm and low labor productivity. The cluster also features 8 foreign companies with average sales of RM 127 million. As we saw, some of these firms do export to foreign markets. It would be interesting to probe deeper to get a better understanding of the capabilities in this cluster and the potential for linkages

between the foreign and the local firms. Interviews have revealed that Malaysia has some capabilities in traditional medicinal products. A potential productive collaboration could link the production capabilities of local firms to the global marketing and sales abilities of the foreign firms.

Figure 21: Sales and Productivity Distributions of Malaysian and Foreign Firms, by Sector



Source: Authors' calculations using the 2010 Malaysian Census of Manufacturing Industries, DoS
Notes: Vertical dotted line in each case represents the average log of sales and of labor productivity.

Table 3: Summary Statistics of Firms in C&P, 2010

MSIC code	Description	Total sales	% foreign	Number of establishments		Avg. establishment sales		Avg. workers / establishment		Avg. productivity (sales / workers)		Avg. knowledge workers		Avg. investment (capex / sales)	
				Domestic	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*
201	Manufacture of basic chemicals, fertilizer and nitrogen compounds, plastic and synthetic rubber in primary forms	51,324,664	36%	376	56	86,100	333,253	77	185	617	1,953	29%	41%	3%	2%
221	Manufacture of rubber products	31,146,534	27%	464	81	48,423	104,870	131	300	443	647	19%	14%	3%	4%
222	Manufacture of plastics products	22,624,976	30%	1327	126	12,161	53,932	68	192	197	328	19%	22%	3%	5%
202	Manufacture of other chemical products	15,923,669	43%	546	76	16,875	90,505	46	146	241	859	27%	32%	3%	20%
210	Manufacture of pharmaceuticals, medicinal chemical and botanical products	2,871,815	36%	196	8	8,724	127,877	45	92	131	968	29%	30%	6%	4%
203	Manufacture of man-made fibres	323,085	98%	5	1	1,042	317,875	9	173	138	1,837	43%	31%	0%	4%

Source: Authors' calculations using the 2010 Malaysian Census of Manufacturing Industries, DoS
Notes: All values are in RM 000's.

Table 4: Summary Statistics of Firms in E&E, 2010

MSIC code	Description	Total sales	% foreign	Number of establishments		Avg. establishment sales		Avg. workers / establishment		Avg. productivity (sales / workers)		Avg. knowledge workers		Avg. investment (capex / sales)	
				Domestic	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*	*Domestic*	*Foreign*
261	Manufacture of electronic components and boards	82,592,336	80%	240	126	76,012	548,915	277	921	329	468	26%	28%	3%	27%
264	Manufacture of consumer electronics	33,300,596	97%	57	33	17,271	1,010,420	118	1,014	215	646	29%	24%	1%	4%
263	Manufacture of communication equipment	11,296,629	93%	38	17	21,546	620,147	137	1,297	224	407	22%	24%	3%	2%
273	Manufacture of wiring and wiring devices	8,434,771	27%	113	24	61,411	95,571	93	243	474	497	20%	23%	3%	2%
271	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	6,812,584	58%	208	38	14,442	104,026	82	402	147	297	26%	17%	3%	2%
275	Manufacture of domestic appliances	3,814,699	35%	87	6	29,545	222,153	82	442	468	328	24%	22%	1%	4%
274	Manufacture of electric lighting equipment	800,749	45%	49	3	9,036	119,326	65	414	131	235	20%	13%	2%	10%
279	Manufacture of other electrical equipment	784,046	27%	141	10	4,310	26,898	34	118	214	256	25%	26%	0%	3%
272	Manufacture of batteries and accumulators	705,756	22%	18	2	32,461	76,778	106	269	222	276	28%	33%	2%	3%

Source: Authors' calculations using the 2010 Malaysian Census of Manufacturing Industries, DoS
Notes: All values are in RM 000's.

Overall, the firm-level data lends support to the view that Malaysia is well positioned in C&P. It has a strong presence in the basic feedstock and basic chemicals. It also has a broad presence in rubbers and plastics, although the small size and low productivities of the firms that operate here suggests that there is room for growth. Moreover, while foreign firms play an important role, a significant share of the capabilities reside with the local firms. We saw that, in terms of productive capabilities, Malaysia appears ready to capture even larger shares of the chemicals space.

In this context, it is once again striking to observe the low investment levels of domestic firms. Domestic firms are investing only 3 percent of sales on average, with little variance among the different clusters. On the other hand, foreign firms are investing 6 percent on average and as much as 20 percent in other chemical products. It would once again be important to understand what constraints are holding back greater investment by domestic firms. Preliminary interviews with the Chemical Industries Council of Malaysia (CICM) suggest that among the challenges that the sector faces is the ability to market Malaysian products in global markets (issues of reputation, certification, intellectual property management, product differentiation), the need to find foreign commercial partners in order to market a product abroad, and the lack of greater local demand for the industry's outputs (e.g. in medical equipment, autos). Unlike in M&E, access to capital was not highlighted as an important constraint in this sector.

Firms in Electrical & Electronics

Now, we turn to the firms in the largest of the three priority sectors, E&E. Not surprisingly **semiconductors** is the single largest category in E&E, accounting for more than RM 82 billion of sales in 2010. As we saw in the prior chapter, a significant share of this volume is exported to global markets. On the production side we see in Table 4, 126 foreign establishments account for 80 percent of all sales. 240 smaller domestic firms make up the remainder. Average labor productivity in this sector, while not low per se, is well below that of office machinery. The Malaysian-owned firms in this cluster, although significantly smaller and younger, have labor productivities that are not too far off from those of the foreign firms.

In the two next largest clusters – **consumer electronics and communications equipment** – the dynamics are slightly different. The foreign firms are more dominant and the domestic presence in these sectors much less significant

compared to semiconductors. The foreign firms here are very large (with average sales per firm above RM1 billion in consumer electronics and above RM 600 million in communications equipment), and they employ large pools of workers. Average productivity in communications equipment is comparable to semiconductors, while it is somewhat higher in consumer electronics.

Next, we see a number of smaller clusters, which likely house input providers to the three larger ones. In these sectors, Malaysian-owned firms have a larger footprint and with the exception of electric lighting equipment have productivities that are not too far off from the average levels of the foreign firms. Malaysian firms appear particularly well positioned in the manufacture of **wiring and wiring devices**, where their scale and productivity is fully comparable to the foreign firms.

Finally, we see three smaller clusters, namely **electric lighting equipment, other electrical equipment, and the manufacture of batteries and accumulators**. Both the foreign as well as the domestic establishments in these industries are still relatively small and less productive compared to the other E&E clusters.

On the investment levels once again we see a significant disparity in the average investment levels of foreign and domestic firms with domestic firms investing no more than 3 percent of sales on average across the sectors. Meanwhile, foreign firms invested 6 percent on average and as much as 10 percent in electric lighting equipment and 27 percent of sales in semiconductors. It is important to probe and understand what constrains domestic firms from investing more, whether the availability of financing or lack of growth opportunities. Based on initial interviews with Malaysian E&E firms, their dependence on a handful of large buyers could present a risk that constrains their financing opportunities. Banks may be unwilling to lend in fear of a firm losing their biggest customer. As a result, local firms sometimes have to rely on consigned equipment or credit arrangements with their customers in order to access the needed machines.

Overall, the E&E sector is home to a number of powerful foreign players as well as a significant number of smaller scale domestic firms, which throughout the years have acquired a significant amount of know-how. The foreign firms have significant capabilities and some (for example Intel) have already invested in bringing ever more advanced capabilities to Malaysia (e.g. product design). Targeted government incentives that support locating their high-end and R&D efforts in Malaysia are helpful. The domestic firms often are quite dependent on their foreign buyers. However, they also have acquired significant capabilities over the years. While the

domestic firm may not have intellectual property over products, they have a lot of knowledge about production processes. Their capabilities can be leveraged to help Malaysia move into more strategic parts of the E&E space and into related sectors.

VII. Case Study: Product-Specific Analysis

In the preceding chapters, we stated that the composition of a country's exports is a critical predictor of growth and we identified products where Malaysia has potential to upgrade economic complexity. Malaysia's priority sectors identified include M&E, C&P, and E&E. Together, these contain 151 of the 238 prioritised "frontier products" to unlock Malaysia's "second modern industrial transformation." Section VI has alluded to potential barriers for firms in each sector and in this chapter we dig further into product-specific analyses to understand the micro policy implications of developing greater competitiveness in the products. Two products from each priority sector are selected in order to ascertain possible constraints to firms and investors engaged in developing greater capabilities in the targeted products. The six products selected include:

Machinery and Equipment (M&E)

- Electric, laser or photon beams;
- Apparatus using X-rays;

Chemicals and Plastics

- Beauty/make-up preparations;
- Lubricating products;

Electrical and Electronics (E&E)

- Power tools;
- Electric ignition;

After identifying the frontier products, a case study was undertaken to determine what constrains existing manufacturers of these products from scaling up their operations to become globally competitive; and what will constrain manufacturers who are not manufacturing those products from shifting production to these frontier products. The selection of two products for the case study was based on the triangulation of the following factors:

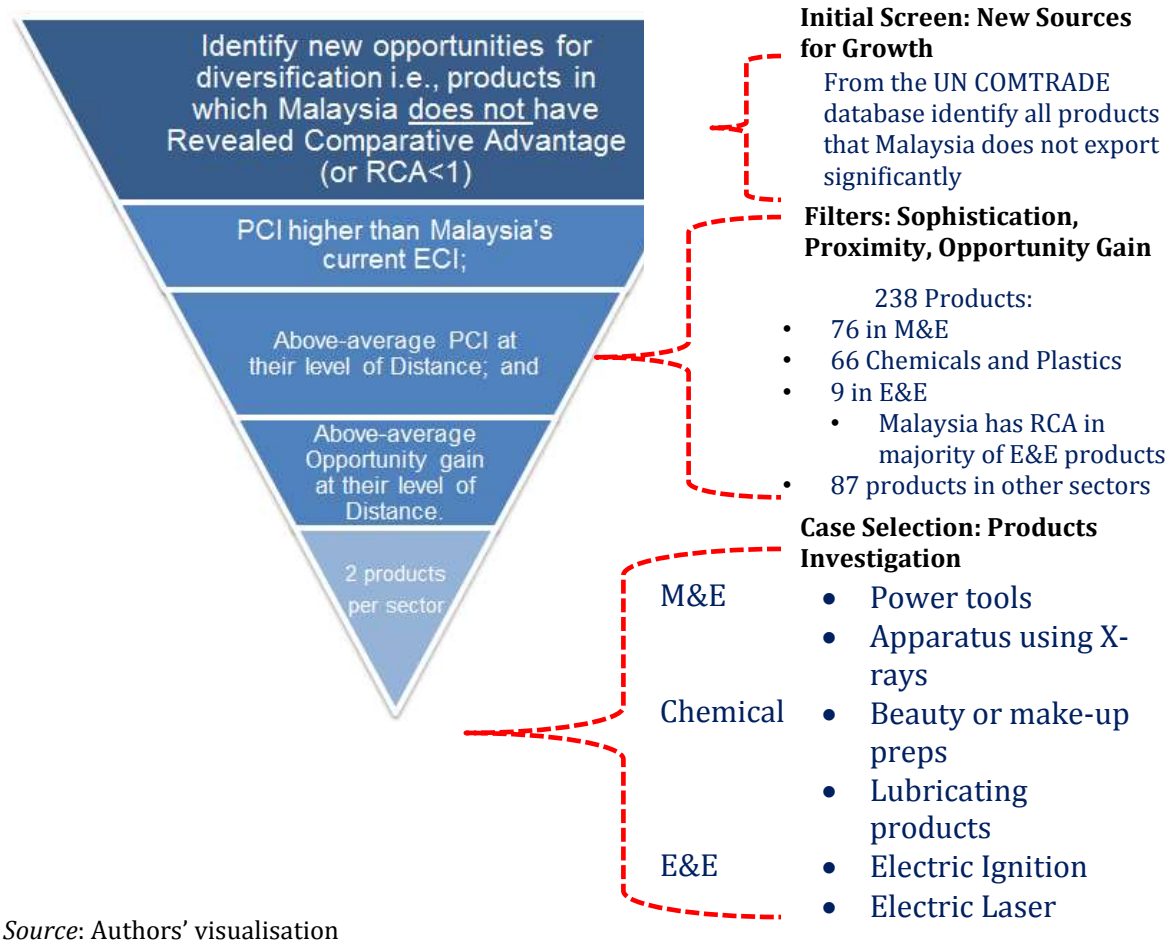
1. Generally high scores across the three filters – distance, complexity and opportunity gain;

2. Alignment with the priority sectors of MIDA and MITI and the industry;

3. Alignment with the views expressed by the various industry associations and industry experts as to the viability of production, such as the availability of feedstock, especially indigenous feedstock; and

4. Potential for growth as evidenced by average export volume and growth rate.

Figure 22: Product Selection and Growth Diagnostic Analysis



Source: Authors' visualisation

It is important to note that not all products (based on HS6) under each category of the selected product (based on HS4) meet the purpose of strategic diversification. For example under the C&P sector, lubricants products are highly complex and provide good Opportunity Gain, making them good candidates for improving Malaysia's economic complexity. However, information from industry players highlighted difficulties in entering a market that is cartelised and recommends that

Malaysia focus on biolubricants. Global volume consumption of biolubricants is estimated at 1.3 million pounds in 2013, valued at about US$2 billion. The consumption is forecasted to reach at 1.4 million pounds in 2014, valued at US$2.1 billion. With a CAGR of 5.5% between 2010 and 2020, consumption of biolubricants is projected to reach 1.9 million pounds with a value of US$3 billion, by 2020. Governmental regulations in North America and the European Union regarding restricted use of synthetic lubricants is expected to drive the demand for bio-lubricants. Additionally, lesser use of raw materials in alternative lubricants is a potential driver for the market. However, higher prices are restricting the greater use of bio-lubricants. Our analysis went beyond complexity analysis to identify niche opportunities within the Malaysian context.

Bio-lubricants are made from raw materials including animal oils and vegetable oils such as palm oil, castor oil, sunflower oil and others. Additionally they can be made from mineral oil-based products or modified renewable oils. The availability of palm oil as raw material for the production of biolubricants places Malaysia in a favorable position to participate in this segment of the lubricants market. The diversification in the use of palm oil for the production of downstream products is in line with MIDA's strategic direction to leverage on the availability of local feedstocks for new growth areas.

On the other hand, beauty and make-up products, which passed the filters with a relatively low PCI, could offer good opportunity gains in certain market segments such as products based on natural ingredients including palm oil. Again, the strategy of leveraging indigenous feedstocks (palm oil) gives Malaysia a comparative advantage in this market segment. In addition, the growing market for halal beauty and make-up products provides opportunity gains for Malaysia. The global halal cosmetics market is estimated at US$13 billion annually.

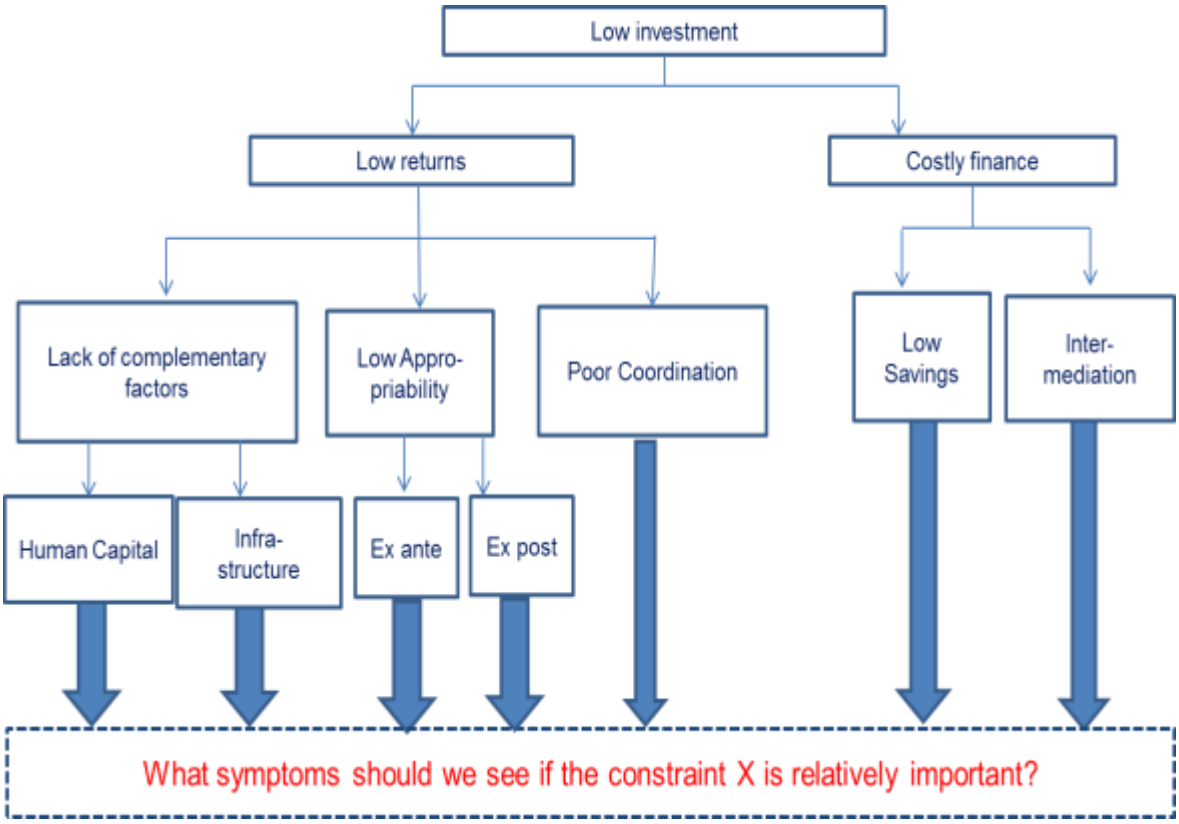
This section begins with a discussion of the need for growth diagnostic analysis for the prioritised products. The remainder of the section is broken into three parts focusing on the prioritized products. Each part begins with an overview of global demand and Malaysia's performance vis-à-vis key exporting countries of the prioritised product. We present product specific growth diagnoses focusing on three constraints, identified by engagement with stakeholders and statistical analyses. We conclude with a summary of the binding constraints.

The Growth Diagnostic framework gives structure to our investigative process. The heuristic below (Figure 23) serves as a guide to diagnose constraints to investment.

By going through the decision tree, the analysis builds a model of how investment decisions in the product evolve at a particular point in time.

Once a constraint is identified, corroborative evidence is provided to illustrate the effects of the missing input. Analysis focuses on how private agents cope with the lack of the identified input and look at the current industrial landscape to determine key drivers for potential policy interventions. We proceed in this manner for the selected products.

Figure 23: Growth Diagnostic Tree



Source: Authors' visualisation

M&E Case Study: Power Tools and Apparatus using X-rays or of alpha, beta or gamma radiations

Selected products in M&E and Precision Instruments

The two products selected for the case study are: **tools for hand working with pneumatic or hydraulic motor** (HS 8467); and **apparatus based on the use of X-rays or of alpha, beta or gamma radiations** (HS 9022). The following subsections provide a brief introduction on the two selected products.

About the products

Tools for hand working with pneumatic or hydraulic motor (henceforth referred to as "power tools")

Types of product included under this product category are, for example, pneumatic hand tools, rotary type (including combined rotary-percussion); other pneumatic hand tools; drills of all kinds, with self-contained electric motor; saws, with self-contained electric motor; other tools for working in the hand, with self-contained electric motor; chain saws, with self-contained non-electric motor; other hand tools with self-contained non-electric motor; parts of chain saws; parts of pneumatic hand tool; and parts of other hand tools.

Currently, changes in power tool technology are most likely to be driven by competition for market share, changes in related industries (i.e. batteries, electronics), and environmental regulations. Cordless electric tool technology made an important shift from nickel based to lithium-ion batteries. Lithium-ion's properties of high energy density and light weight improve performance by increasing battery life and power while decreasing product weight. Another improvement to electric power tools is seen in the emergence of brushless motors. Brushless motors utilise electronic control panels to direct the electronic current so as to eliminate frictional energy loss.

Also, ongoing efforts in technology development include producing lighter weight, easier to use tools that have reduced vibrations and simplified accessory changes. New products are most likely to be introduced in the professional market, as a professional will use the tools for longer periods of time, need to replace them more frequently, and be more willing to pay a higher price for the added technological

benefits. Box 1 provides a brief summary of the main forces shaping the product development in the power tools industry.

Box 1: Five Forces Shaping Power Tools Industry

More power, smaller size

Tools are getting lighter and more powerful at the same time. The batteries are holding more charges for longer because of the new technology. One significant advantage lithium ion has brought to the power tools market is the ability to pack more power in a smaller package.

Battery life

The lithium performance gives the user more power, improved run time and better performance in colder or hotter temperatures. The increased voltage over 18V that some manufacturers are doing is a direct result of better battery life.

Product innovation

Rapid development of new materials provides the tools with a more robust and durable look and feel, and they reduce the overall weight. Ergonomics with the goal of ensuring that tools are comfortable and balanced for users who will be spending long hours on a project.

Value Pricing

Price, along with innovation, is driving the power tool category, with pragmatic consumers looking for value wherever they can find it. Many of the value-oriented are DIY shoppers, and big brands are aggressively targeting this market.

Private label

These tools offer lower price points and step up features and benefits. Consumers get more tools for less money. Retailers get better margins in a low-margin category.

Source: www.homechannelnews.com/article/five-forces-shaping-power-tools

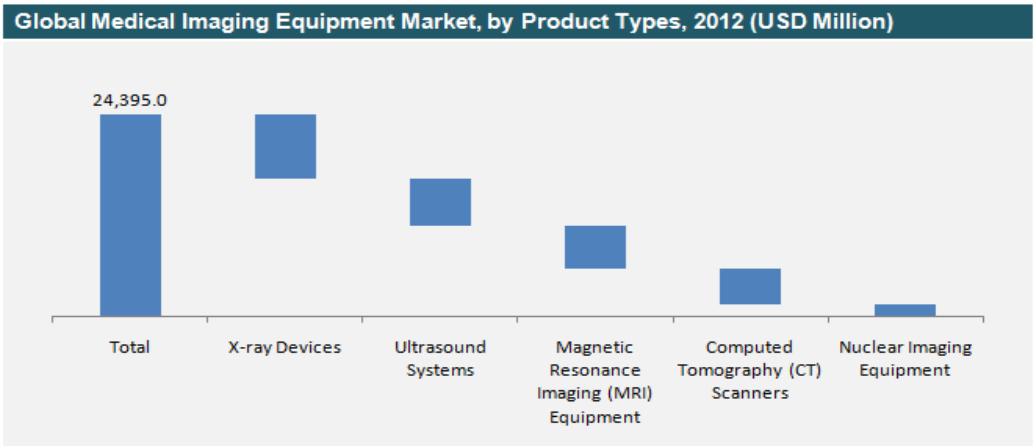
Apparatus based on the use of X-rays or of alpha, beta or gamma radiations (henceforth termed "apparatus based on radiation")

Types of product included under this product category are, for example, apparatus based on the use of X-rays for medical uses; apparatus based on the use of X-rays for other uses; apparatus based on the use of alpha beta or gamma radiation for medical uses; apparatus based on the use of alpha beta or gamma radiation for other uses; X-ray tubes; and parts and accessories for applications based on the use of X-rays or other radiations.

The changing dynamics of the overall x-ray devices market is marked by the shift of buyers' focus from stationary and analog x-ray devices to digital and mobile or portable x-ray devices. This demand shift is driven by the growing picture archiving and communication system (PACS) adoption rates in the U.S. and Europe and the introduction of healthcare reforms encouraging the use of digital x-ray systems. Image quality is one of the most important buying criteria as it has a direct influence on the quality of diagnosis. This further drives growing demand for digital x-ray systems. Box 2 provides an overview of the trend in the medical imaging industry.

Box 2: Main Product Types In Medical Imaging Industry

Currently, there are five major categories in the global medical imaging equipment market that function based on the use of x-rays and other radiations. These five categories are X-ray devices, ultrasound systems, magnetic resonance imaging (MRI), computed tomography (CT) and nuclear imaging equipment. The key market players profiled in the report include Carestream Health, Inc., Fonar Corporation, GE Healthcare, Hitachi Medical Corporation, Philips Healthcare, Samsung Medison Co. Ltd., Shimadzu Corporation, Siemens Healthcare, and Toshiba America Medical Systems, Inc.

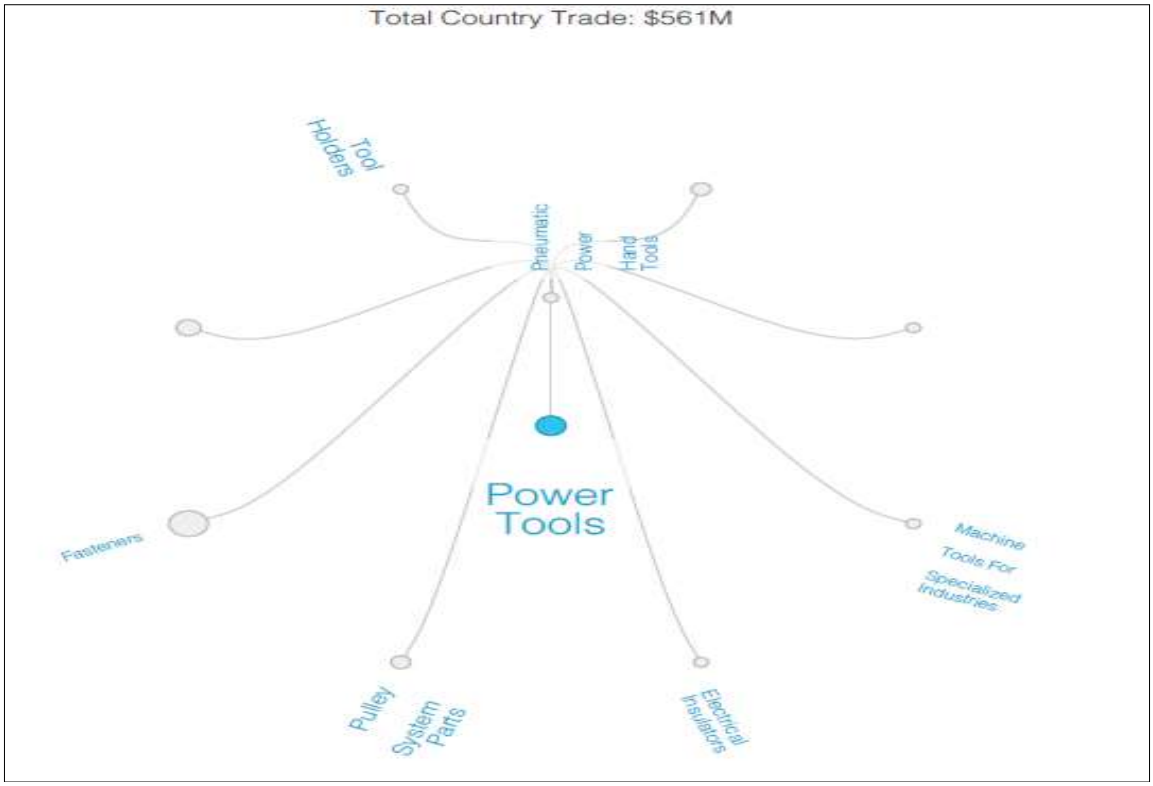


Source: KOL Opinions, Company Annual Reports, Expert Interviews, Investing Publications, Press Releases and TMR Analysis

Malaysia's Performance in the Two Selected Products

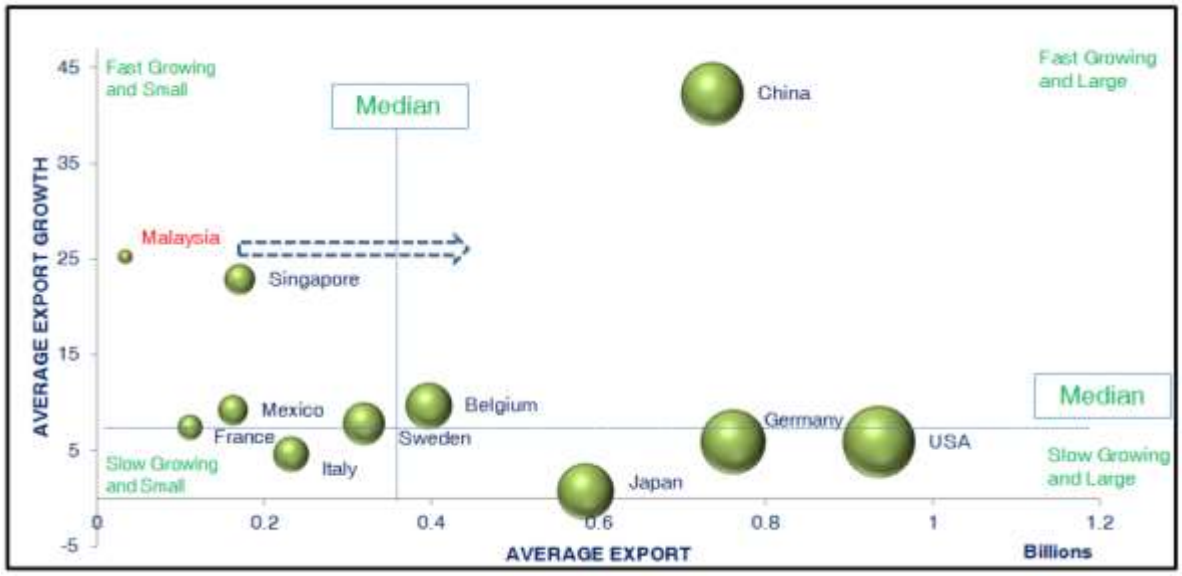
In 2012, Malaysia recorded a total trade of US$561 million in power tools products. As shown in Figure 24, power tools in Malaysia has strong connectivity with other products including tool holders, pneumatic power hand tools, fasteners, pulleys, electrical insulators, and machine tools for specialised industries. Figure 25 illustrates Malaysia's performance compared to the top 10 exporters of power tools during the period of 1990-2013. Malaysia belongs to a group of fast-growing and small-export volume power tools producers in the global market. China, USA and Germany hold the biggest market share in this product category. After China, Malaysia has the fastest export growth rate among the major exporters such as USA, Germany, Japan, France, Italy, etc.

Figure 24: Product Connectivity of Power Tools, Malaysia, 2012



Source: Observatory of Economic Complexity

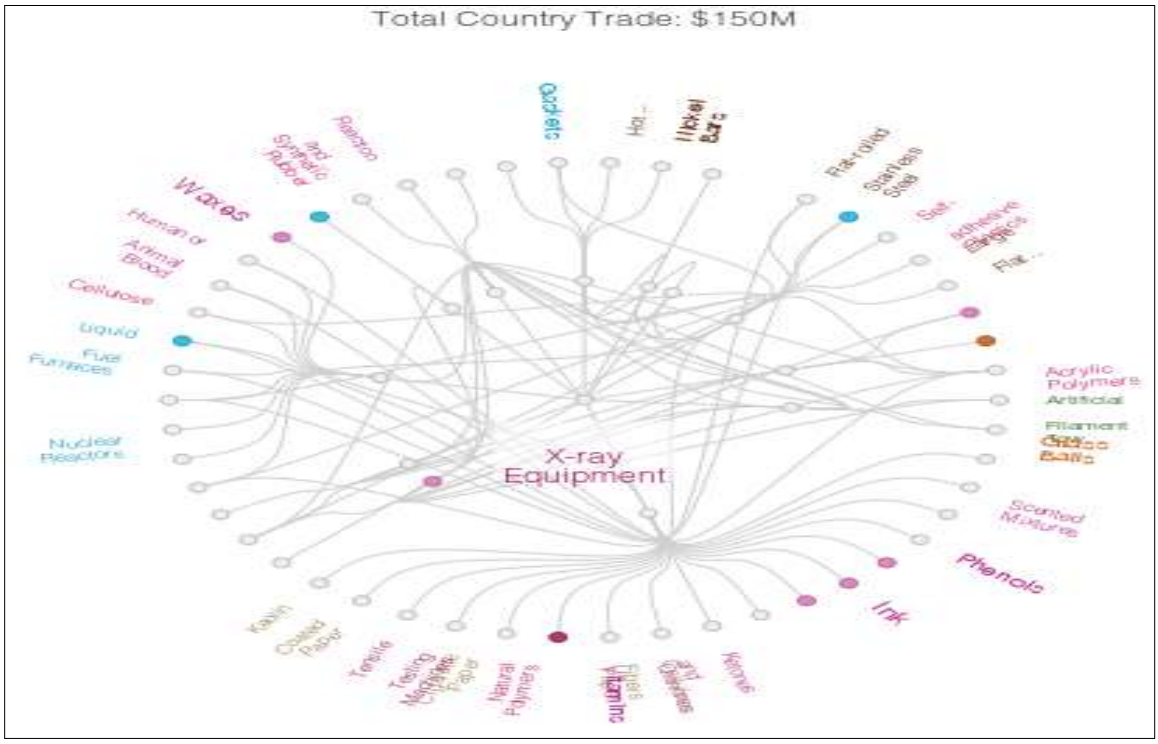
Figure 25: Malaysia's Performance Compared to the Top 10 Exporters of Power Tools



Source: Observatory of Economic Complexity

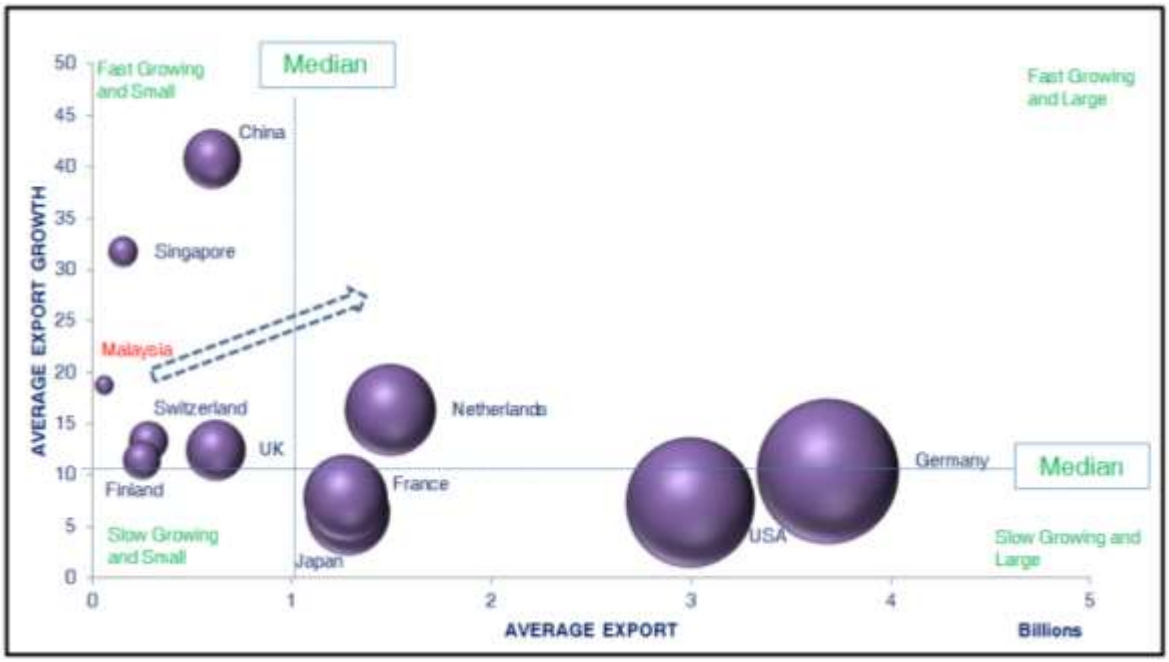
Figure 26 illustrates the product connectivity of X-ray equipment in Malaysia. In 2012, Malaysia's total trade for this product category reached USD150 million. The X-ray equipment industry in Malaysia has strong connectivity with products such as photographic plates, photographic paper, non-optical microscope, forklifts, lubricating products, etc. Figure 27 illustrates Malaysia's performance compared to the top 10 exporters of X-rays or of other radiation equipment during the period of 1990-2013. Like the power tools products, Malaysia belongs to a group of fast growing and small export volume economies in the global market of producers of apparatus based on the use of X-rays or of other radiations. Germany holds the biggest market share in this product category followed closely by USA. China has the fastest export growth rate among the major exporters. Singapore has a higher market share and a faster export growth than that of Malaysia.

Figure 26: Product Connectivity of Apparatus Based on the Use of X-Rays or of Other Radiations, Malaysia, 2012



Source: Observatory of Economic Complexity

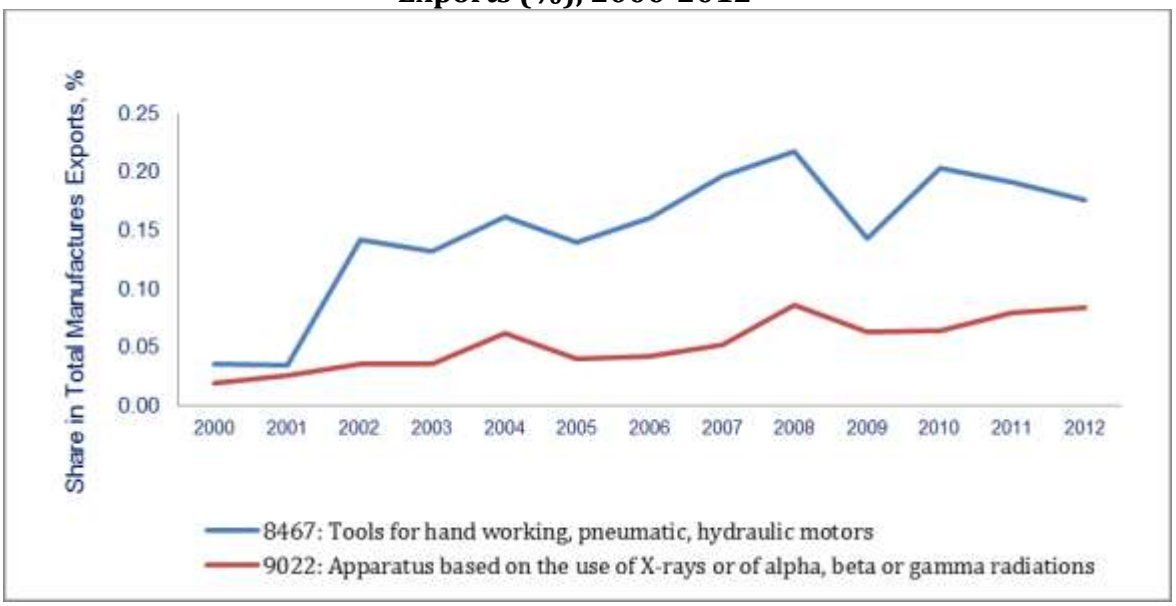
Figure 27: Malaysia's Performance Compared to The Top 10 Exporters of Apparatus Based on the Use of X-Rays or of Other Radiations, 1990-2013



Source: Observatory of Economic Complexity

Figure 28 shows the contribution of the two selected product categories to total manufacturing export during the period of 2000-2012. The share of Malaysia's exports of power tools has been somewhat volatile since their rise in 2002 while that for apparatus based on the use of X-rays and other radiation has seen marginal increase. Key exporters of power tools are Robert Bosch (M) Sdn Bhd. and Hitachi Power Tools (M) Sdn Bhd. while key exporters of X-ray apparatus are Plexus Manufacturing Sdn Bhd., Agilent Technologies (M) Sdn Bhd., ViTrox Technologies Sdn Bhd and UWC Holdings Sdn Bhd.

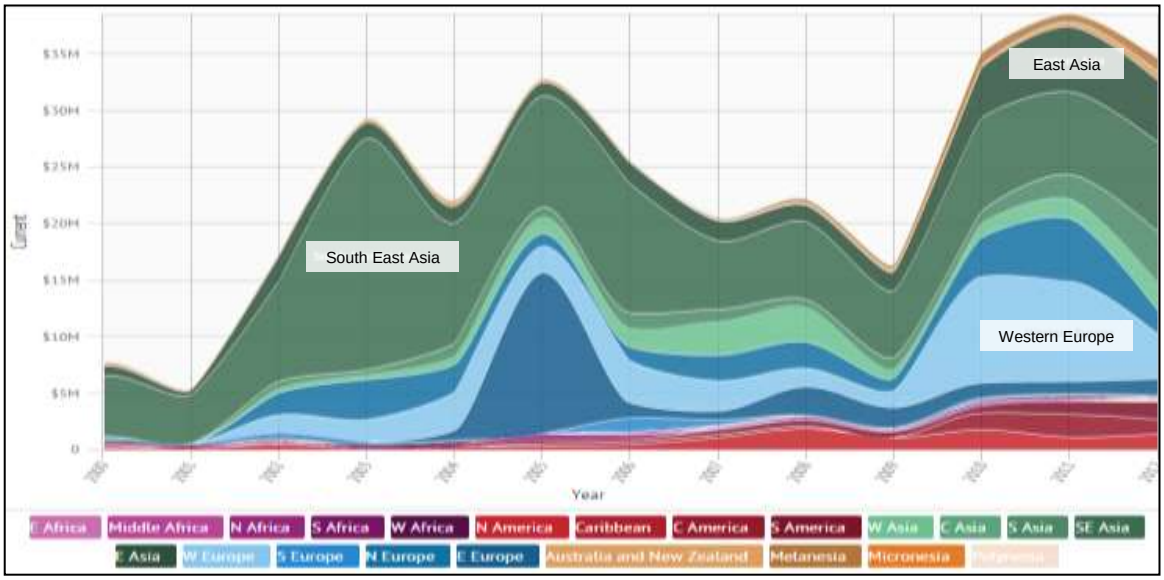
Figure 28: Share of Power Tools and X-rays Equipment in Total Manufacturing Exports (%), 2000-2012



Source: UN COMTRADE

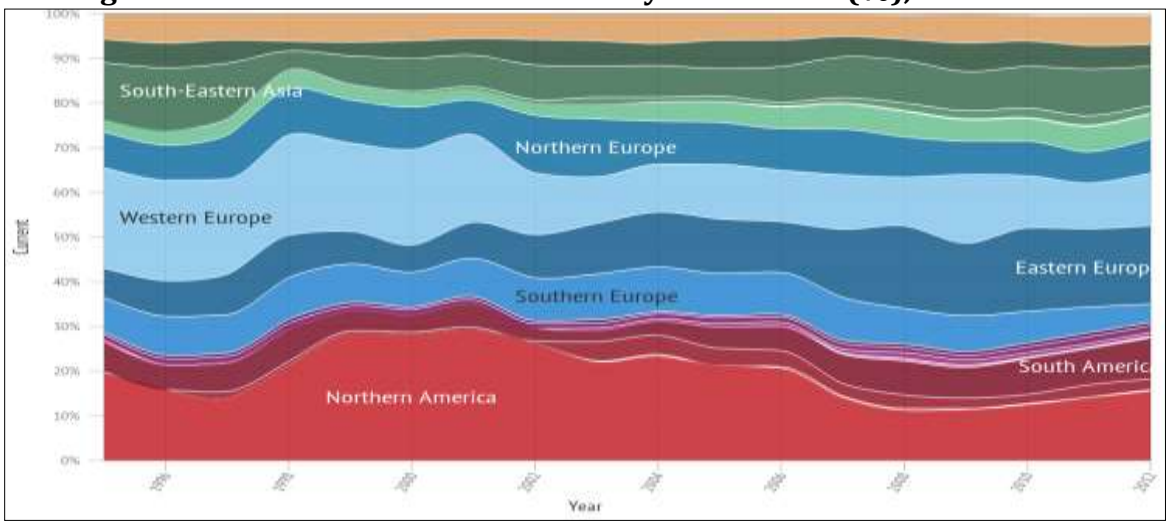
In terms of power tools exports by destination, as shown in Figure 29, South-east Asia has consistently been the main export market for Malaysia. At the same time, the export to East Asia has grown substantially since 2010. However, Malaysia's power tools export to Western Europe market has been slowing down as the market has reached the saturation point. Overall, Malaysia exports power tools to East-, Southeast-, and Western Asia as well as to Western Europe. However, Asia accounts for a smaller share of the global market. Malaysia has yet to seriously penetrate Eastern and Southern Europe and the Americas, which account for over half of the world market (see Figure 30).

Figure 29: Malaysia's Power Tools Exports by Destination (US$ million), 2000-2012



Source: Observatory of Economic Complexity

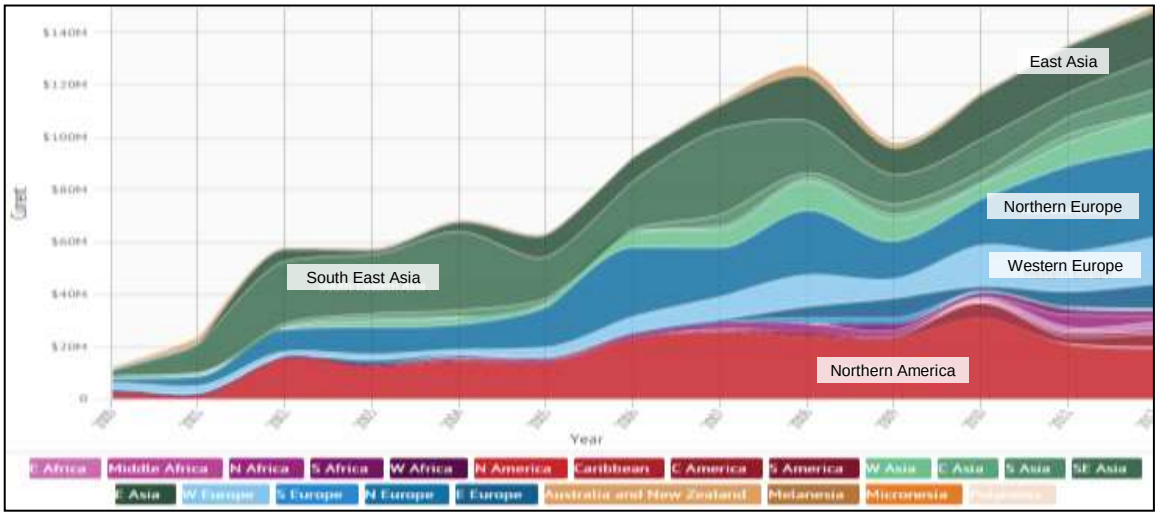
Figure 30: World Power Tools Market by Destination (%), 2000-2012



Source: Observatory of Economic Complexity

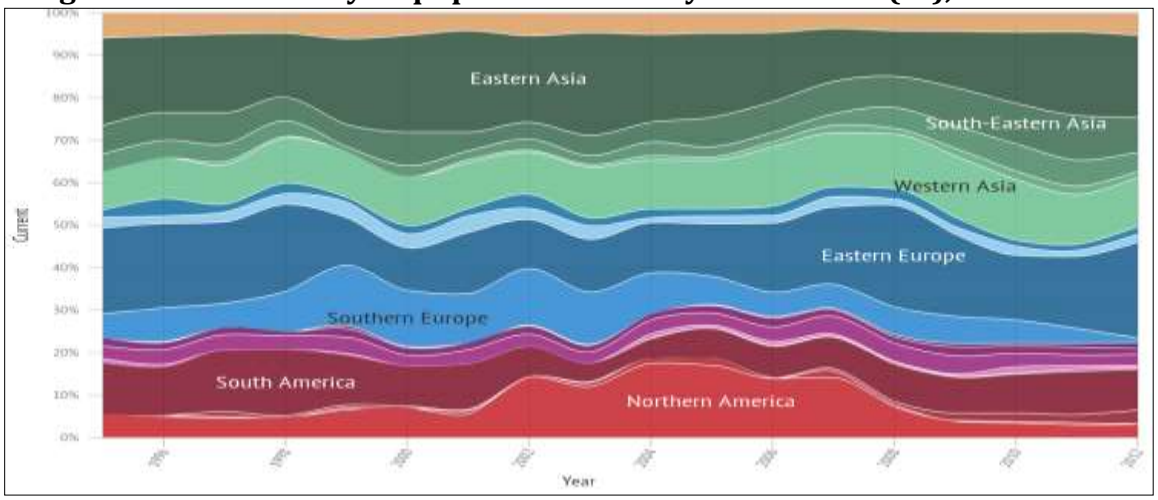
In the case of apparatus based on the use of X-rays and other radiations, as shown in Figure 31 and Figure 32, Malaysia's export destinations for this product category are diverse encompassing all key destinations, namely Northern and Western Europe, Southeast and East Asia, and America.

Figure 31: Malaysia's X-rays Equipment Exports by Destination (US$ million), 2000-2012



Source: Observatory of Economic Complexity

Figure 32: World X-rays Equipment Market by Destination (%), 2000-2012



Source: Observatory of Economic Complexity

Binding Constraints

Since Malaysia's share of world exports for the above two product categories is still small, the challenge is to scale-up production at a faster rate than the current capacity of the industry players. However, this could be achieved by removing the binding constraints presented in Table 5. For power tools, the top binding constraint that hindered the transition of manufacturers towards fabrication of more sophisticated products is a lack of quality human capital. Other main binding constraints faced by manufacturers are the high cost of finance and low R&D

capabilities. In the case of manufacturers of apparatus based on the use of X-rays and other radiations, the most significant binding constraint is a high cost of finance. The other constraints, which are also significant in this product category, are a lack of quality human capital and low R&D capabilities.

Table 5: Summary of Binding Constraints in Selected M&E Products

	Binding Social Returns						Binding Finance	
	Lack of Complementary Factors		Low Appropriability			Coordination	Low Aggregate savings	High Cost of Finance
			Government Failure			Market Failure		
			Ex Ante	Ex Post				
	Human Capital	Infra-structure	Ex ante Risk	Tax	Property rights, crime & corruption	Low R&D, low self-discovery		
Tools for hand working, pneumatic, hydraulic motors								
Apparatus based on the use of X-rays or of alpha, beta or gamma radiations								

Note: most binding; second most binding; not critical

The following sub-sections provide in-depth analysis on the main binding constraints for each of the selected products:

Tools for hand working with pneumatic or hydraulic motors

Lack of skilled human capital: Shortage of skilled manpower particularly engineers with design competency and understanding of industry's needs has hampered the manufactures' efforts in moving up the value chain and has prevented them from becoming more resilient to global competition. Such skill mismatch and

weak skills base especially among the fresh talent pool has resulted in low competency of companies to transform from goods manufacturers to products developer that demand greater customisation and service-related business. A representative product manager and industry association member emphasised this during the interview:

There is deficiency in local technological capabilities such as skill sets and know-how even in parts and components fabrication.

-Power tools MNC

The level of skills training in our vocational institutions requires upgrading. Students who come for internship to our company are not proficient in the rudiments of welding.

-Member of industry association

The evidence of shortage of skilled workforce is supported by a study by the Penang Skills Development Centre (PSDC) on 2011/2012 Penang Industrial Talent Required Study (PITRS). The key excerpts from the PITRS Report show that while there is an increasing demand especially for mechanical engineers and mechanical design engineers, the industry is suffering from a decreasing supply of quality workers. The report also concluded that there is inability to meet future manpower requirement in automation, instrumentation and machinery; precision engineering, tooling and machining in M&E industry, particularly in the case of Penang (see Table 6).

Table 6: Summary of Lack of Skilled Workforce in Penang

COMMON CORE JOB FUNCTIONS ACROSS MAJOR INDUSTRY SECTORS IN PENANG.

CORE TECHNICAL JOB FUNCTIONS	CURRENT NO. OF EMPLOYEES	ADDITIONAL MANPOWER REQUIRED	PERCENTAGE INCREASE
Production operator	14,187	2,253	15.9%
Production/ Manufacturing technician	1,380	216	15.7%
Mechanical engineer/ Mechanical design engineer	360	137	38.1%
Quality engineer	309	33	10.7%

ABILITY TO MEET FUTURE MANPOWER REQUIREMENT BY SECTOR IN PENANG

SECTOR/SUBSECTOR	ABILITY TO MEET FUTURE MANPOWER REQUIREMENT
E&E: semiconductor	✓
E&E: industrial electronics	✓
E&E: PC peripherals	✓
Automotive systems/Transport equipment	✓
Automation, instrumentation and machinery	✗
Precision engineering, tooling and machining	✗

Source: 2011/2012 Penang Industrial Talent Requirement Study

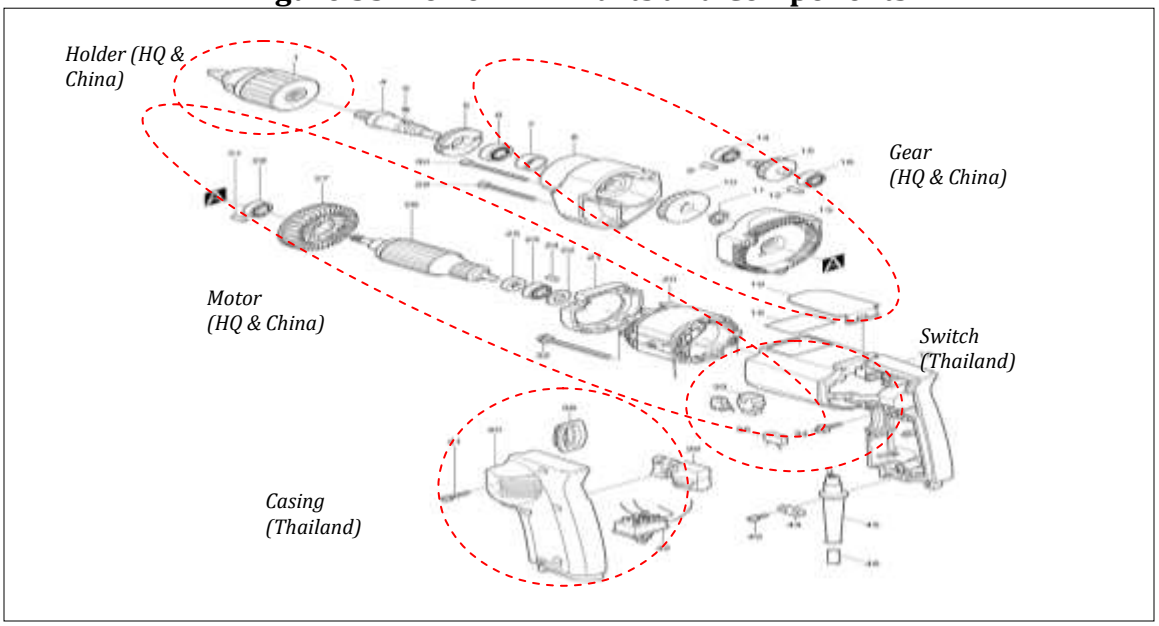
The shortage of skilled workforce limits the capabilities of the local supply chain. Local firms are often denied the chance to participate in the MNCs' global supply chain because they are not able to achieve international capabilities.In the case of power tools industry, a representative product specialist manager at one of the power tool MNCs suggested that:

All parts and components are imported from headquarters and regional plants at Thailand, China, Brazil and Germany.

-Power tools MNC

In order to provide a clearer illustration to this constraint, the interviewee gave a real example of power drill service and repair network in Malaysia. For this particular model, as shown in Figure 33, all the five most important components of the drills, namely the motor (with armature as the heart of the motor), gear, switch, holder and casing are all sourced from manufacturing plants abroad. The secret of manufacturing armature and gear are kept in the headquarters in Japan. None of these components are sourced from the local vendors.

Figure 33: Power Drill Parts and Components



Low R&D capabilities: Local firms perceive themselves to enjoy limited benefit from the presence of MNCs in power tools in Malaysia in the form of technological spillover. MNCs are seen to keep their technological knowhow at home, in their headquarters, and Malaysia is perceived as a production base. At the moment, only Robert Bosch and Hitachi Power Tools have set up their manufacturing plants in Malaysia. Other major manufacturers in power tools such as Makita, Black & Decker

and Skil are present as regional distributor in Malaysia. A product specialist manager at one of the power tool MNCs informed the research team that:

There is not much R&D here in Malaysia as higher value-added activities in product development such as R&D and design are hosted in the headquarters of MNCs and that the Malaysian branch plant is set up for the purpose of assembling.

-Power tools MNC

The above comment was supported by several M&E manufacturers during focus group discussions, particularly on the lack of coordination in R&D support systems in the country. Such shortfalls have resulted in inadequate support for frontier product development activities such as design, simulation and analysis, prototyping, pilot production, and testing and evaluation. Members of MEMA informed us that:

Our industry generally does not do R&D. We don't have the resources and we don't want to spend on R&D for which the returns are uncertain. Government funding for R&D should be channeled through the industry or universities should conduct R&D together with the industry.

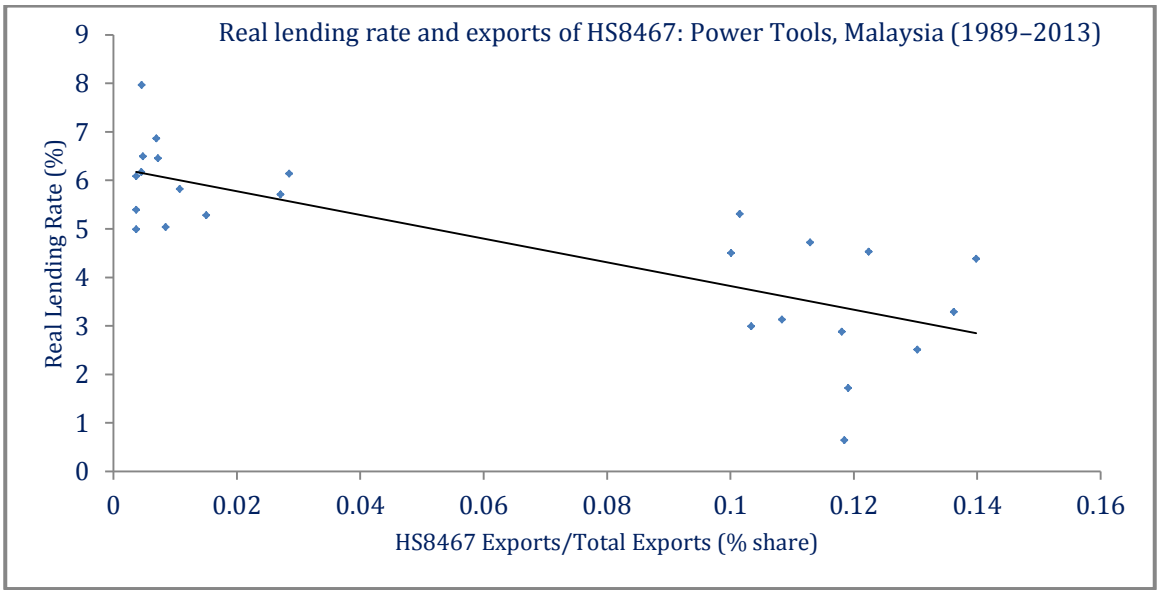
-Member of MEMA

The idea to start this M&E research center is good. However, it seems nobody wants to use the facilities. Not because of the equipment is not suitable, but when people want to go into to talk about the use of this equipment, there is no following up from the staff. The staffs are not pro-active and the main problem is the staff capability. People there are directly transferred from public agency. Perhaps, this type of centre should be privatised, open it to the industry and let them come out with ideas what they want to do with it.

-Member of MEMA

High costs of finance: The shadow price, caused by: (i) the need for in-house retraining and reskilling programme to equip workforce with hands-on and creativity skills, and (ii) higher R&D and product development cost as companies need to source R&D supports from abroad and eventually companies have to absorb the total R&D cost, has led to a higher cost of product development in power tools industry. This claim is supported by our observation that when the real lending rate rises, it results in the fall of power tools export. On the contrary, when interest rates fall, exports will increase. This suggests shocks to the supply of credit and a contraction of demand for financing upon real interest rises. This indicates constraining finance for power tools industry (see Figure 34).

Figure 34: Real Lending Rate and Exports of Power Tools



Source: World Development Indicators, World Bank Group

Apparatus based on the use of X-rays or of alpha, beta or gamma radiations

High costs of finance: The shadow price caused by the need for in-house retraining and reskilling programme to equip workforce with design capability and market intelligence has led to a higher cost of product development in X-rays equipment. Moreover, the cost of materials especially the base of steel and the need for setting up of complex organisation for X-rays equipment fabrication and commercialisation have hindered the participation of SMEs in this product space. This is confirmed by our interviews with MEMA members and medical industries associations:

The base cost of steel is about 10-20% higher than similar manufacturers in China. Overall, our cost of manufacturing is easily about 20% higher than China. Their machine price is ridiculously low that we cannot match. China's way of doing business is very different from us. For China, cost is not an issue to them, they just want the business. They have the economies of scale.

-Member of MEMA

The manufacturing of this type of capital equipment will require a setting up of complex organisation. Since our small market size is limited, MNCs are not ready to locate their manufacturing plants in Malaysia.

-Medical industries association

Consequently, only firms with strong financial status are able to compete in this capital product. ViTrox Corporation Bhd is a good example to illustrate how easing of the financing constraint can facilitate growth in the X-rays equipment development (see Box 3).

Box 3: The Success Story of ViTrox Corporation Bhd.

Since its inception in 2000, ViTrox has designed and manufactured innovative, leading-edge and cost-effective automated vision inspection equipment and system-on-chip embedded electronics devices for the semiconductor and electronics packaging industries.

ViTrox went public in 2004. With the funds raised from its IPO ViTrox was able to acquire skilled and experienced R&D engineers from Agilent Technologies which decided to exit the market amidst the 2008/2009 financial crisis. That acquisition gave ViTrox the technological capabilities to produce in 2009 an improved version of 3D X-rays optical inspection equipment which is faster, cheaper and better than that which existed in the market.

With adequate finance, ViTrox achieved significant growth in market penetration and production capabilities. So much so, ViTrox is now a top-10 global player in the 3D X-rays optical inspection equipment market.

Given its strong financial base (over RM 100 million in the first-half of 2014) Vitrox now pays its skilled talent, especially its 180 R&D personnel – who constitute about 70% of its total workforce - salaries and bonuses that are well above the industry average.

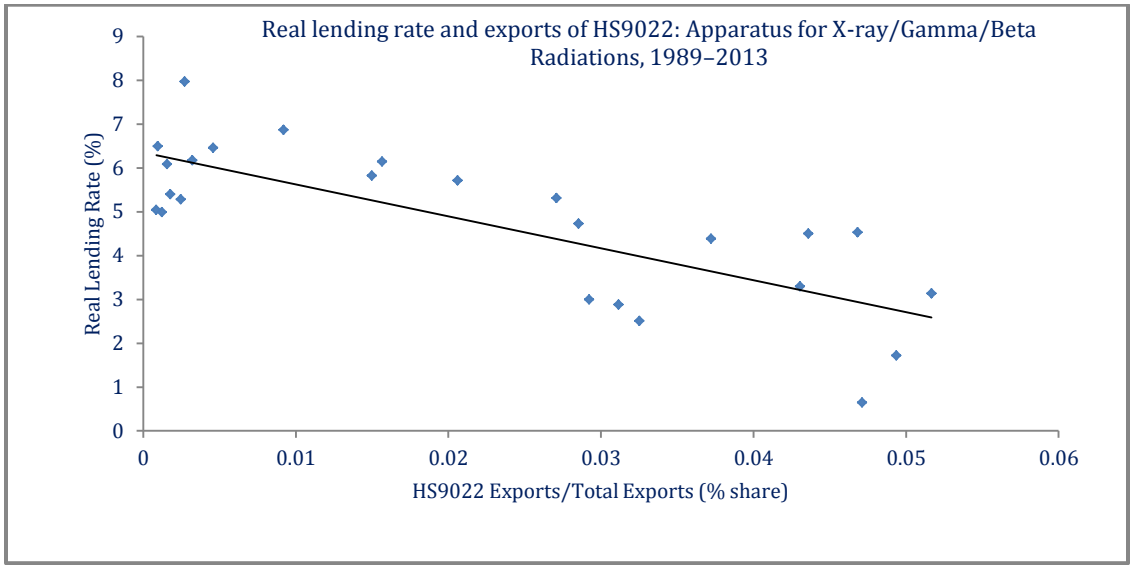
Product quality requires R&D to match the demanding standards of its export markets. Accordingly, ViTrox, annually spends about 14% of its revenue or RM 15 million on R&D.

Recently, ViTrox has also been a beneficiary of public funding for R&D, especially from MIDA's Domestic Investment Strategic Fund.

Source: ViTrox Corporation Bhd. Annual Report 2013 and Personal Communication

Besides, the significance of finance constraint to product development in X-rays equipment is also exhibited in the lending rate in which the rise of lending rate will result in the slowdown of export, and vice-versa (see Figure 35).

Figure 35: Real Lending Rate and Exports of X-rays Equipment in Malaysia



Source: World Development Indicators, World Bank Group

Low R&D capabilities: All interviewees have cited the difficulties in conducting R&D in Malaysia as a main constrain in their efforts to developing new products. There are several root causes for this shortfall which include the weak university-industry linkages, and lack of private driven R&D. A local X-rays machine industrialist and an industry association leader shared insights into these issues:

Our universities do R&D to satisfy their KPIs. Their KPIs should be industry-related so that university research can result in industrial application. The interactions between the tertiary education institutions and industries are very low. There is not enough related research between the universities and industries. Not many companies can afford to collaborate with universities in the research. There is not enough though ongoing in both directions, the private sector not thinking wide enough, and the research institute not thinking industrial enough.

-Local producer of X-ray machines

Our product fabrication and wiring is outsourced to local companies. However, we have quality and cost issues with the local companies. They are small and scattered around. The supply chain is weak. Most of them are not ISO certified and run as family business and hiring foreign workers. They have problem with the higher-end fabrication process.

-Local producer of X-ray machines

In Taiwan, the industry growth is mainly driven by the big local companies – TSMC [i.e. Taiwan Semiconductor Manufacturing Company] and Acer. However, in Malaysia, government tries to act as a company to help the local firms. We also rely on MNCs. We need to be more private sector driven and at the same time develop our local companies.

-Local producer of X-ray machines

Lack of skilled human capital: Similar to power tools industry, the shortage of skilled manpower, particularly engineers with design competency, is one of the main constraints faced by the x-rays manufacturers in Malaysia. Local SMEs have to compete with the MNCs in recruiting the best engineering graduates as these graduates have a preference to join MNC. Only a few of Malaysia's graduates seek entrepreneurship as a career option and the best get hired by MNCs. As such the industry is lacking of entrepreneurial talent and culture. As a result, the local supply chain is unable to compete in the global market. These concerns were raised in our interviews with local X-ray machine manufacturers:

Skilled human capital is a problem in this industry. Lower wages do not attract talent. We pay above-industry compensation and we attract the best in the industry. [This] shortage of skilled and semi-skilled labour has prevented M&E companies from expanding into upstream or downstream activities in the value chain. Local firms are not able to hire first class graduate because of the financial problems.

-Local producer of X-ray machines

SMEs in Malaysia are more content to be village champions. SMEs are not aggressive. Neither are they competitive as they can only employ mediocre talent. The best join the MNCs.

-Local producer of X-ray machines

Our company is constrained by a poor supply chain. We source from local suppliers who are not world-class. They lack ISO certification and with mediocre employees they produce mediocre supplies. Most of them are family-owned and lack the ambition to produce quality and world-class products. The suppliers are also small in number and scattered across the country. If they want to prosper they would have to do R&D and design. Our company needs to make sure that they get good suppliers. Otherwise they cannot compete.

-Local producer of X-ray machines

Chemical & Plastics Case Study: Beauty products and Lubricating Products

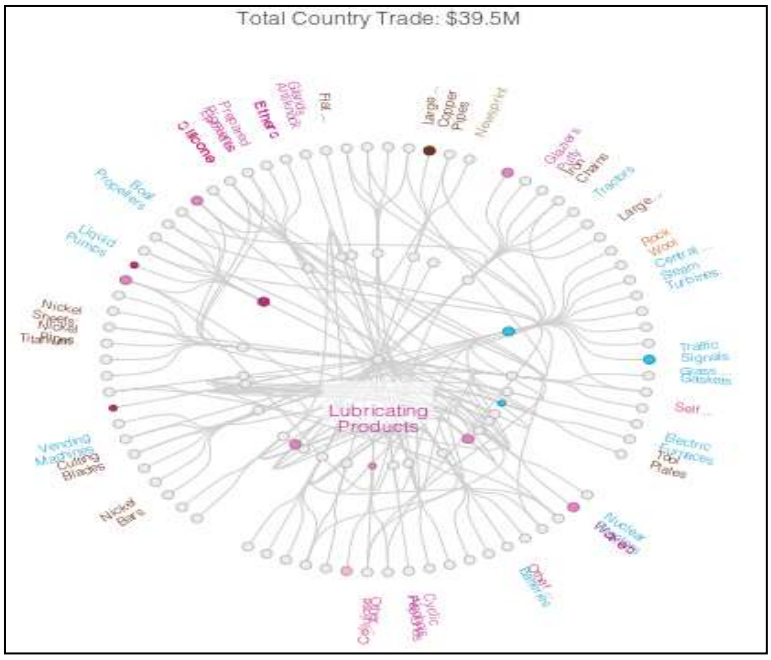
Selected Products in C&P

The two product categories examined are **lubricating products** (HS 3403) and **beauty or make-up preparations** (HS 3304).

About the products

A **lubricant** is a substance that reduces friction and wear by providing a protective film between two moving surfaces. Almost 90% of the lubricants market is based on mineral oils. However, growing concerns over the environment have renewed interest in the production of biodegradable lubricants although its production is not without problems. Figure 36 reveals that lubricants have high connectivity with other products in Malaysia's product space including electric furnaces, vending machines and liquid pumps etc.

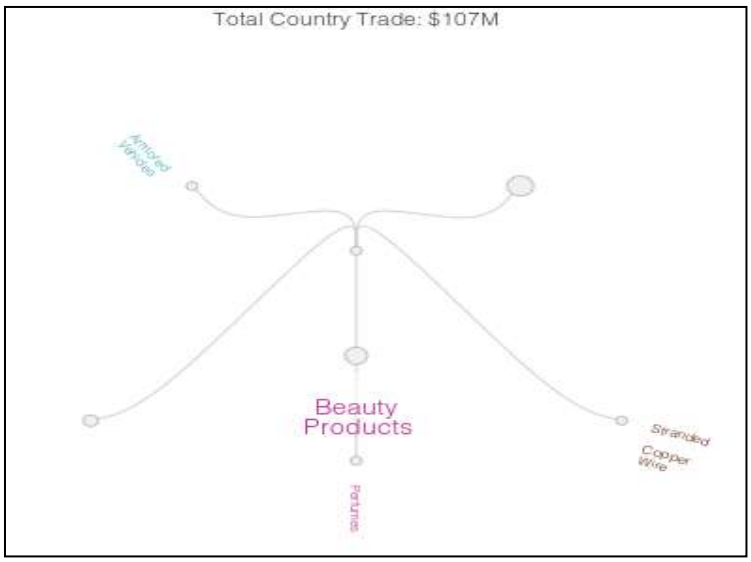
Figure 36: Product Space Matrix for HS3403 (Lubricating Products, Antirust and Treating Textiles Etc.)



Source: Observatory of Economic Complexity

Beauty or make-up preparations for the care of the skin is a fast expanding segment of the chemicals sector. It is an industry segment that is relatively less affected by the economic cycle. Figure 37 illustrates the connectivity that this family of products has to others in Malaysia's product space including perfume, armored vehicles, etc.

Figure 37: Product Space Matrix for HS3304: Beauty, Make-Up and Skin Care Preparations, Etc.)



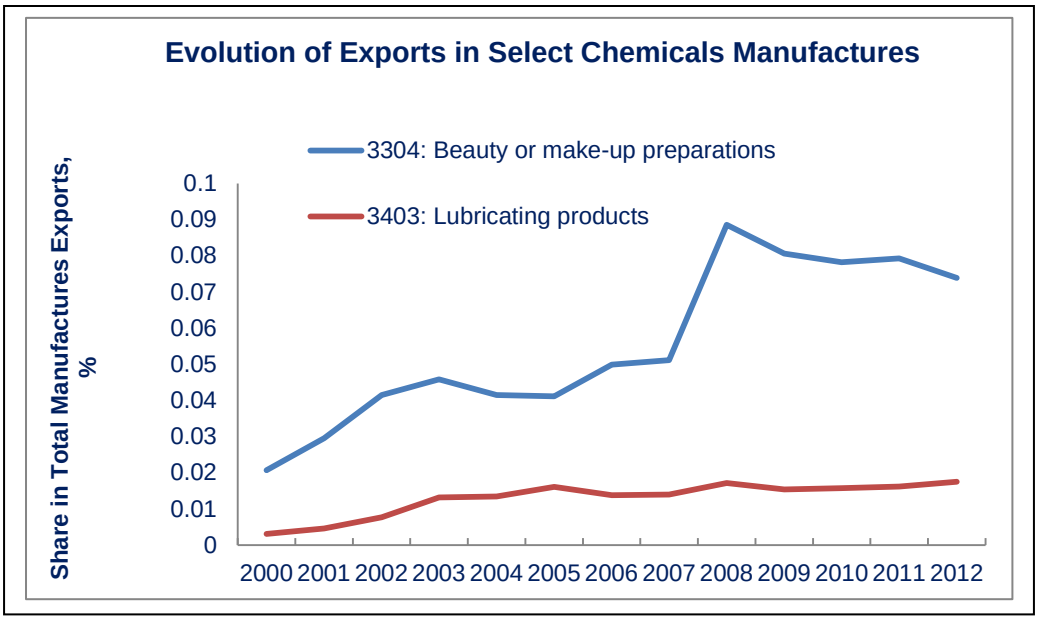
Source: Observatory of Economic Complexity

Malaysia's Performance in the Two Selected Products

Lubricants

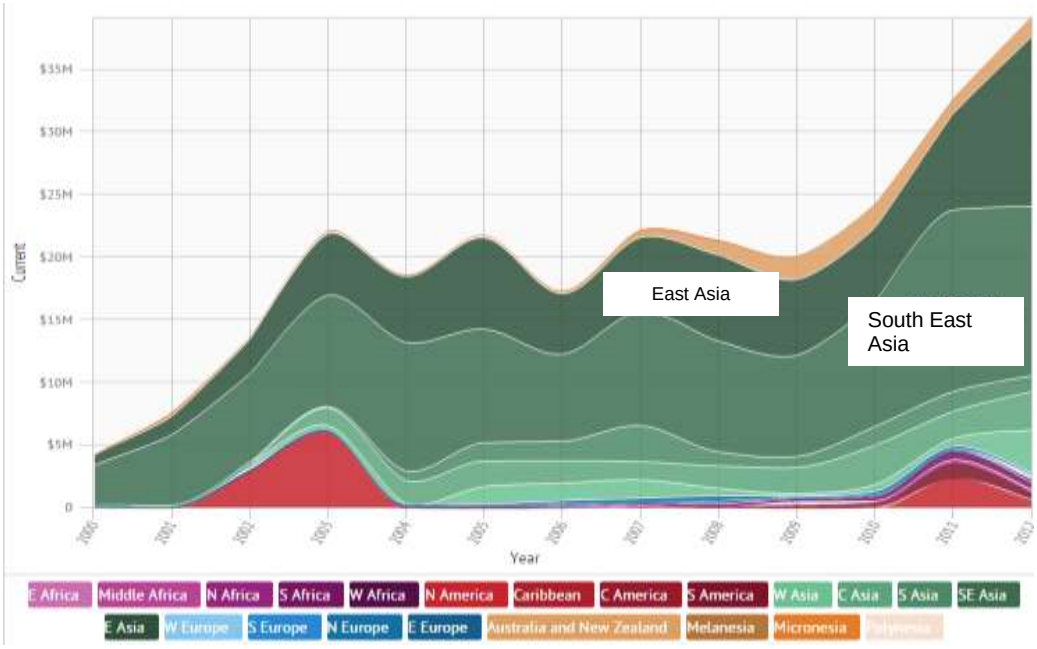
In 2012, Malaysia recorded a total trade of US$ 39.5 million in lubricants. The share of lubricants in Malaysia's total exports of manufactures has been small and stagnant (Figure 38). The country exported some US$ 20 million worth of lubricants in 2013 – a global market share of 0.2%. The leading exporters in this category of products include Germany, USA, Japan, France, Netherlands, UK, Italy, Switzerland, Spain and Brazil. Malaysia's exports are mainly confined to Asia. Figures 39 and 40 reveal that the country's exports have yet to seriously penetrate the European and North American markets.

Figure 38: Evolution of Exports in Chemicals



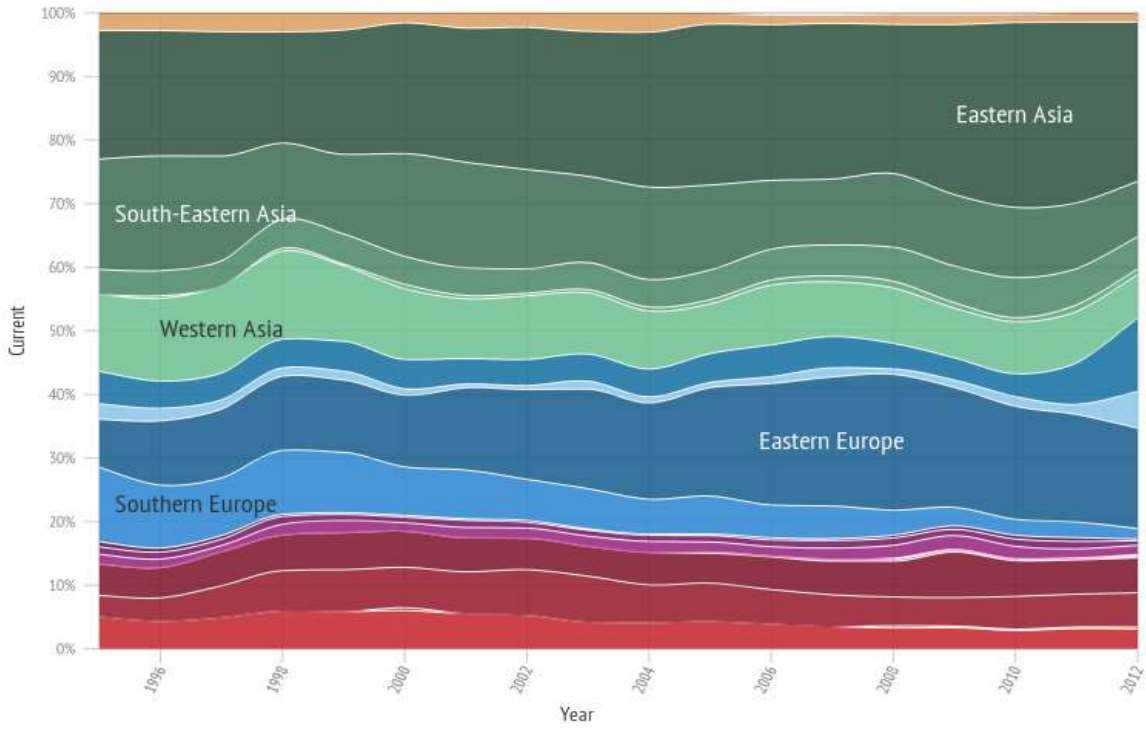
Source: UN COMTRADE

Figure 39: Malaysia's Lubricating Products Exports by Destination (US$ Million), 2000-2012



Source: Observatory of Economic Complexity

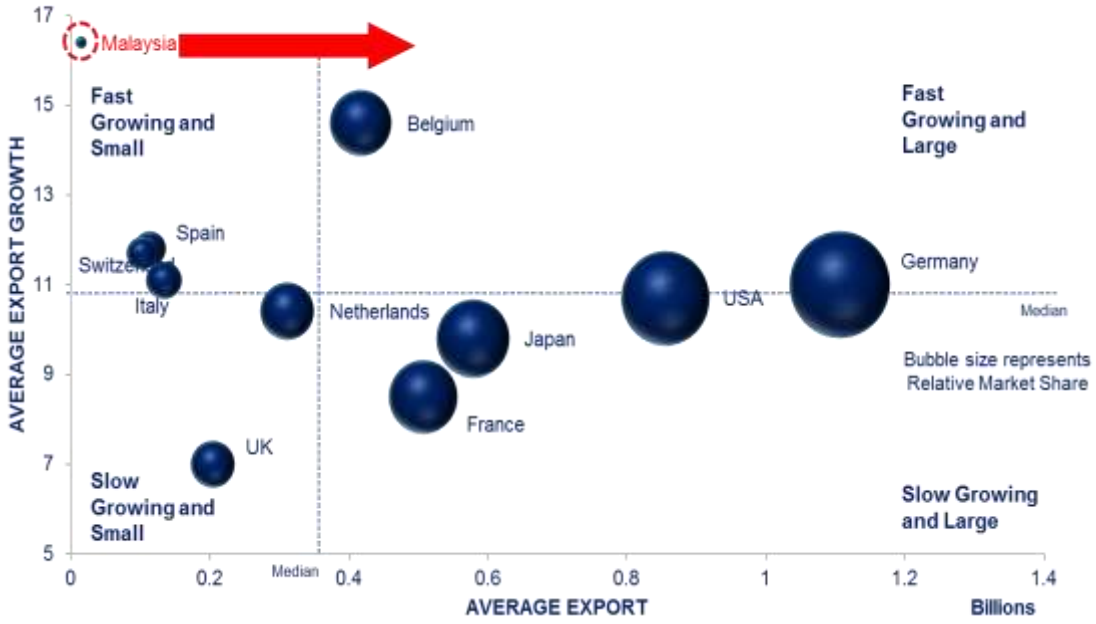
Figure 40: Evolution of the Lubricating Products Market (% Imports), 2000–2012



Source: Observatory of Economic Complexity

Figure 41 illustrates Malaysia's performance compared to the top 10 exporters of lubricating products during the period of 1990-2013. Malaysia has the highest growth rate in this product category which is commendable given the dominance of the 'big players' from the OECD countries such as Shell, Exxon, BP and Chevron. Germany, USA and Japan hold the biggest market share in this product category. Petronas, through Petronas Lubricant International, has in recent years emerged as an important global player in this fast expanding market. The major challenge for Malaysia is to become a bigger market player in this market as well as to make a presence in the more specialised biolubricant segment which will assume importance in the near future.

Figure 41: Malaysia's Performance Compared to the Top 10 Exporters of HS3403: Lubricating preparations, antirust & treating textiles etc., 1990–2013



Source: UN COMTRADE

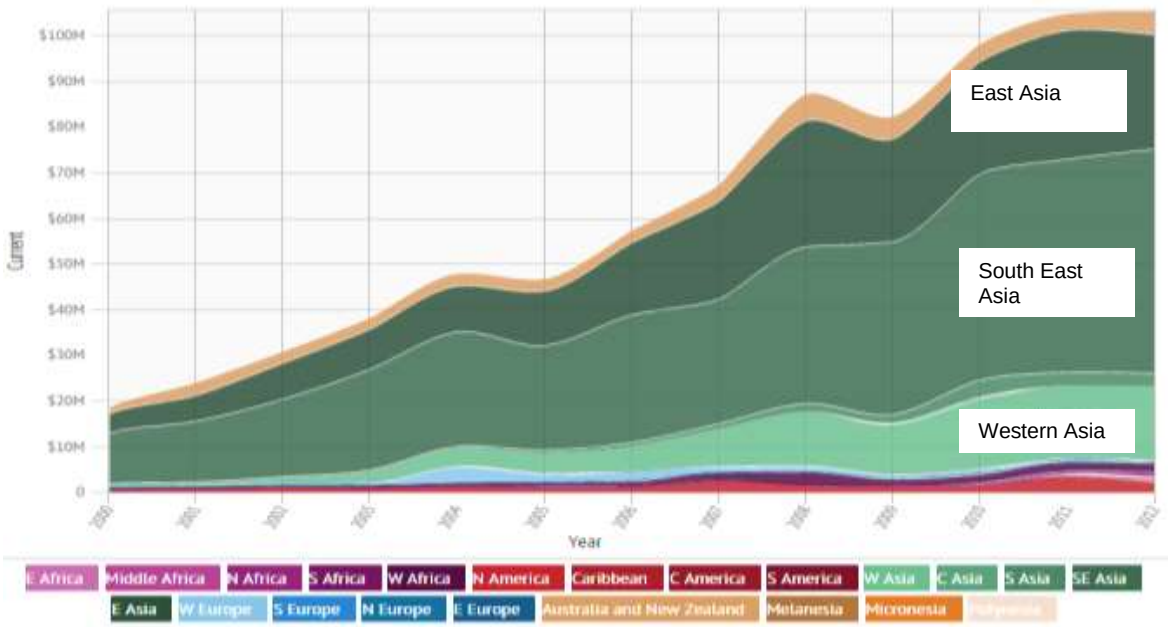
The lubricant market is dominated by players from China (Petro China and Sinopec), Japan (Idemitsu, Nippon oil) as well as the traditional players such as Shell, Exxon, BP, Chevron, Total, Fuchs. Petronas is one of the leading producers in this expanding market. The top 10 producers account for almost 50% of the world's lubricant market.

Beauty or Make-up Preparations

In 2012, Malaysia recorded a total trade of US$ 107 million in this product category. The share of beauty products in Malaysia's total manufactures exports has been on the upward trend – peaking in 2008. The country exported some US$ 113 million worth of beauty products in 2013 – a global market share of 0.3%. The leading exporters in this category of products are France, USA and Germany. The beauty market, particularly at the higher end, is dominated by companies such as Unilever, Shiseido, L'Oreal and Estee Lauder etc. The local market is also dominated by players from Thailand and Singapore.

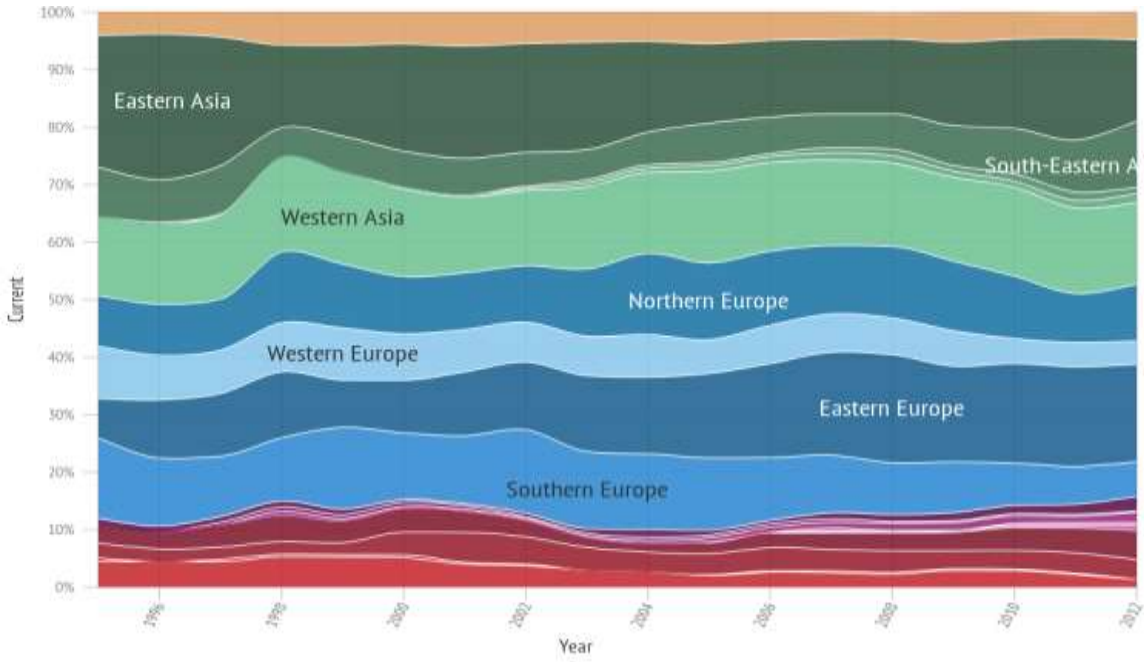
Like lubricating products, most of Malaysia's beauty products exports have gone to the Asian region. They have yet to penetrate Europe and the Americas as depicted in Figures 42 and 43.

Figure 42: Malaysia's Beauty/Make-up Exports by Destination (US$ million), 2000-2012



Source: Observatory of Economic Complexity

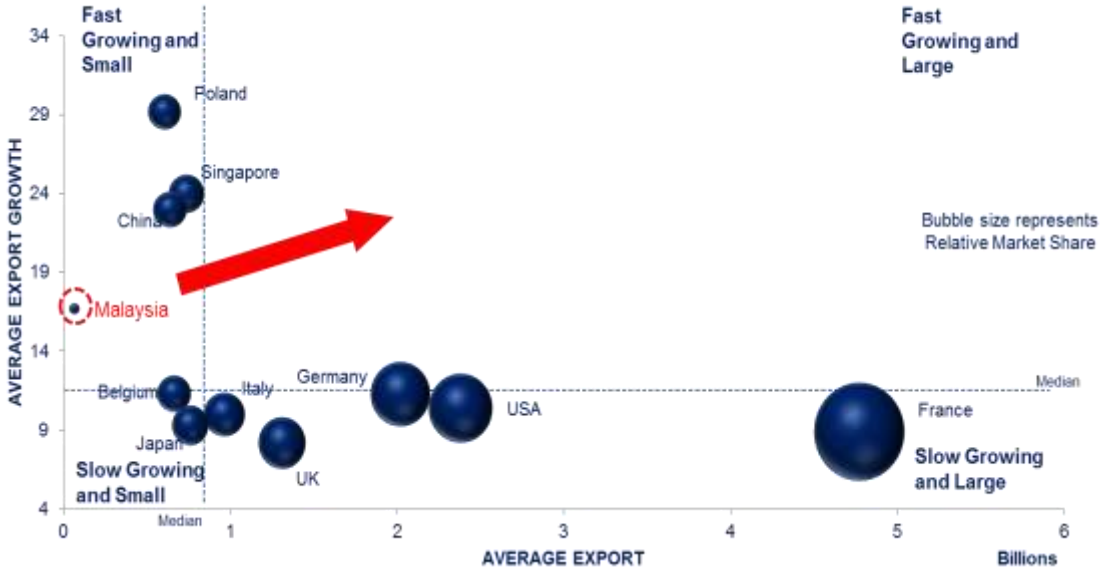
Figure 43: Evolution of the Beauty or Make-up Preparations Market (Imports), 2000-2012



Source: Observatory of Economic Complexity

Figure 44 highlights Malaysia's performance in beauty products compared to the top 10 exporters during the period of 1990-2013. Malaysia's export growth rate of 17% is commendable given the dominance of this market by traditional players such as France. Many of the local cosmetic and toiletries companies are contract manufacturers for established brands. In recent years a number of companies have ventured into halal beauty and skin-care products. This niche market has witnessed rapid expansion both in number of players and exports. Leading exporters include Clara International Beauty Group Sdn Bhd, L&S Cosmetics & Toiletry (M) Sdn Bhd, Alliance Cosmetics Sdn Bhd and Ginvera Marketing Enterprise Sdn Bhd. The major challenge for Malaysia in this product category is to increase its market share and more importantly to venture into the upper-end spectrum of the market.

Figure 44: Malaysia's Performance Compared to the Top 10 Exporters of HS3304: Beauty, Make-up &Skin-care Prep, Manicure etc. 1990–2013



Source: UN COMTRADE

A summary of the exports of the two chosen product categories is given in Table 7.

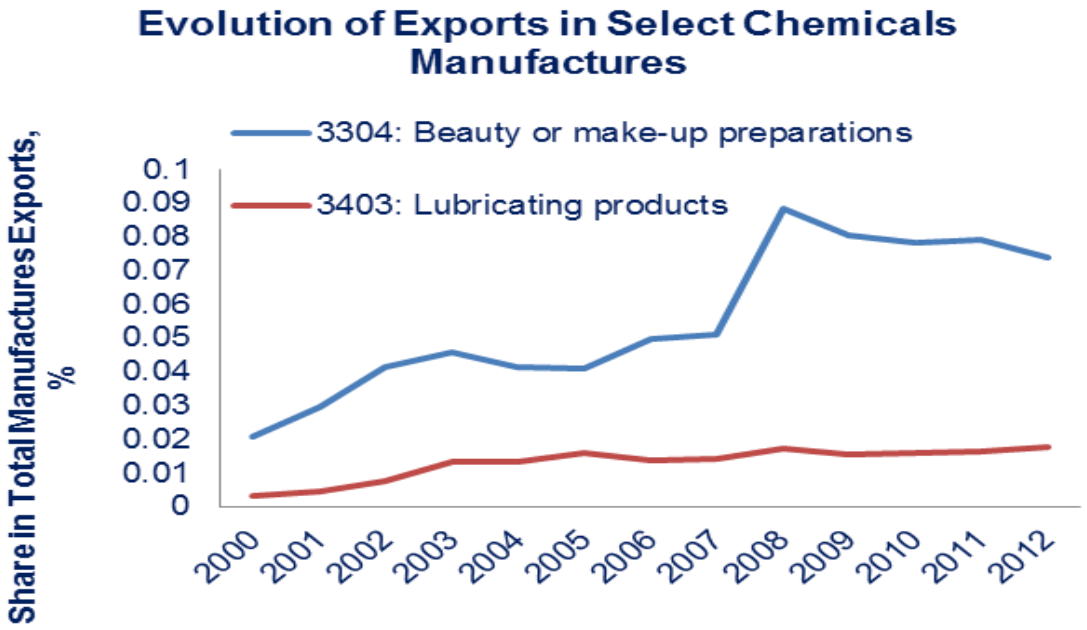
Table 7: Export Summary of the Chosen Products

Products	World Exports ($million)	Malaysia Exports ($ million)	Malaysia's Share in World Exports (%)	Malaysia's Average Exports Growth (1990-2012)	Main Exporters
Beauty or make-up preps	33,063	113	0.3	16.7	France, Germany, Italy, Belgium, China, UK, Japan, Poland
Lubricating products	8,712	20	0.2	16.4	Germany, USA, Japan, France, Netherlands, UK, Italy, Switzerland, Spain, Brazil

Source: UN COMTRADE

Figure 45 shows the contribution of the two selected product categories to total manufacturing export during the period of 2000–2012. While the share of lubricants in Malaysia's total exports of manufactures has been small and stagnant, that of beauty or make-up products has been on an upward trend since 2000 – peaking in 2008.

Figure 45: Exports of Selected Chemical Products



Source: UN COMTRADE

Binding Constraints

Table 8 presents a summary of the binding constraints encountered by the selected two product categories. The constraints emerged from interviews with firms and organisations engaged in both product categories as well as quantitative analyses. For beauty products, the top binding constraint to increased investment can be attributed to the lack of skilled human capital. Other binding constraints faced by the industry include high cost of finance and low research and development (R&D) capabilities. On the other hand, the most binding constraint faced by the manufacturers of lubricants (specifically bio-lubricants) can be attributed to coordination problems, which manifest in low R&D. The other constraints, which are also significant to the industry, are cost of finance, and lack of quality human capital.

Table 8: Summary Constraints in Chemicals

	Binding Social Returns						Binding Finance	
	Lack of Complementary Factors		Low Appropriability			Coordination	Low Aggregate savings	High Cost of Finance
			Government Failure			Market Failure		
			Ex Ante	Ex Post				
	Human Capital	Infrastructure	Ex ante Risk	Tax	Property rights, crime & corruption	Low R&D, low self-discovery		
Beauty or make-up preparations								
Lubricating products								

Note: most binding second most binding not critical

Lubricating Products

A firm we interviewed entered the biolubricant market because the feedstock for biolubricant production (palm oil) is cheaper. Given this cheaper supply its cost of production of biolubricants is lower by 20% compared to global players such as Shell, Exxon and Chevron. Demand for biolubricants is increasing in Japan and Korea due to regulatory requirements. There is potential in this regard for Malaysia and hence the need to address potential barriers.

Coordination challenge, according to a biolubricant company, limits Malaysia's expansion abroad. The company employs only two chemists for R&D purposes, limiting its ability to venture into the development of different types of esters. These ingredients are vital for its diversification efforts and differentiation in a competitive global market space. In 2008 it had joint-ventured with a local university to develop esters for biolubricants. That collaboration kick-started its operations but the partnership has since remained dormant.

Moreover, according to the company, banks shy away from **financing** business expansion - through marketing and R&D - as the banks have a conservative view of returns from technology-driven products. The company can make significant in-roads into R&D and, consequently, into global markets if it can partner with big

MNCs such as FELDA and PETRONAS, according to interviewees. This will allow it to exploit the resources of these MNCs to embark jointly in R&D in biolubricants as well mobilise **skilled marketing personnel** to promote its products in identified markets.

Further Evidence on Constraints

The chemical sector as mentioned earlier is capital intensive. In the case of biolubricants, an interviewee stated that an average of RM400 million is needed to produce the base oil for the bio-lubricant as well as for the personal wellness markets. Assuming a 10% lending rate, such an investment outlay would require an annual repayment of RM 40 million in interest.

Another interviewee estimates that RM100 million is needed to enter the global biolubricant market. This investment would be required for technology, production, R&D, compliance with technical standards, marketing, after-sales (provision of credit facilities) and a global presence in terms partnerships.

Beauty Products

Lack of Skilled Human Capital &Coordination challenge

Traditionally most beauty care products have been based on oil related products. However, there is an increasing demand for natural based products in the beauty business since such products are perceived to be friendlier to the skin. Malaysia's rich biodiversity is home to many herbs that can be harnessed for beauty care and fragrance products. However, local beauty producers experience difficulty in accessing and exploiting this rich endowment due to the lack of skilled people in the entire chain of this industry from identification, extraction, formulation, testing and regulatory conformity. Additionally, many have cited that working with the various authorities has not been without its fair share of problems. Consider this illustrative quote from one interviewee:

I have started working on my own herbal plantation as I do not have to encounter difficulties with the various authorities. It would have been much easier if the public authorities could promote the use of natural products in the beauty industry. Malaysia has the potentials to be a leading player in this category of beauty products.

-Local manufacturer of beauty products

High end skilled people in the chemicals sector are in short supply. Most chemistry graduates end up teaching. Very few proceed to higher degrees in chemistry. Not many make their way to industry. Additionally, the teaching of chemistry in universities is undertaken in a traditional mode with minimal industry input. There is a need to incorporate electives that cover topics such as marketing and sales; blending and formulation; project management, among others, to make the current chemistry curriculum relevant to industry trends. Two quotes from a local manufacturer and a MNC company exemplify this point:

I have to personally train our R&D personnel. Although they are knowledgeable in chemistry, they have no knowledge in formulation and blending which are integral in the production of biolubricants. The industry is prepared to train our local undergraduates in the skills necessary for the lubricant industry.

–Local manufacturer of biolubricants

We wanted to invest in a place where ease of doing business is more stable and with more developed infrastructure. One area of concern, however, is getting people with the right skills. For example, for our new plant in Johor, we have difficulty in recruiting chemistry graduates with project management skills.

–Beauty products MNC

Finance

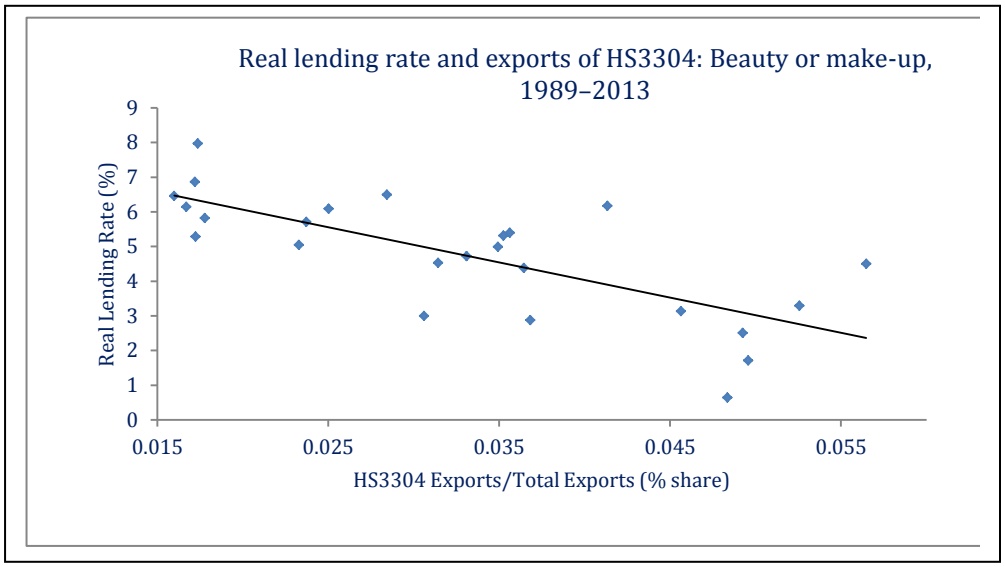
Developing beauty care and skin care products for the global market requires not only a pool of dedicated research personnel but also market intelligence to understand the peculiarities of each market. Such resources are beyond the capacity of most local beauty care producers. Given their limited resources most of the local producers focus their activities to the local market or even the regional markets for the more enterprising ones. Not many local players have the financial muscle and army of research personnel to keep abreast of the latest technologies in the beauty care business. One local beauty care producer stated:

I am a mid-sized producer of beauty and skin care products. I focus my activities in the local and regional markets given my understanding of these markets. It is difficult for me to enter the European or North American markets as I need many resources to adapt my products to these markets. Also, we are dwarfs compared to the multinational giants in those markets. I am satisfied doing contract manufacturing for other labels.

- Local manufacturer of beauty products.

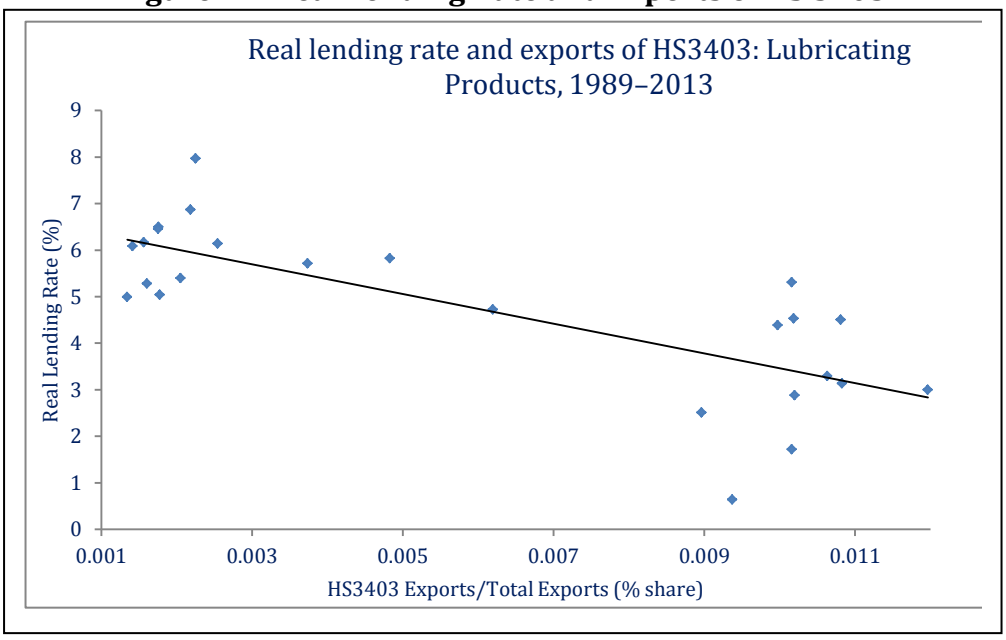
To lend credence to the argument that finance may be constraining consider the relation between exports and the cost of finance. For both beauty product (and lubricating product) exports we observe that when lending rates rise, exports of frontier products fall, implying finance could be a constraint (see Figures 46 and 47).

Figure 46: Relationship Between the Real Lending Rate and Exports of Beauty Products



Source: World Development Indicators, World Bank Group

Figure 47: Real Lending Rate and Exports of HS 3403



Source: World Development Indicators, World Bank Group

Concluding remarks

The chemical industry is one of the prime industries fuelling the growth of the Malaysian economy. Given the availability of feedstocks such as petroleum, natural gas and palm oil resources the industry is poised to expand further in the coming years. Due to the high-technology and capital-intensive nature of the industry, market share is dominated by MNCs and large local players that possess the necessary trained human resources and research infrastructure. However, SMEs have provided niche manufacturing and supply chain support services to MNCs and the larger firms. While the outlook for the industry is positive, the various issues raised in this write-up serve to remind the authorities that these issues need to be addressed urgently lest the industry loses its competitive edge as well as new opportunities to rivals from neighboring countries.

E&E Case Study: Electrical Ignition and Electric Laser

Selected Products in the Electric and Electronic Sector

This section reports the case study evidence of two products in the electrical and electronics sector: **electric ignition or other starting equipment** (HS 8511) and **electric laser or other light or photon beam**(HS8515). The following subsections provide a brief introduction to the two selected products.

About the selected products

Electric laser and other light or photon beam products

The electric laser and other light or photon beam products (subsectors) are involved in the manufacturing of soldering irons and guns, other brazing or soldering machine and apparatus, machines for resistance welding of metal, fully or partly automatic, other machines and apparatus for resistance welding of metal, machines, apparatus, for arc welding of metals, fully or partly automatic, other machines and apparatus for arc welding of metals; other welder, electric machines, apparatus, for hot spraying of metals; and parts of soldering, brazing or welding machines and apparatus.

In electric laser and other light or photon beam products, Malaysia too already has developed local capabilities. For example, the Welding Industries Malaysia Bhd. produces the entire photo beam product in-house.

Electric ignition or other starting equipment

Among the products included in this category are: sparking plugs; ignition magnetos; magneto-dynamos; magnetic flywheels; distributors; ignition coils; starter motors and dual purpose starter-generators; other generators for internal combustion engines; electrical ignition, starting equipment and cut-outs for internal combustion engine; and parts of ignition or starting equipment for internal combustion engine.

In electrical ignition and starting equipment, Malaysia already has a strong base due to a relatively well-established automotive industry.

Malaysia's Performance in the two Selected Products

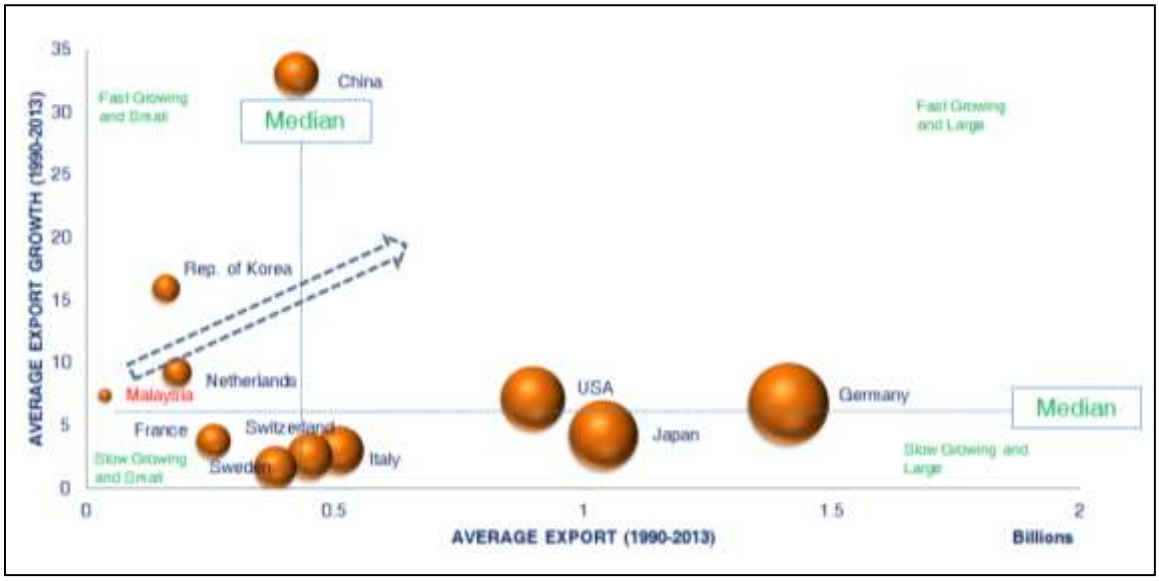
Electric laser and other light or photon beam products

In electric laser and other light or photon beam products, Germany has the largest market share with China enjoying the fastest growth rate. Malaysia already has established capabilities in this product. It only needs to move into laser technology. The product has high potential as it supports many other industries such as automotive, construction, shipbuilding, heavy equipment, aerospace, electronics, medical products, and precision instruments, electric power and petrochemicals.

Currently, Malaysia records a 7% growth. However, the relative export market share is still low. Malaysia records above the median growth rate for the top 10 exporting countries, which stands at 6%. (Figure 48). This is a high-potential product category with China being the fastest growing exporter in this product. While Malaysia has established capabilities the stiff competition from China (low-cost producer) prevents local companies from scaling up their operations. Given the Chinese competition, there is also anecdotal evidence that the industry is currently reorienting from being manufacturer to being traders and assemblers.

Local companies benefit from local procurement support especially from the mega projects related to infrastructure. The industry requires moving itself to more value-added activities as well as improving its productivity to be able to improve its export share. The local market consumes 60% of its production. However, local production faces stiff competition from China which enjoys low-costs for low-end versions of the product. As such, it requires the scale economies to compete. Quality is a competing factor in developed markets. In emerging countries clients require time to understand the quality dimensions of the product.

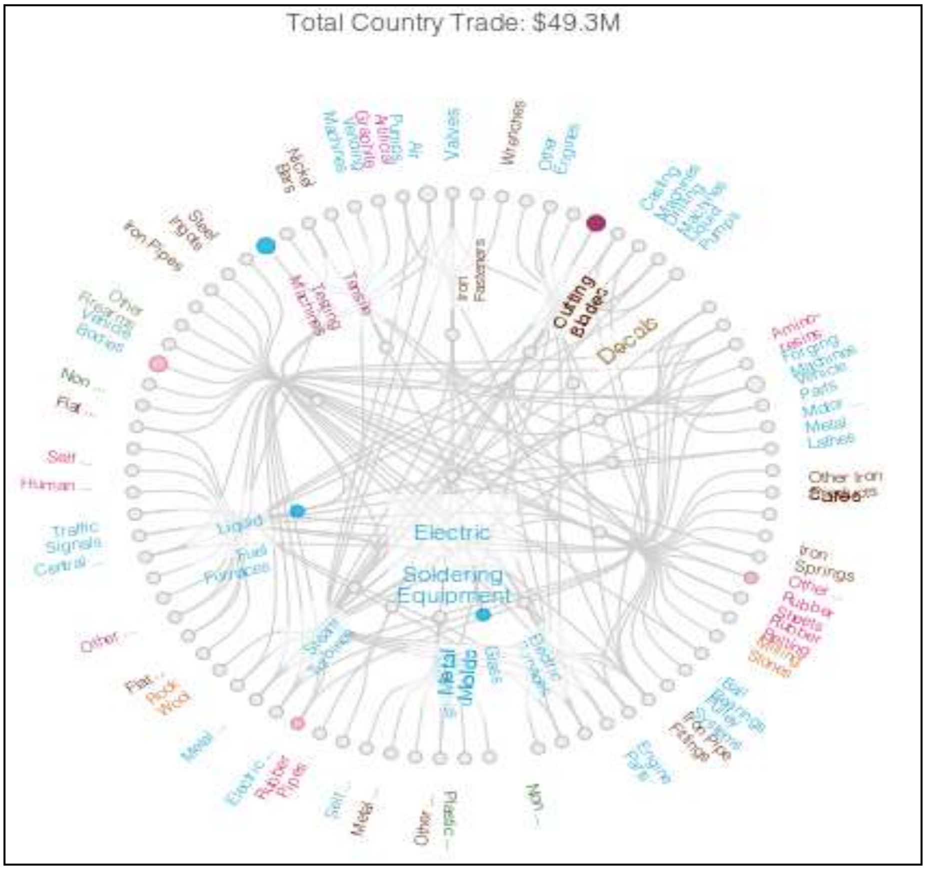
Figure 48: Malaysia's Performance Compared to the Top 10 Exporters of HS8515: Electrical Laser or Other Light or Photon Beam, 1990–2013



Source: Observatory of Economic Complexity

The electric laser and other light or photon beam products are well connected with other products. Figure 49 illustrates the connectivity this family of products has to others in Malaysia's product space including cutting blades, fuel furnaces, engine parts, etc. The dense connectivity warrants attention as its further development will improve the spill over effects to the other products. The current total trade is US 49.4 million.

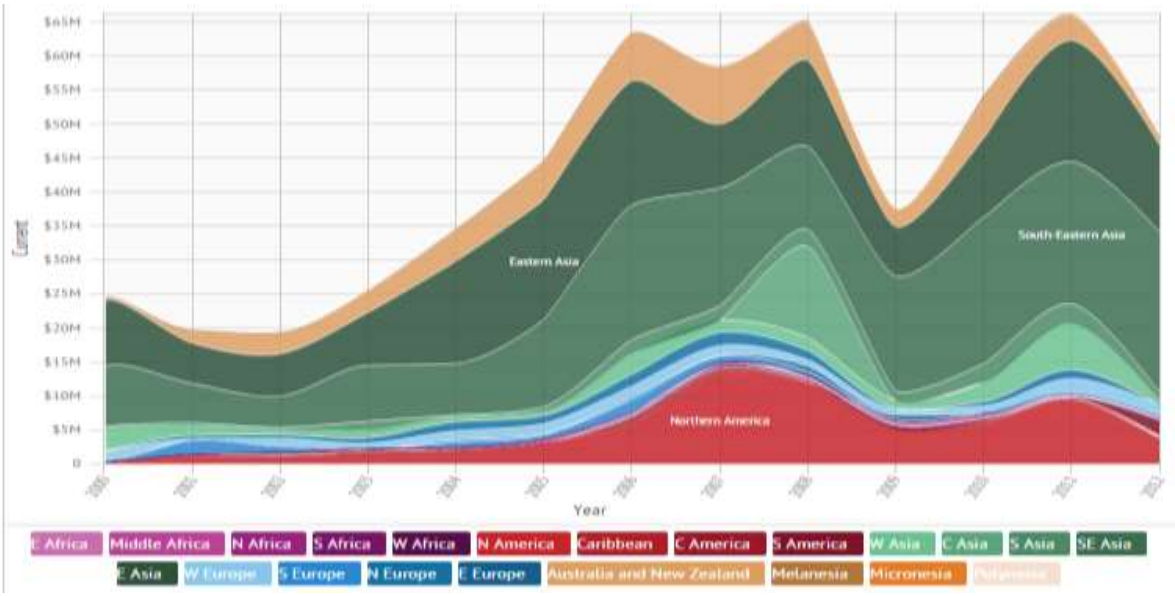
Figure 49: Product Connectivity: Electrical Laser and Other Light or Photon Beam, Malaysia 2012



Source: Observatory of Economic Complexity

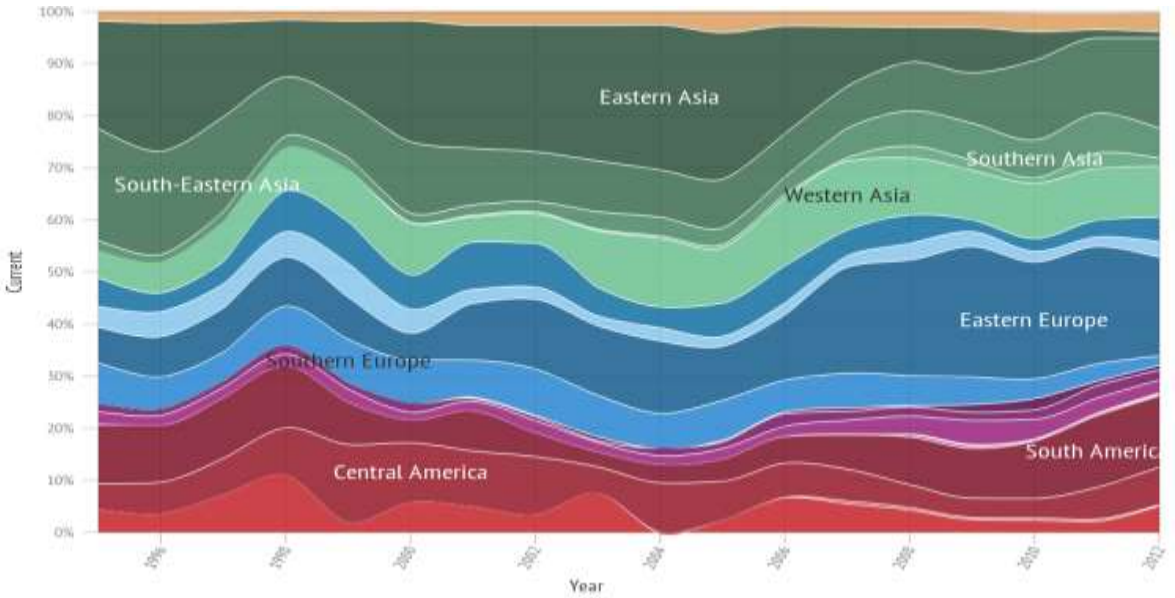
Malaysia exports electric laser or light photon beams to East, Southeast and North America (Figure 50). Nevertheless, exports to the Northern American market are declining. When Malaysia's export destination is compared to that of global exports, East Asia constitutes a declining market while North America is small. But Eastern Europe has been a growing market (Figure 51). However, Malaysia's exports to Eastern Europe are too small. It is important to enhance firms' export capability in order to penetrate growth centres of Eastern Europe and South America.

Figure 50: Malaysia's Export Destination: Electric Laser and Other Light or Photon Beam Products, 2000–2013



Source: Observatory of Economic Complexity

Figure 51: Global Export Destination: Electric Laser and Other Light or Photon Beam Products 2000-2013

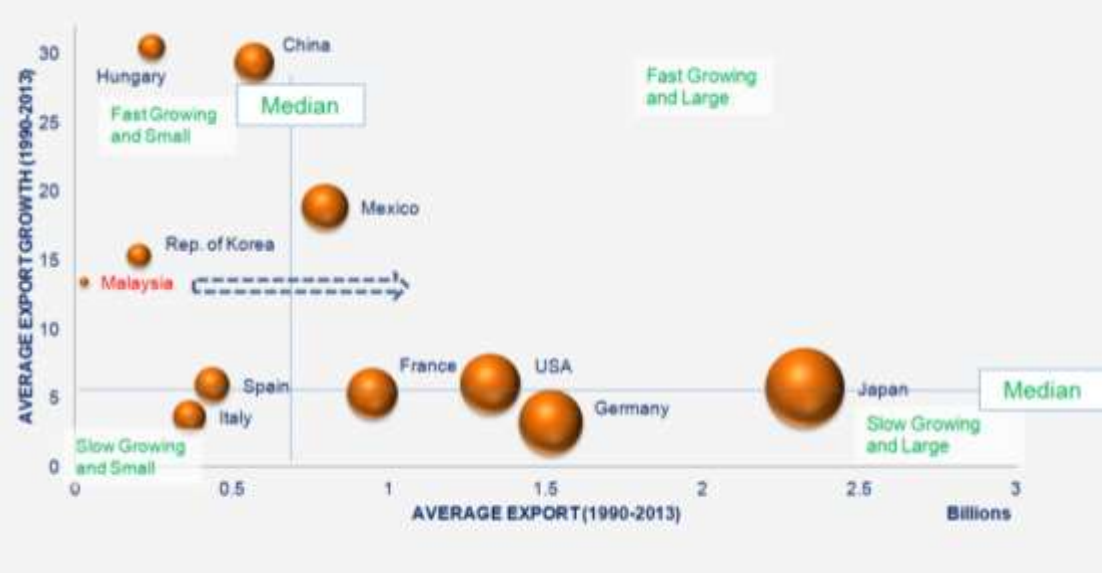


Source: Observatory of Economic Complexity

Electrical ignition or starting equipment

In the electric ignition or starting equipment, both local and foreign firms participate actively. In electric ignition or starting equipment, Japan dominates the market with the biggest market share. Hungary and China are among the fastest growing exporters of this product. While Malaysia has the smallest market share among the top exporters, its average export growth of about 13% is commendable (Figure 52).

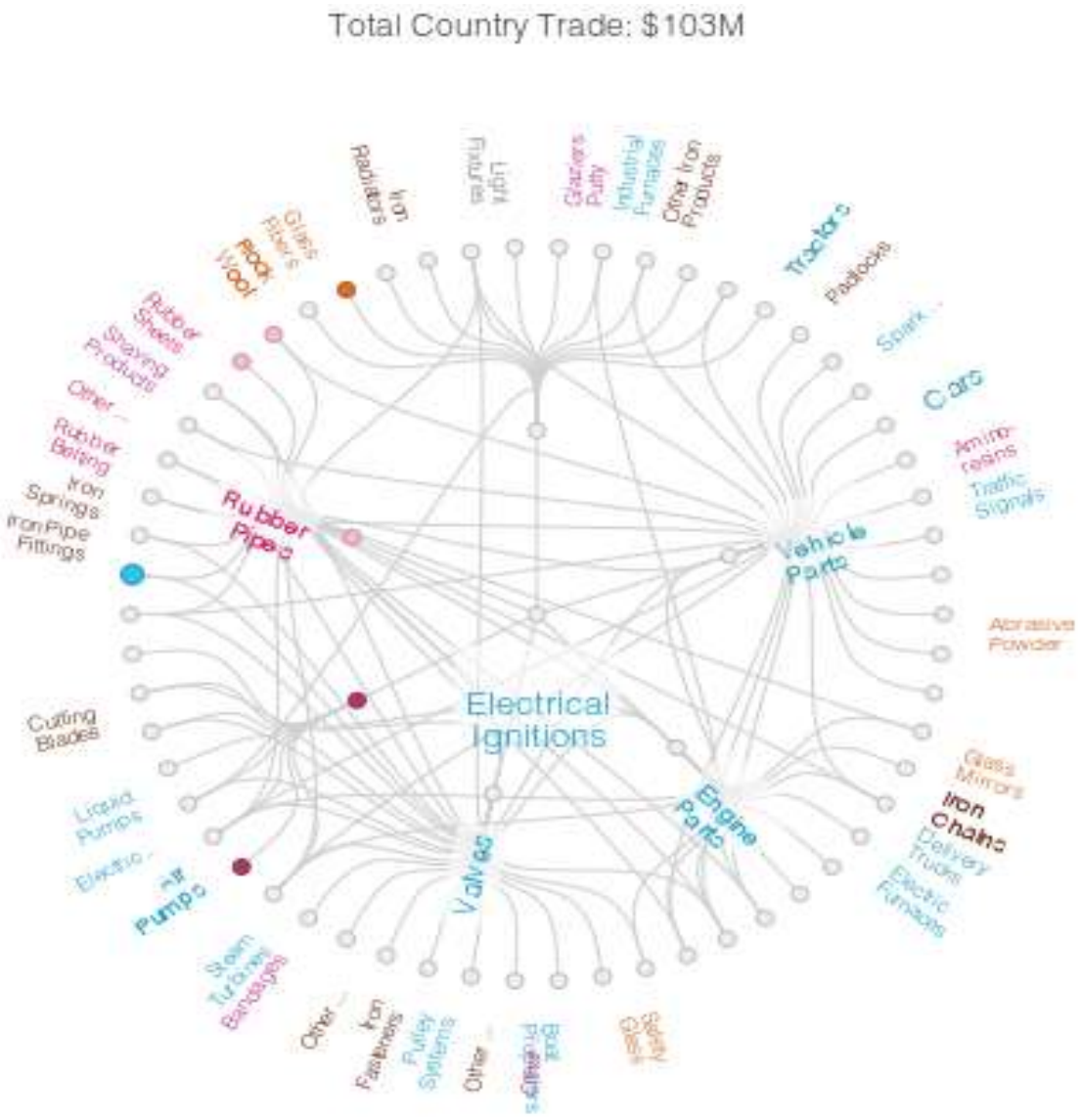
Figure 52: Malaysia's Performance Compared to the Top 10 Exporters of HS8511: Electrical Ignition or Starting Equipment, 1990–2013



Source: Observatory of Economic Complexity

Figure 6 illustrates the connectivity this family of products has to others in Malaysia's product space including padlocks, cars and iron chains. The product is mainly connected with the automotive industry. Nevertheless, it is also linked to rubber as well as to other products such as valves, pumps and iron.

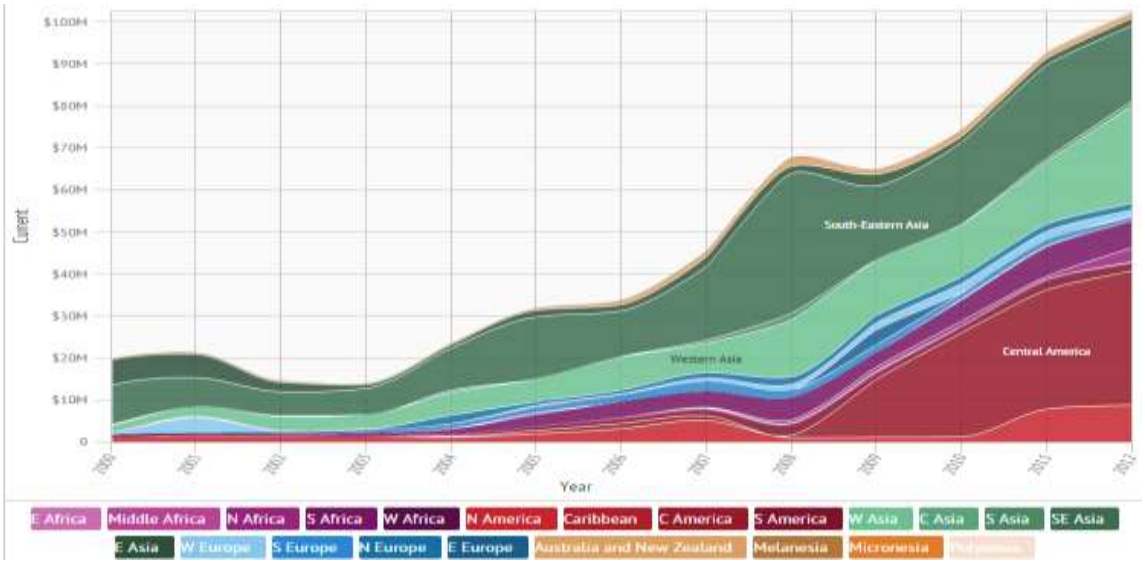
Figure 53: Product Connectivity: Electrical Ignition or Starting Equipment, Malaysia 2012



Source: Observatory of Economic Complexity

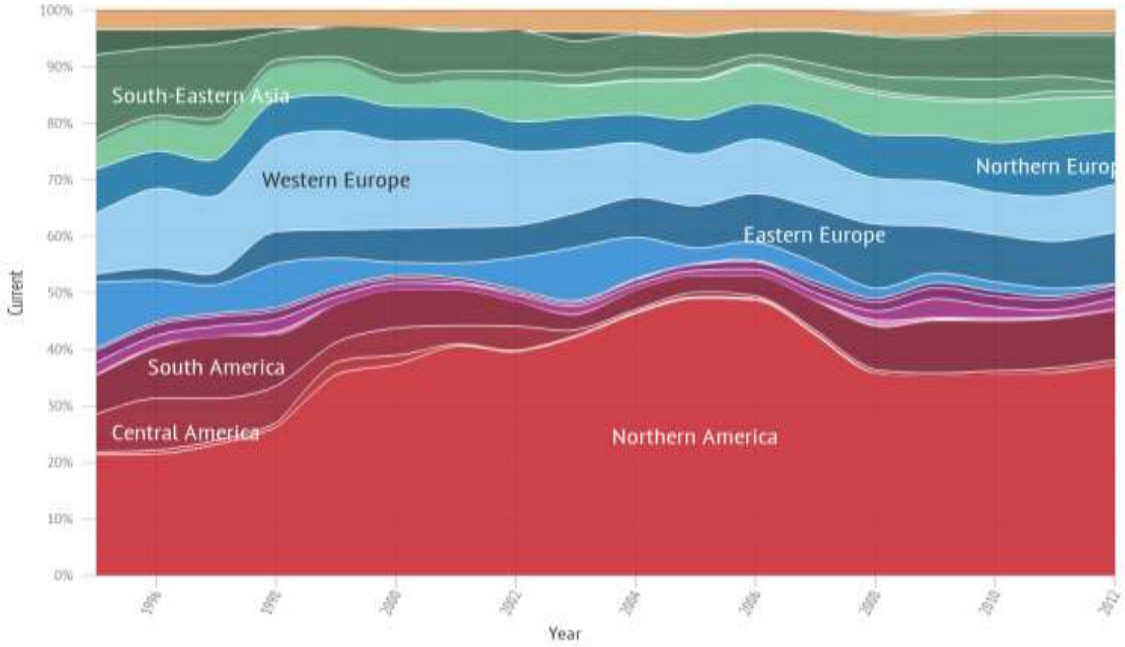
Malaysia's exports of electric ignition or starting equipment record a growing trend to Southeast- and Western Asia as well as Central America. After 2008, Central America has become the main export market for Malaysia. However, when compared to that of global exports, Central America is relatively smaller in importance. North America dominates the market and constitutes an untapped destination for Malaysian exporters. It suggests that the focus of Malaysia's exports has been on markets that have had sluggish growth (Figure 54). There is a huge potential for Malaysia to penetrate Northern America (Figure 55). However, it requires capability among exporters to penetrate this market.

Figure 54: Malaysia's Export Destination: Electric Ignition or Starting Equipment Products, 2000–2013



Source: Observatory of Economic Complexity

Figure 55: Global Export Destination: Electrical Ignition or Starting Equipment Products, 2000–2013

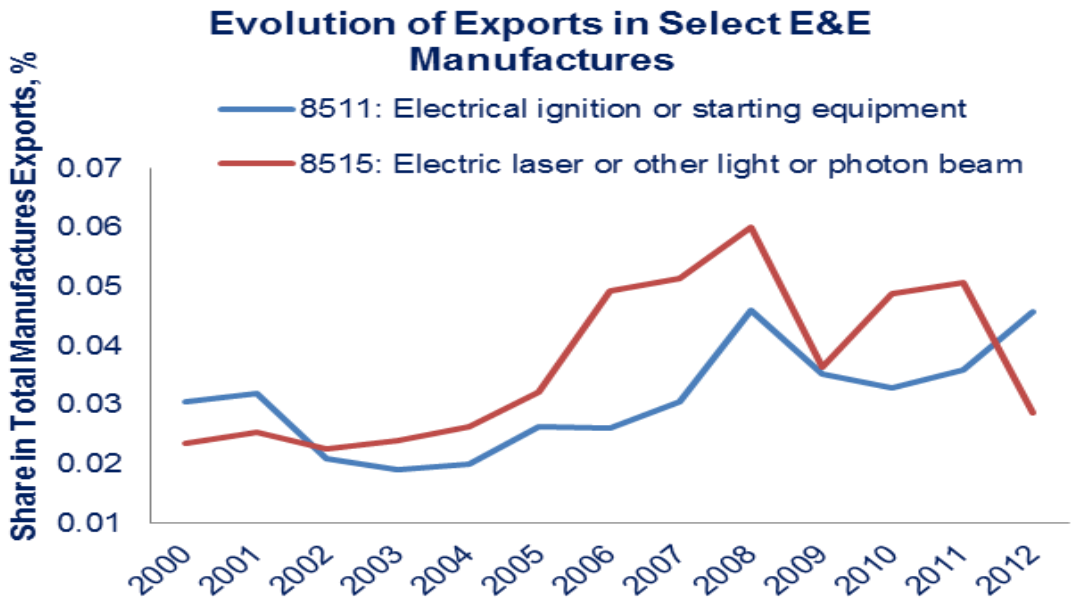


Source: Observatory of Economic Complexity

The analysis of both the products over time indicates the following: Malaysia's exports of electric ignition or starting equipment have been on the rise since the early 2000s with a recent peak in 2012. On the other hand, exports of electric laser or other light or photon beam have been trending downward since 2011 (Figure 56).

Among the key exporters in electric ignition or starting equipment are Denso, Protec Industries Sdn Bhd, EH Auto Link Sdn Bhd, YJ Prodicts Sdn Bhd, Milux Corporation Bhd and Embun Persona Sdn Bhd. Key exporters for electric laser or other light or photon beam are Welding Industries Malaysia, Laser Welding Electrodes Sdn Bhd, Will fast Sdn Bhd, Longlife Weld Sdn Bhd and Technical Resources Sdn Bhd.

Figure 56: Evolution of Exports in Select E&E Manufactures



Source: UN COMTRADE

Binding Constraints

Malaysia's limited presence in the global export market for the products under study implies low investment by investors in said products. Indeed, Malaysia was unable to penetrate the most important markets where global exports record larger export shares. Export growth in these markets is important given that it offers potential for Malaysia to improve competitiveness and increase capabilities. To achieve this goal, greater investment is needed to create the scale to be competitive.

Growth diagnostics informs us that economic agents may be reluctant to invest because of limited financial resources or because private expected return rates to investing are low.

Quantitative and qualitative analyses indicate that among the binding constraints to the production of the selected products are the high cost of financing, lack of skilled human capital and low R&D. If those constraints are relaxed, the industry will be able to improve scale and productivity to compete in the international market. Low productivity is the main cause of concern of the industry currently. Table 10summarises the binding constraints faced by the products.

Table 9: Summary of the Binding Constraints

	Binding Social Returns						Binding Finance	
	Lack of Complementary Factors		Low Appropriability			Coordination	Low Aggregate savings	High Cost of Finance
			Government Failure			Market Failure		
			Ex Ante	Ex Post				
	Human Capital	Infra-structure	Ex ante Risk	Tax	Property rights, crime & corruption	Low R&D, low self-discovery		
Electric laser or other light or photon beam								
Electric ignition or starting equipment								

Notes: most binding; second most binding; not critical

The following sub-sections provide in-depth analysis on the main binding constraints by each of the selected products:

Electric laser or other light or photon beam

High cost of finance: Costly finance manifests in different ways for SMEs than it does for larger companies. The former would be deterred by prohibitive collateral requirements and credit rationing by banks. The former may lack sufficient retained earnings or require greater risk-weighted returns given the uncertainty associated with new production.

The electric laser or other light or photon beam product displays a negative correlation between the cost of capital and exports - potentially signifying finance as a constraint (Figure 57). In interviews, market participants suggested that cost of finance constrains investment in welding, machinery and high-end technology to produce laser or photon beam products competitively.

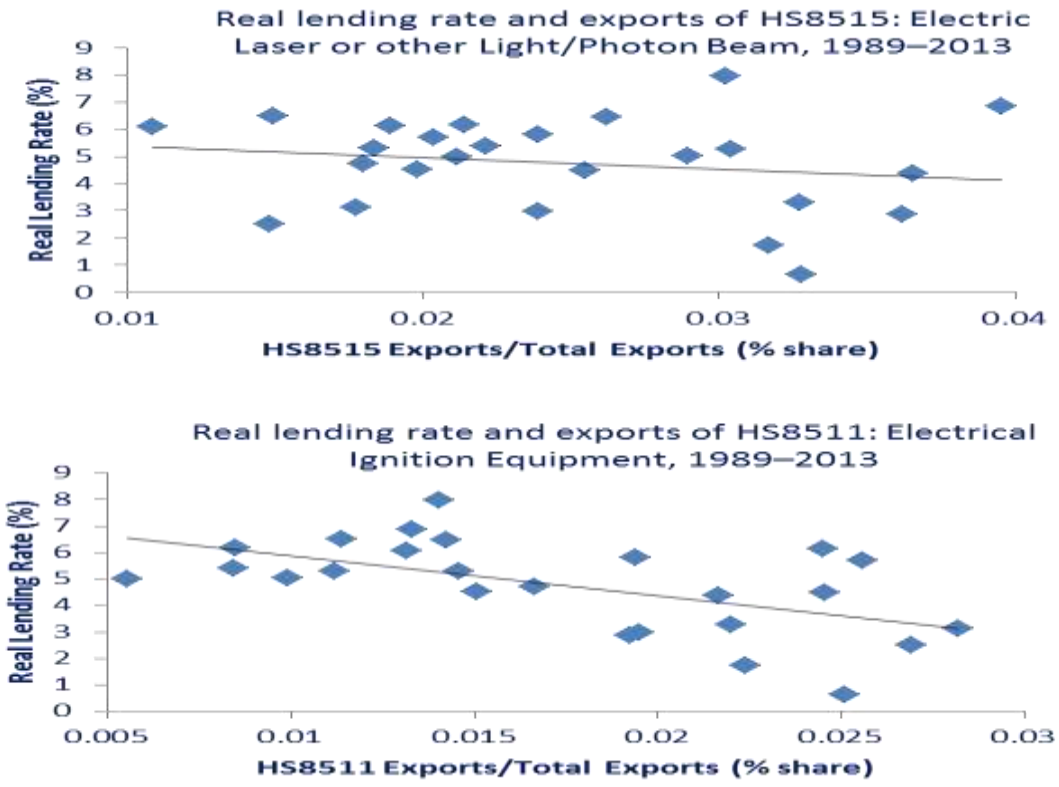
A representative comment from an owner of an SME E&E manufacturing plant highlights how finance may bind growth:

We can manufacture this product. But we don't want to. I went to China to visit their factories. Even the smallest factory is bigger than mine. I also visited another factory. I walked and walked and walked. Yet I did not reach the other end. China's manufacturing scale is too huge to compete with. To expand our scale to that of China will be too costly.

-Local manufacturer of electric lasers

The comment aligns well with others on the prohibitively high cost of finance to compete with other, large-scale players. Quantitative analysis of lending rates and export growth lends further credence.

Figure 57: Relationship Between the Real Lending Rate and Exports of Electric Laser and Electric Ignition, 1989–2013



Source: World Development Indicators, World Bank Group

Lack of skilled human capital: Another important binding constraint is human capital. There is a lack of welding technology experts and structural integrity engineers in the electric segment of the E&E sector due to limited training courses on welding, oxy-fuel cutting, engineering machinery and engineering sciences. Other skills that are in short supply in the electric segment of the E&E sector include welding testing and inspections, non-destructive testing, plant inspection and painting and blasting.

A representative comment from a manager of an SME E&E company illustrates the lack of skilled human capital particular to his or her industry as follows:

And what about my labor force? Where am I going to get them to expand my scale? As it is we have a shortage of skilled and unskilled manpower…We are not sure if [the frontier product] will give us any profit.

-Local manufacturer of electric lasers

There is a need to develop specific skill-sets for the industry. When asked about those important skills the following was the answer given by an E&E manufacturer:

We find it difficult to recruit talented technical people in welding technology, metal joining, welding structural engineering, and metallurgy. When I visited Germany, specific institutions are created to support the welding industry cluster. The cluster is dynamic in that it supports each other. In Malaysia, we lack institutions that are specifically focused on welding technologies. Universities are not in these fields.

-Local manufacturer of welding machines

Lack of R&D: The third most binding constraint is the capability for firms to undertake R&D activities. This is more prominent in the electrical laser or other light or photon beam product category, especially, the welding machinery industry than in electrical ignition and starting equipment. Given that the former are major local producers than the latter, the R&D investment is low in the electrical laser or other light or photon beam.

In the electric laser industry evidence shows that manufacturers fail to compete due to lack of R&D that can differentiate their products. The manufacturers' current and only strategy seems to be to replace some of the components with China-made components without much effort to improve the productivity through skill development & R&D. The companies are taking short-term solutions. A representative comment from a manager indicates the following:

We face intense competition from China especially in the low-end welding machinery market. Competing with them requires scale. Currently, we are substituting some of our components for welding machinery with the China-made parts to lower the cost of production.

-Local manufacturer of welding machines

When asked why the manufacturer was not thinking about differentiating his or her product to compete with China, the following answer was given:

Currently buyer's main concern is price. For us to convince buyers about quality, it takes time since the buyers need to experiment the product to know the difference in the quality of the product. Therefore, our current emphasis is on price. However, we are losing our market share in Malaysia since China is still coming strong given their price is more competitive due to export incentives given by their government.

-Local manufacturer of welding machines

The sentiments of the manufacturers show that they would not want to differentiate the product by investing in improving the quality of their products because of their current focus on price-sensitive regional markets. They are still competing in the same product line.

Malaysia is in danger of losing share in the domestic and global markets if firms are unable or unwilling to increase productivity or make successful bids at higher sophistication products. This requires R&D investment in process and product innovation.

When asked why they are not competing in more advanced markets, e.g. Europe, since the company has decades of experience, the manager indicated the following:

The advanced market is a more mature market in the sense that they produce higher-end welding machinery products [as], for example, laser-based machinery products, which support automotive and other industrial usage. They are very R&D intensive and technologically we are not there yet. We have 60% of the domestic market and our domestic market does not require high-end machineries since there is no demand for it. We will not get back our ROI. However, currently we are losing our domestic market share."

-Local manufacturer of welding machines

Another representative SME E&E manufacturer has the following to say of their lack of interest in R&D:

This product [electric laser] is doable. We only need to [tweak] the production technology and improve product quality. But we do not have the R&D capability to do this…Our local universities have the skills and the latest equipment to do this kind of research. But the R&D funding is misallocated to those projects that have little industry application.

-Local manufacturer of welding machines

The following case study further illustrates the binding constraints of the welding industry.

Box 4: The Welding Industries Malaysia

The welding machinery industry is championed by few players with Welding Industries Malaysia (WIM) being the major local manufacturer of welding machineries. The other two players have concentrated their activities in assembling while majority of them are still involved in trading and distribution activities.

WIM's domestic market share is 60% while exports account for the rest. Export markets are mainly Indonesia, Vietnam and the Middle East. The choice of export destination is determined by the presence of China. In Vietnam and the Middle East China's presence is lesser. One of the major challenges of WIM is the stiff competition from China where welding machinery is sold at a cheaper rate. Given the export subsidisation of about 15% of the cost of production to the exporters, Chinese products are crowding out the welding machinery market including in Malaysia. Chinese competition appears to be the central factor that prevents the local industry from investing further into the sector as well as to upgrading technologically. Even the assemblers and distributors are more complacent being at their current position given the profitability that they enjoy currently.

WIM's case generally represents the state of the welding machinery industry given that WIM's market share is nearly 60% and that it is the sole manufacturer relied upon by many other assemblers and traders and distributors.

The inability of WIM to compete with low-cost producers or even to co-exist with the low cost-producers suggests the following:

WIM is unable to attain the needed productivity to compete (to lower its cost of production). Currently the company is substituting some of the components for welding machinery with Chinese-made components to lower the cost of the product.

WIM is unable to differentiate its product. As such it is incapacitated from moving into higher-end welding machinery.

The current export destination market of WIM itself is a testimony of its inability to penetrate the more developed market. That suggests a lack of technological upgrading in the production of welding machinery.

The low social return is due to the lack of human capital especially skilled workers to contribute to the upgrading of the industry. Even an entrepreneurial spirit to find different avenues to start a business and compete in the current market is lacking due to the lack of skilled human capital (those who have the know-how). Indeed, the lack of human capital also limits the drive to move into research and development (R&D). The current institutional setting is inadequate to meet the human capital needs of the industry, especially, skilled workers who have knowledge in metallurgy, material sciences, welding and structural and integrated engineering.

Financing availability both for business start-up and to finance R&D is limited in this industry. Given that the industry is not in the promotional list of the government, R&D grants favor the ICT and biotechnology fields.

Source: Interviews

Electric ignition or starting equipment

High cost of finance: As is the case with electric laser, the electric ignition or starting equipment displays a negative relationship between real lending rate and exports. That indicates that finance is a constraint in up scaling production or to shifting to this new product by existing companies (Figure 8).

That financing is an issue is especially true for the small and medium-sized industries. The high cost of finance limits R&D which is critical in this R&D-intensive industry. Companies are constrained by finance to undertake R&D for product development. Product development is necessary to make the shift to the frontier products and to producing them to a scale that would make their exports globally competitive. It is also important to penetrate the most growing global markets where Malaysia is yet to penetrate. Penetrating the right markets also provides the scale for the manufacturers.

Lack of skilled human capital: Interviews with senior managers at an internationally recognised skills training institute also support the contention that the lack of skilled human capital is a binding constraint. When asked about the current supply of human capital in supporting the electric ignition or starting equipment and its associated industries as, for example, construction, automotive and oil & gas, the chairman of a skills training institute indicated the following:

We have shortage of talented manpower… Currently, the university curriculum does not emphasise on the need of this specific sector. Although we have the engineering programmes…what the industry needs is a combination of engineering knowledge and some practical application with internationally recognised qualification like the Certification Scheme for Welding Inspection Personnel (CSWIP), PCN by [the] British Institute of Non-destructive Technology, ASNT (America) and IIN [International Institute of Welding]. We have established few of these programs. One of it is with [the] UiTM allowing its students to undertake a seven-day program that allows them to be certified as welders. However, due to MQA's requirements, universities and technical schools find it difficult to make changes to [their] curriculum. We also lack programmes in engineering science that emphasises and produces scientists and structural integrity engineers at postgraduate levels.

-Welding training institute

Human capital also deters firms from building adjacent capabilities. A representative manager who has served the gas and welding industry highlighted this challenge in moving from product to product.

When I was working in one of the major gas companies in Malaysia, the company decided to produce electrodes due to the demand from customers. However, we did not have the capabilities to produce it. [So] we decided to joint venture with another company that supplied the fluxes. First, we bought the electrodes and supplied them to the customers. Over time, the company encouraged us to learn the technology and we were sent for training. We acquired the know-how about the components and technology. The key here is the ability of the workers to understand the mechanics of how electrodes are manufactured. For this the workers require wide range [including] welding, chemistry, metallurgy and skills to acquire the capabilities to manufacture. However, our current [university] curriculum does not emphasise on the need to learn a range of knowledge. This is why we encourage a joint program [between the industry and the universities] that also allows for certification of [university] engineering graduates in welding. This is what the market requires.

-Welding training institute

Lack of R&D capability: Within the electric ignition or starting equipment, the MNCs, such as Denso undertake R&D activities. Average R&D spending by foreign MNCs: Bosch alone spends 9% out of the sales per annum for R&D. Denso spends 9.3% out of sales per annum for R&D. Nevertheless, many of the R&D activities are still located in their headquarters abroad. In contrast, local manufacturers in electric ignition or starting equipment industry spend relatively lesser on R&D activities.

The lack of R&D activities cripples a manufacturer from competing in other markets thus relying mainly on the domestic market and limiting its search and venture into a more value-added product lines that promise better returns. The industry trend shows that the industry is reversing itself from being a manufacturer to being an assembler and or trader. The consequence is that there is no movement up the value-chain and accordingly a limited contribution to economic growth. Indeed, net export values would suffer from the high level of importation from China. The export market structure of the industry is also changing due to its inability to compete as a result of lower productivity that keeps the cost high. Manufacturers are shying away from potential growth markets.

There is also a coordination challenge as supporting institutions for R&D and testing are either lacking or relatively ineffective. When asked how such a situation can be improved one manager of an E&E company remarked:

We also need centres of excellence to support R&D. Some of the government facilities are superb but [their] operators are not good. I believe public-private partnership initiatives are important and, if forged, will help uplift the sector.

-Local manufacturer of welding machines

Concluding Remarks

Overall, in the two products investigated, lower productivity deters manufacturers from competing globally. Indeed lower productivity leads to lower returns that further deter manufacturers from investing. Due to this, the root cause for lower productivity and accordingly lower investments were found to be the high cost of financing, lack of skilled human capital and limited R&D activities. Policy interventions should address these fundamental constraints if firms that have the technological capabilities to do so are to be nudged into the accelerated production of these frontier products.

Summary of case studies

The diagnostic tree analysis presented in the introduction to this section has led us to conclude the following about what constraints current and would-be investors face in each of the 6 prioritised products studied. The table offers a heat map of the constraints with the most binding highlighted in red. Overall, it appears that infrastructure, unstable government policies including tax and regulatory policies do not significantly constrain agents in any of the prioritised products. The cost of finance, lack of skilled labor, and coordination challenge respectively constrain the prioritised sectors.

Table 10: Summary Constraints Encountered in the Case Study

	Binding Social Returns						Binding Finance	
	Lack of Complementary Factors		Low Appropriability			Coordination	Low Aggregate savings	High Cost of Finance
			Government Failure			Market Failure		
			Ex Ante	Ex Post				
	Human Capital	Infrastructure	Ex ante Risk	Tax	Property rights, crime & corruption	Low R&D, low self-discovery		
Electrical ignition or starting equipment								
Electric laser or other light or photon beam								
Tools for hand working, pneumatic, hydraulic motors								
Apparatus based on the use of X-rays or of alpha, beta or gamma radiations								
Beauty or make-up preparations								
Lubricating products								

Notes: Red denotes the most binding constraint while yellow denotes the next most binding constraint. Green indicates the factor is not a binding constraint.
The diagnosis has implications for policy as it helps focus limited resources on the most binding constraints. This is the subject of the next section.

VIII. Policy Framework for Productive Transformation

This report has outlined Malaysia's opportunities for strategic diversification using the Economic Complexity approach. We now turn to policy implications and recommendations based on our quantitative and qualitative findings.

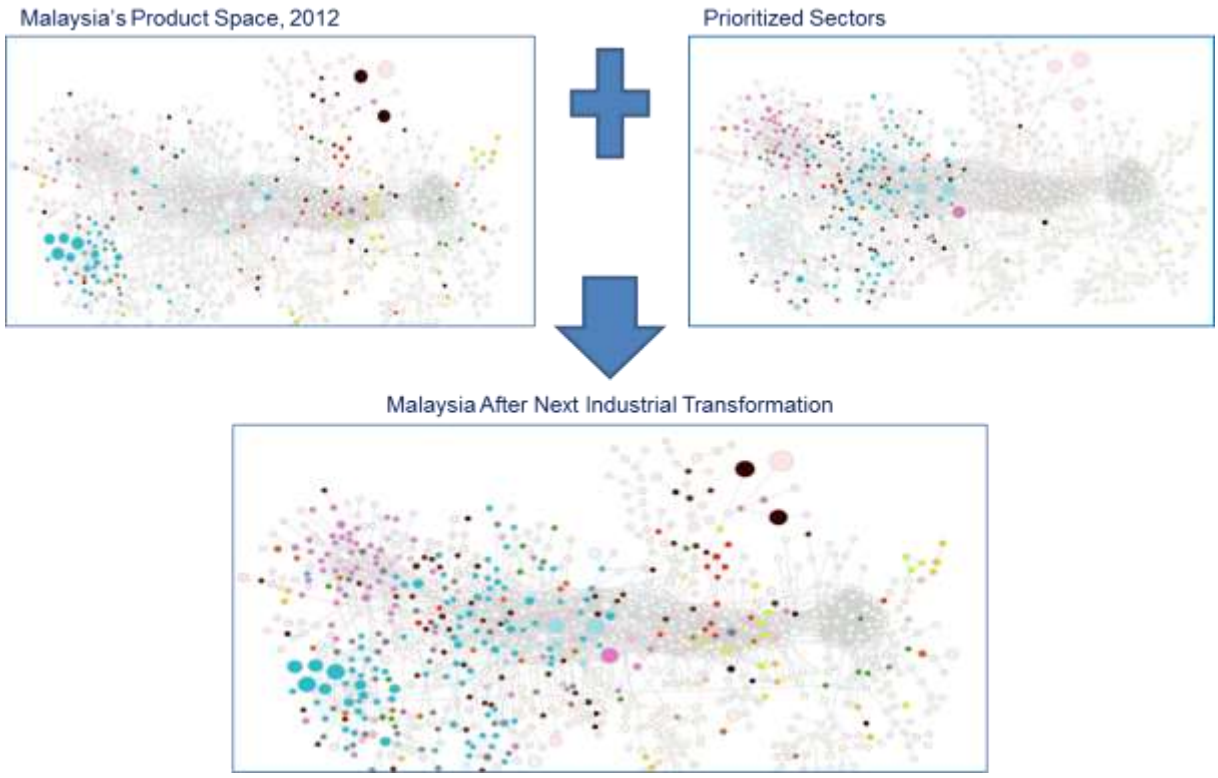
An enhanced vision for Malaysia's economic transformation

We have argued that the composition of a country's exports is a critical predictor of economic growth. Countries that upgrade the complexity of their export baskets increase their productive capabilities, allowing them to produce rarer products and sustain higher levels of growth. In this context, a central element in Malaysia's vision of economic transformation should be to boost the economic complexity of its economy and improving their position in the product space.

Our analyses in Sections V and VI show that the priority sectors identified by EPU (M&E, Chemicals and Plastics, and E&E) contain many of the prioritised "frontier" products. By "frontier" we are referring to products that hold very promising opportunities to upgrade Malaysia's economic complexity and open the doors to what we call a "second modern industrial transformation."

The top left panel in Figure 58 shows the current position of Malaysia's product space while the top right panel shows the position of the 238 prioritised products. The central panel below illustrates what Malaysia's product space could look like if, in addition to the products in which it already exports with RCA, it also develops RCA for the 238 prioritised frontier products. It represents a vision of a country that is not only more complex, but also much better positioned for further diversification into high-complexity products.

Figure 58: Current and Potential Position of Malaysia in the Product Space



It may not be optimal for Malaysia to maintain its position in all the industries in which it currently has RCA. Higher-complexity countries such as Korea and Japan have noticeably abandoned the less complex products in sectors in which they have a strong presence (e.g. E&E).

Keeping these considerations in mind, the products highlighted in Section Vll and detailed in Appendix I do outline concrete goals for strategic diversification for Malaysia. Broadly speaking, we believe that by developing RCA in a large number of these products the country can achieve higher levels of complexity, higher income, and better diversification opportunities for the future.

It is important to emphasise that developing RCA in these new products does not necessarily mean obtaining prime market-share positions in these markets worldwide. Given the size of the Malaysian economy and the emergence of large-scale competitors like China and India, a successful development of many of these products will involve targeting higher-value sub-segments or "niche markets" in which Malaysia's current capabilities can give domestic producers a competitive advantage.

Along these lines we envision an M&E sector populated with medium-sized, dynamic and innovative firms that serve high-value specialised market segments and provide specialised inputs for MNCs and other end-product manufacturers in the global markets (for example, as do the M&E sectors of Taiwan or Poland). Our vision for the Chemicals and Plastics sector is similar, but with a key additional component: a central role of the Hydrocarbons and Palm Oil feedstock both in generating supply-side advantages and in facilitating market access. Given the existing strength of the E&E sector in Malaysia, we visualise a stronger focus on the most complex products within the sector, the discontinuation of focus on the less complex and stable growth coming from new applications of already consolidated products and from the production of more highly specialised products, many of which are small or new enough to escape the bulk of product commoditisation. Finally, we envision strong linkages and complementarities among the frontier products and the already established industry of Malaysia, generating a powerful source of synergies and activities that lead to the deeper development of both local and global market opportunities.

Regarding the E&E sector, the maturity of many of its industries calls for a different strategy. More than in the other sectors, it is important to evaluate which E&E products continue to be of strategic importance for Malaysia, and which are no longer adding to the country's economic complexity. The GoM should consider discontinuing support to less complex and low-capital-intensity firms. This strategy, however, should be matched with increased support to innovation by established and new firms. Established firms, including large and highly competitive MNCs, are in a great position to bring new R&D investment and higher-value activities to the country, and such initiatives should be encouraged. In addition, the experience of PEMANDU in promoting investment in LED lighting and related industries suggests that some E&E firms (established and new) may be moving into novel, high-complexity products, which have not been captured in our analysis due to the coarseness of the HS4 classification system. The GoM would do well in seeking to understand this innovation space better and to incentivise the development of high-complexity products in this context.

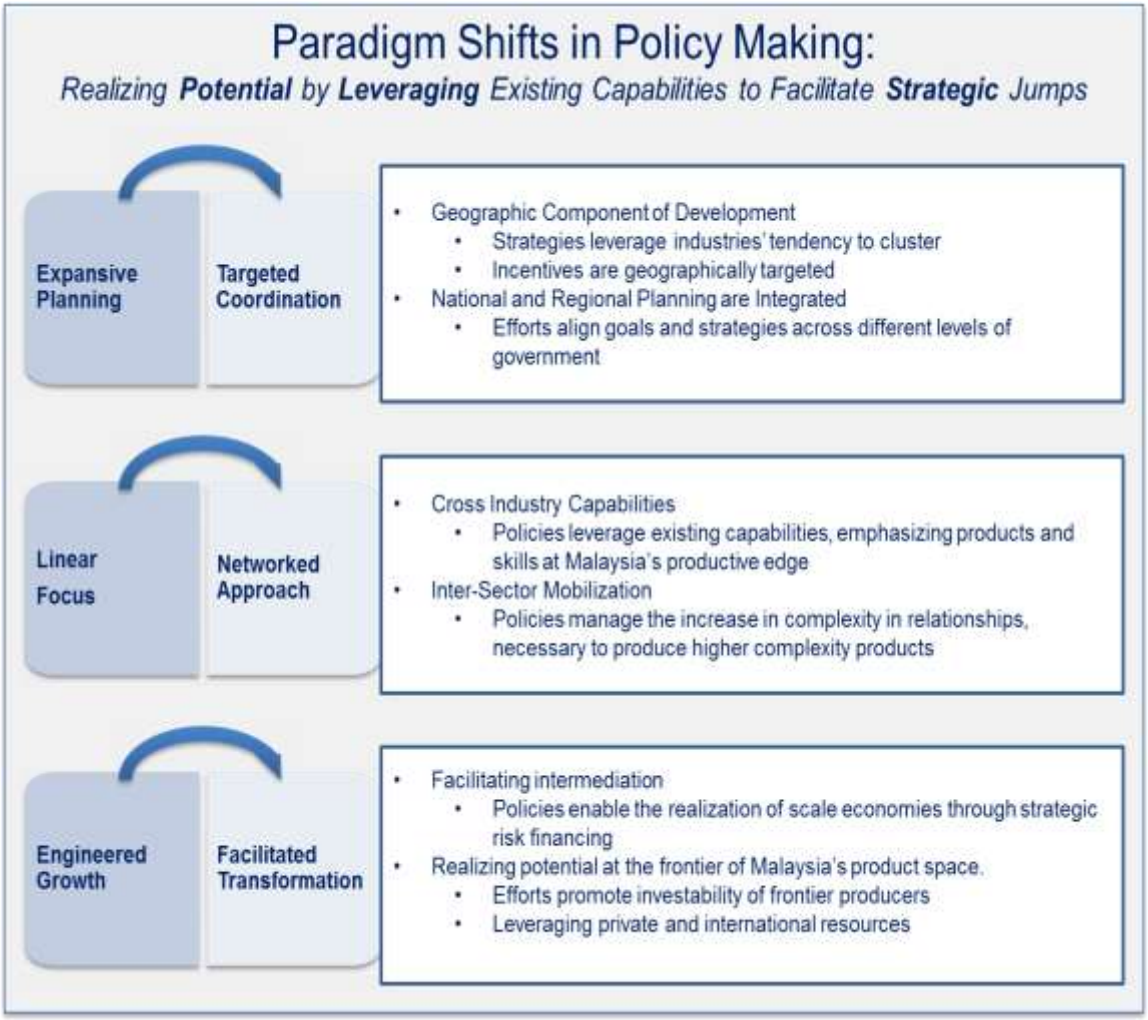
Paradigm Shifts in Policy Making to Facilitate Transformation

It will be crucial for policy makers to emphasise a paradigm shift in thinking about structural transformation in order for the vision articulated here to be realised. The recommendations outlined in this report embody the following three important paradigm shifts:

- From expansive planning to targeted coordination;
- From linear focus to a networked approach to upgrading capabilities; and
- From engineering growth to facilitating or catalysing transformation.

Figure 59 below describes each of the paradigm shift stated above.

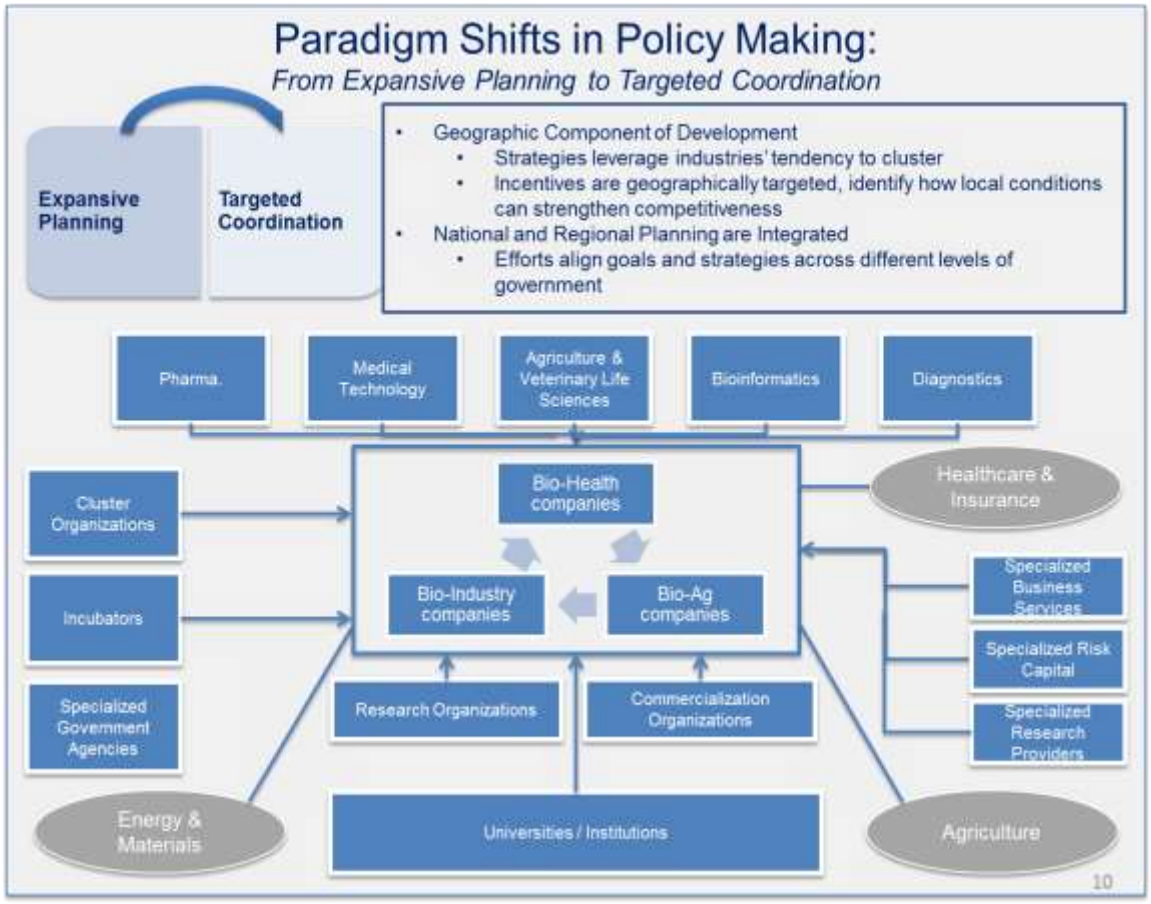
Figure 59: Paradigm Shifts in Policy Making



From Expansive Planning to Targeted Coordination

The Economic Complexity framework has been presented to guide policy making in the direction of greater complexity in manufacturing. This helps target limited resources in a manner that will improve growth. Realising potential at the frontier requires coordinated action from both large and small players and government incentives can be decisive in achieving this coordination. A viable cluster is an agglomeration of firms and critical institutions that support growth and competitiveness of these related industries. This is illustrated in figure 60 for the bio-technology cluster. It is important for policy makers to identify and support such agglomeration of related entities in order to strengthen cluster competitiveness, with attention to the clusters that we have identified.

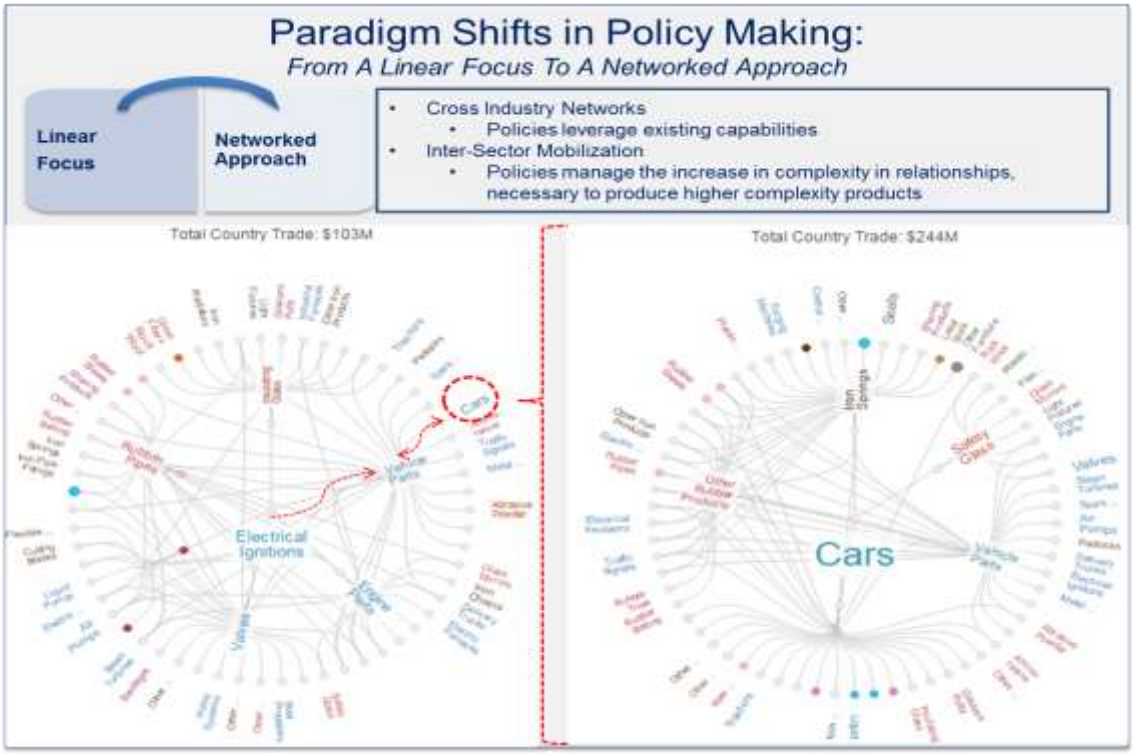
Figure 60: Clustering in the Bio-technology Industry



From a Linear Focus to a Networked Approach

The Economic Complexity framework emphasises that the capabilities that a country generates in certain products makes them more able to develop other *related* products. This network approach is a break from intensifying activities in a single supply chain in order to reap greater value addition. A network approach allows for growth along the extensive margin as opposed to the intensive margin. Malaysia already has a substantial set of capabilities that could facilitate success in frontier products. The country has potential to develop machines that are used in sectors in which domestic producers already have a strong presence (e.g. oil and gas related machines or precision machinery such as testing machines for integrated circuits). It also has the potential to strengthen input-output relationships across sectors (e.g. E&E using chemical inputs and materials produced in Malaysia, or M&E using circuits, sensors, and precision manufacturing services from the E&E sector), which can position the country to take advantage of emerging opportunities such as the rise of the "Internet of things". This paradigm shift is illustrated in Figure 61, which shows the networks of capabilities among different products.

Figure 61: From a Linear Focus to a Networked Approach

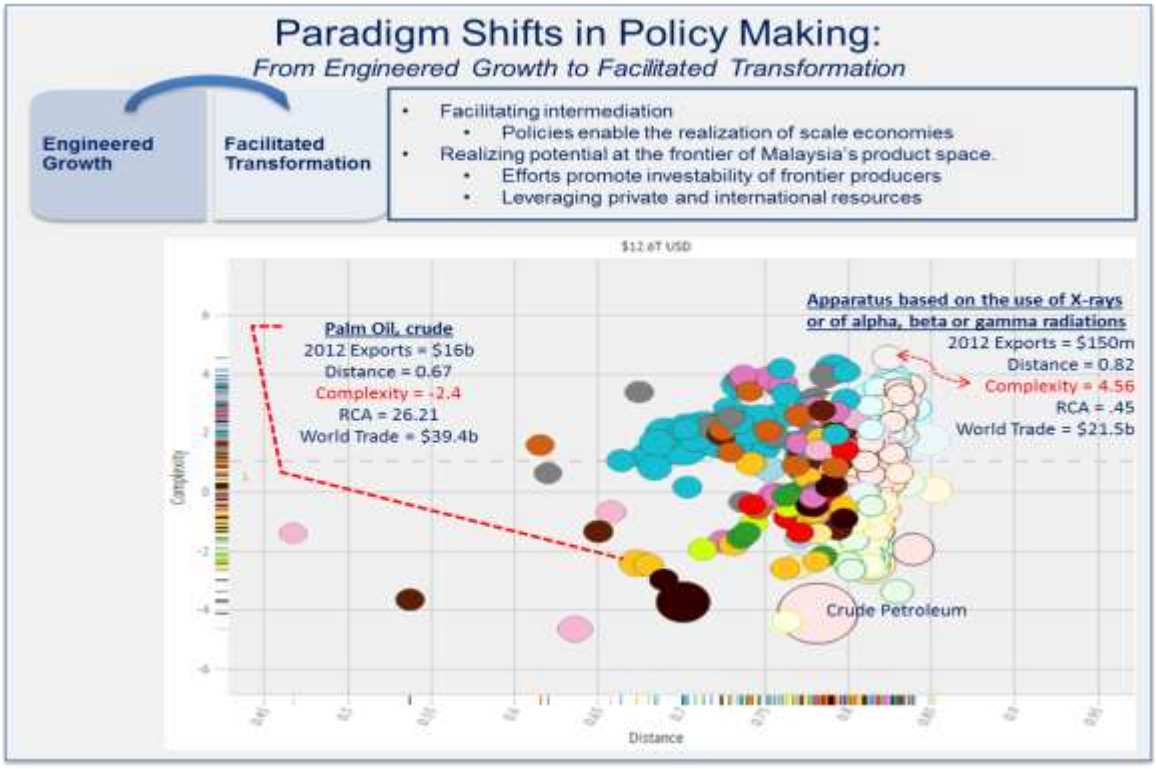


Source: Observatory of Economic Complexity

From Engineered Growth to Facilitated Transformation

Taking advantage of existing capabilities, however, is something that doesn't happen automatically. The image below (Figure 62) shows that, while promising, one of the targeted products, **Apparatus based on the use of X-rays or alpha, beta, or gamma radiations**, is distant to Malaysia's current product space. The government and other support organisations can play a pivotal role as catalysers of the process of taking advantage of existing capabilities in this this case. A clear example of this is Collaborative Research in Engineering, Science & Technology (CREST), a government-supported private sector initiative in which multiple players from the E&E sector have joint efforts to collectively promote innovations in products and processes that can be used by the sector at large. As they move forward in their research collaboration, the members of CREST have realised that their combined capabilities can position them well to jointly forge ahead into related businesses beyond E&E, such as medical devices. A strong policy through which the GoM incentivises linkages that allow Malaysians to truly leverage their existing capabilities is a strategy that can have potentially very large impacts at a moderate cost.

Figure 62: From Engineered Growth to Facilitated Transformation



Source: Observatory of Economic Complexity

Strategies

What strategies can Malaysia employ to realise this "higher-complexity" vision of economic transformation? There are many valid answers to this fundamental question. Here we highlight a set of suggested strategies that are informed by our qualitative and quantitative findings. In developing these strategies we worked extensively with local stake holders to determine the key binding constraints affecting the development of these industries and worked to formulate tailored solutions. We also referenced global best practices to inform our strategies and assess the potential costs and benefits of each approach.

These strategies were validated through a workshop with stakeholders at the Economic Planning Unit in Putrajaya. Table11summarises these in a manner that addresses the three main constraints identified in the preceding chapter.

Table 11: Summary of Strategies and Recommendations

The following sections detail opportunities for policy interventions identified through our research and recommended strategies to facilitate the transformation of Malaysia's economic complexity. Each strategy identifies a suggested implementing agency. Strategies need not duplicate existing measures, and we articulate how we can leverage what the authorities are already doing. A key element of such an approach is that it minimises the cost of the envisioned structural change. For each strategy, we provide an illustrative example in Appendix III in which the recommended policy direction has been implemented. There are fifteen strategies, which are divided into three areas comprising five each. The first five strategies pertain to coordinating resources to populate the sparse areas of Malaysia's product space. The second five addresses the issue of capabilities needed to realise the opportunities including skills training and workforce development policies. The last five strategies seek to address the intermediation of financial resources to facilitate the "second industrial transformation."

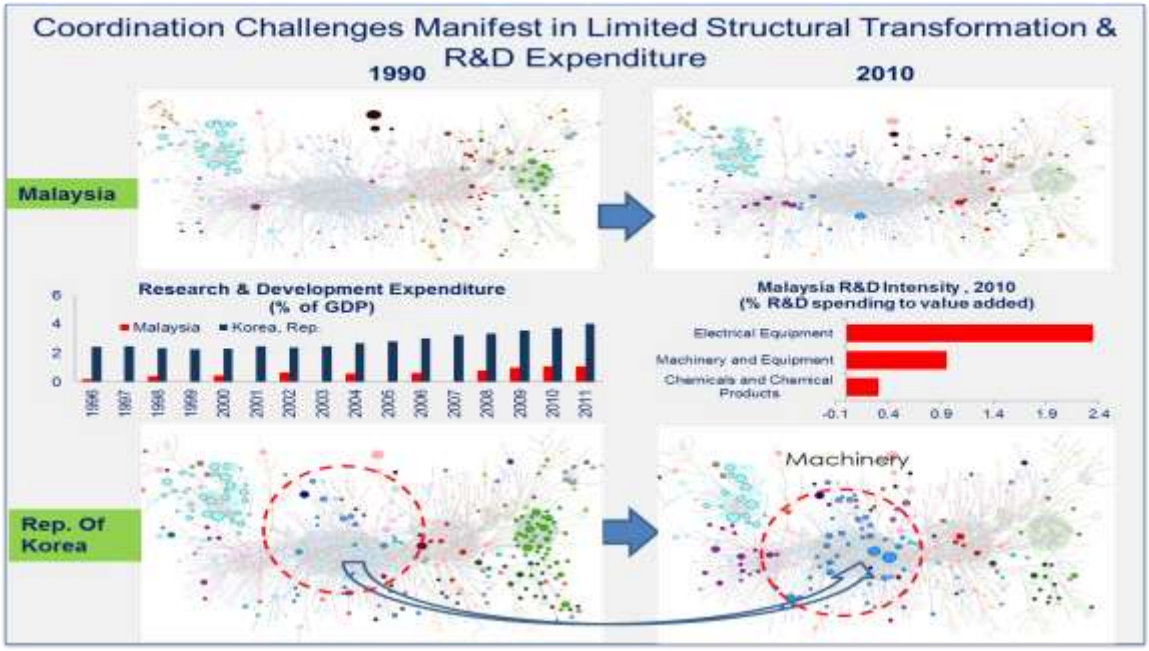
Strategy 1.1: Incentivising Pioneers in Identified Sectors to Promote Exploration of New Sources of Growth

Opportunities

The objective of this recommendation is not only to encourage new producers of the identified products but also to facilitate diffusion of knowhow by pioneers in the respective products. Shown below in Figure 63 is an illustration of Malaysia's progress toward populating the dense part of the product space, relative to South Korea. Changes in Korea's product space suggest a deliberate move away from garments (in green) towards machinery in the middle of the product space. On the other hand, Malaysia's product space shows limited progress towards greater complexity within the 20-year period.

High fixed costs of scaling up and lack of market intelligence, especially for SMEs in the frontier sectors, were cited during interviews as inhibiting the scaling up of production. Low R&D expenditure over GDP, again relative to Korea, is one manifestation of coordination challenges as discussed in previous sections. There are significant gains to be made from coordinating efforts at the intersection of M&E and the mature E&E sector in order to populate the dense part of Malaysia's product space.

Figure 63: Coordination Challenges Illustrated



Sources: Observatory of Economic Complexity, WDI, & Malaysia Manufacturing Census, 2010

Recommendations

MIDA should incorporate the 238 frontier products in the Promoted List with a goal to directing assistance including the Pioneer Status and Investment Tax Allowance. At present, a company granted Pioneer Status enjoys a five-year partial exemption from the payment of income tax. It pays tax on 30% of its statutory income, with the exemption period commencing from its Production Day (defined as the day its production level reaches 30% of its capacity). As an alternative to *Pioneer Status*, a company may apply for Investment Tax Allowance *(ITA).* This entitles a company to an allowance of 60% on its qualifying capital expenditure (factory, plant, machinery or other equipment used for the approved project) incurred within five years from the date the first qualifying capital expenditure is incurred. The company can offset this allowance against 70% of its statutory income for each year of assessment. Any unutilised allowance can be carried forward to subsequent years until fully utilised. The remaining 30% of its statutory income will be taxed at the prevailing company tax rate.

MIDA should identify producers of frontier products with a view to targeting aforementioned assistance, while strategically limiting support to relatively less complex but mature products, especially in the E&E sector. MIDA should incentivise pioneers in a similar manner as is currently being done with the added requirement to have recipients play an active role in encouraging diffusion of non-proprietary knowledge. As such, the Investment Tax Allowance should be contingent on successful production of the target product by followers.

Other countries have in the past incentivised pioneers with the goal to facilitate diffusion. Appendix III(a) presents the case of Chile, which in 1985 implemented a simplified drawback system where in lieu of reimbursements for tariffs paid on imported inputs (drawbacks), exporters received a subsidy of up to 10 percent of their export value *as long as total exports of the sector did not exceed $ 7.5 million*[34]*.* Once this threshold was breached, export subsidies in the sector were automatically eliminated. A strength of Chile's simplified drawback intervention is that it did not require picking winners. Subsidies were assigned automatically to every exporting firm in a new sector, thus making the development of new or incipient sectors more attractive to pioneers and early followers. Those that experimented but failed would not receive support.

[34] IADB, (2014). Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation. Palgrave Macmillan. Kindle Edition

An ideal policy for Malaysia would be to directly incentivise diffusion of pioneers to support exports but under current WTO rules, export subsidies are illegal. Incentivising production by pioneers is more feasible as evinced by current practice. Incentives need not have an explicit export proviso but it might be expected that production incentives can lead to the export of the product, which is the ultimate goal if Malaysia is to cultivate revealed comparative advantage in the targeted products.

Strategy 1.2: Targeted Partnerships for Capability Transformation among Frontier SMEs

Opportunities

Another reason for scarcity of companies in the dense part of the product space cited by interviewees is the lack of support from established firms**.** It would seem a natural occurrence that large companies who export from Malaysia would be better served by purchasing from local suppliers. Indeed, there are examples of this happening organically in Malaysia.

In E&E, a number of local firms that do contract manufacturing for MNCs have been created by former engineers or other knowledge workers who started their careers at an MNC. This is the case of Globetronics, which was created in Penang 25 years ago by former Intel employees. The company started with Intel as its sole customer, a single-product line, and working with consigned equipment and material. Today, Globetronics has diversified its client base to a number of multinationals, it owns sophisticated equipment, has a workforce of 2,300 people out of which 15% are knowledge workers, and has developed assembling expertise in a number of high-technology products beyond integrated circuits, including temperature-compensated crystal oscillators, motion sensors, and special-purpose LED lighting solutions. Various government agencies (especially Penang's local development agency) played a key role in supporting Globetronics's establishment and first years of operation through the provision of investment incentives, licensing support, etc*(see Appendix III(b) for more on this*).

Such prior experience suggests that large impacts are likely to come from providing strong incentives to local spinoffs started by former MNCs employees*.* Various government agencies in Malaysia have been doing this with varying focus for some time now. MITI is building the Vendor Development Program (VDP) to assist the development of local SMEs. To attract more anchor companies, the government provides double tax deductions on operational expenditures. There is a need to target this assistance to frontier industries including the chemical sector, where it is important to recognize the strategic role of the firms that control the Hydrocarbons and Palm Oil sectors. Access to stable and reliable feedstock can give an important competitive edge to Malaysian petrochemical and oleo chemical companies, in particular of smaller (high-value) niche market segments.

Recommendations

By virtue of their mandate to promote investment and SME development respectively, MIDA and SME Corp should launch *Frontier Business Matching Sessions* to coordinate face-to-face interactions beyond mere online matching portals between large companies and small companies. This can leverage MIDA's Suppliers Conferences. An expanded mandate of existing linkage programs like the Vendor Development Program under MITI to include companies producing frontier products might also help improve linkages and populate the product space**.** A distinguishing feature of this recommendation is a Pay-for-Success model in which government resources are disbursed after mentee SME achieves significant growth in export capabilities or revenue streams.

Similar programs exist in countries like Singapore and Chile. Singapore's initiative is called Partnerships for Capability Transformation or PACTs[35]. Chile's development agency, Corporación de Fomento de la Producción (CORFO) set up a supplier development program aimed at solving the problems of SME capacity building. The program accepts proposals from anchor firms to help upgrade their SME suppliers. It partially covers the cost of a diagnosis carried out by an independent consultant that determines the needs for upgrading, and presents a plan. Then the program covers up to 50 percent of the costs of activities, including technology transfer, professional services, and technical advice, that help upgrade the group of participant SME suppliers. The sponsor firm must be large, with annual sales of at least $ 42 million, and must involve at least 20 supplier SMEs. The large firm is responsible for implementing the action plan and contributing counterpart funds. The program grew rapidly during its first decade to reach almost 7,000 firms per year in over 300 projects by the end of the 2000s (Dini, 2009)[36].

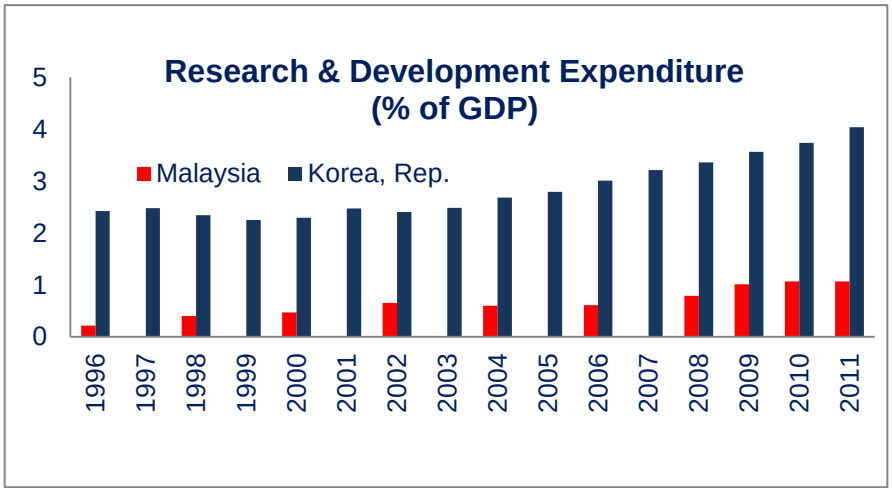
[35] http://www.spring.gov.sg/Industry/Pages/Partnerships-for-Capability-Transformation.aspx
[36] IADB, (2014). Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation. Palgrave Macmillan. Kindle Edition

Strategy 1.3: Foster Cluster-Driven Research and Development Within and Across Prioritised Sectors

Opportunities

R&D expenditure is relatively small in Malaysia (Figure 64). According to the 2010 Manufacturing Census, C&P is the least R&D intensive (defined as expenditure in R&D as a share of sales) of the three sectors studied and is even lower, on average, than manufacturing as a whole. Moreover, there exists little evidence of intra-industry collaboration in R&D with prevalence of in-house research, which limits discovery. For example, Malaysia only has one specialised research institute for the M&E sector compared to 17 in Germany.

Figure 64: R&D Expenditure in Malaysia and South Korea



Source: WDI Online

Recommendations

Malaysia has examples of successful intra industry collaborative efforts including CREST**.** It would be useful to create a task force including key stakeholders from Malaysia's C&P and M&E industries to assess the potential for collaborative research akin to CREST in those sectors. A coordinating body for this is needed and we recommend that government rearrange SIRIM such that it coordinates industry-led research, leveraging knowhow developed in CREST. For their part MITI and Ministry of Science, Technology and Innovation (MOSTI) should catalogue concentrations of industries and the utilisation of current collaborative R&D centers with a view to determine constraints and recommend greater usage thereof.

In order to facilitate the commercialization of frontier product related research, we urge a dedication of the MTDC grant for this purpose. MOSTI already places some of the sectors under consideration in the priority list for the ScienceFund, which is a grant provided by Government to carry out R&D projects that can contribute to the discovery of new ideas and the advancement of knowledge in applied sciences, focusing on high impact and innovative research[37]. According to MOSTI, the objectives of the ScienceFund are:

- to support research that can lead to the innovation of products or processes for further development and commercialisation; and/or
- to generate new scientific knowledge and strengthen national research capacity and capability.

Germany's unique "innovation cluster" concept, outlined in Appendix III(c), has created an environment in which actors in all industry sectors are able to flourish in close proximity with other industry actors and investors, academic institutions, and research centers. The Go-Cluster Germany Initiative of the Federal Ministry of Economics and Technology brings together the best-performing innovation clusters and networks in Germany and promotes cooperation with other international excellence clusters. As part of Europe's largest applied science research organisation, institutes belonging to the Fraunhofer-Gesellschaft are active in developing new technologies for industry and the public sector. Twenty thousand Fraunhofer employees develop cutting-edge technologies in over 80 research institutions spread across Germany. Of these, 17 Fraunhofer research institutes specialise in matters purely M&E related. The Fraunhofer Innovation Clusters are based on established networks of research institutions, investors and companies that lead to new business ideas and start-ups. Regional innovation clusters help close the gap between science and industry. Successful clusters stimulate competition while creating productive collaboration.

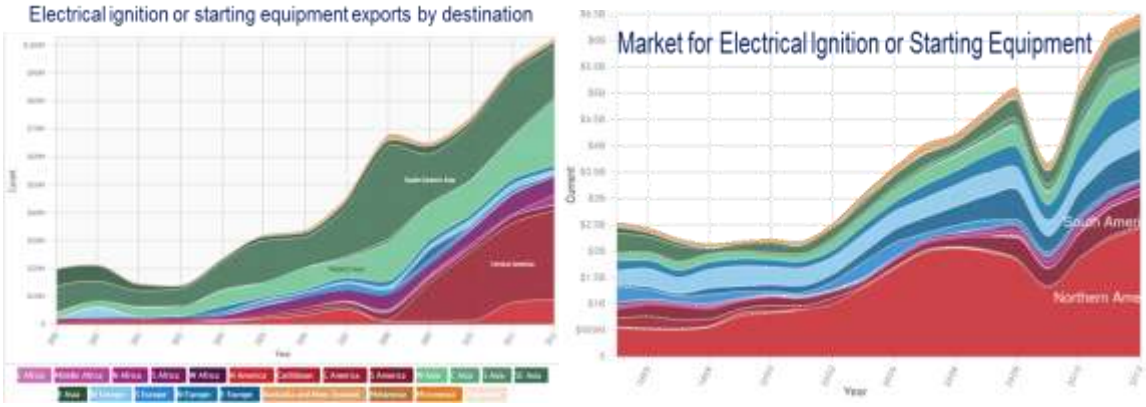
[37] http://ernd.mosti.gov.my/eScience/download/GUIDELINES%20-%20SCIENCEFUND.pdf

Strategy 1.4: Strategic Repositioning of Malaysia's Targeted Manufacturing Exports

Opportunities

Evidence shows limited penetration of advanced and more economically complex markets by exporters of strategic products. For example, Malaysia exports electrical ignition or starting equipment to Southeast-and Western Asia as well as Central America (Figure 65). Globally, Central America is relatively smaller in importance, both in terms of share and in terms of overall economic complexity. On the other hand, North America, which is relatively more complex, dominates the market but it constitutes an untapped destination for Malaysian exporters. The envisioned theory of change is that by exporting to more sophisticated consumers, producers avail themselves to higher standards, which will necessitate an upgrade in capabilities.

Figure 65: Penetrating Global Markets



Source: Observatory of Economic Complexity

Recommendations

MATRADE should assess current and future markets for frontier products. In the Chemical sector in particular, research suggests that it will be important to build credibility and reputation needed to access major international markets. To that end, MATRADE should identify which markets represent the most suitable match for each product, taking into consideration not just the level of demand for each product but also the degree of sophistication in the market. This effort can leverage existing government services, like MIDA's e-BizMatch[38] or the Business Information

[38]http://matriix.mida.gov.my/Promotion/exRegistration.do?userType=extUser&use=public&ctype=test1

Center (BIC) at MIDA, to promote export of frontier products as discussed in strategy 1.2. Other measures currently in place that can support this initiative include MATRADE's Market Development Grant[39], a scheme introduced to assist SMEs, service providers and trade & industry associations/chambers of commerce & professional bodies in undertaking export promotional activities. Companies can apply for a reimbursable grant on the eligible export promotional activities undertaken.

[39] http://www.matrade.gov.my/en/malaysian-exporters/services-for-exporters/exporters-development/new-exporters-development

Strategy 1.5: Encourage Membership in Institutions for Collaboration

Opportunities

Institutions for collaboration (IFCs), such as industry trade associations, can play an important role in supporting companies and coordinating for success. Yet interviews with industry players shows there is room for improvement in Malaysia's context. For example, due to low membership and lack of support from the M&E based companies, M&E interviewees stated that MEMA[40] lacks resources needed to provide support to the industry. Support includes market accessibility at home and abroad, cutting-edge technologies updates, human resources development, etc. Interviewees also report limited participation in other IFCs including the Federation of Malaysian Manufacturers (FMM) due to low perceived returns from membership.

Another concern relates to existing regulations which imposes conditions on the number of sub associations required for registration of an umbrella association. The formation of umbrella associations is an effective means of facilitating collaboration in an industry and leveraging resources to support industry aims. Chemical Industries Council of Malaysia (CICM) is the umbrella body representing the various sub-sector chemical groups (ranging from oleo chemicals, paints, fertilizers, petrochemicals, agriculture chemicals, industrial gases, coating resins and biodiesel sectors), created following a restructuring exercise in 2001 to establish a stronger and better representation of the Malaysian chemical industry.

Recommendations

One suggestion that kept coming up from both participants and government stakeholders is the need to consider regulations that require all registered manufacturers to be members of their respective trade associations. This is the case in countries like Germany and other European countries. A mandatory model might help address the vicious circle where low participation in domestic associations leads to a lack of resources among these organisations, which in turn causes limited expenditure by associations and subsequently unattractive benefits for potential members. We, however, caution that other measures should be tested before a

[40]The Machinery and Equipment Manufacturers Association of Malaysia (MEMA) was formed under the name Heavy Equipment and Machinery Manufacturers Association of Malaysia (HEMMAM) on 22nd June 1998 as a result of the Malaysian government desire to further promote and enhance the development of the Machinery and Equipment (M& E) industries in the Second Industrial Malaysia Plan (IMP2).

drastic legislative change like this is enacted. Korea is a case in point. Its Korea Machine Tool Manufacturers' Association (KOMMA) for example does not require mandatory participation and yet the country's M&E sector, as already discussed, has grown rapidly (Appendix III(e) for more).

In addressing poor participation we recommend that MIDA subsidise membership costs among producers of frontier products. Membership costs in CICM, for example, include an entrance fee of RM1, 000 and annual subscription of RM2, 700 for members with capital below RM10 million, and RM4000 for those with capital above that[41]. This can prevent participation and a shared cost model between participants and MIDA may alleviate this problem.

A co-financing scheme between trade associations and MIDA to promote programs related to frontier products including capacity-building workshops, industry journals and conferences needs to be considered. There is also a need to ease regulations on scaling up existing trade associations into umbrella associations to facilitate interrelated activities. Finally, Institutions for Collaboration (IFCs) should also comprise cross stakeholders not just the manufacturers but the whole cluster (universities, financiers, etc.) as is done by CICM through its associate members subscription model. Associate membership at CICM is opened to companies engaged in trading, consultancy, providing services to the chemical industry in Malaysia.

Mandatory participation should be considered only after the measures outlined here have failed to secure greater participation in Malaysia's trade associations.

[41] http://www.cicm.org.my/2014-04-03-17-07-27/2014-04-03-17-13-18

Strategy 2.1: Encourage Automation in Frontier Sectors to Increase Worker Productivity & Facilitate Strategic Jumps to More Complex Products

Opportunities

There is labor shortage due to the high demand for labor resulting from years of rapid economic growth and the continued reliance on, and hence the predominance of, labor-intensive industries. Some sectors appear to perform worse than others in labor productivity. According to the Manufacturing Census, labor productivity is lowest in M&E among the three sectors (Manufacturing Census, 2010). Scaling up is notoriously difficult because the capital costs of equipping a factory are often too high, or the payback period is too long.

Recommendations

The Ministry of Finance (MoF) should prioritise the frontier industries for automation capital allowance, in line with the Prime Minister's 2015 budget speech**.** To encourage such expenditure, we recommend complementing this measure with tax breaks for skilled operators. To expedite automation in frontier industries, MIDA should incentivise the import of capital equipment, while in the long run promoting robotics as an avenue to foster sustainability of the automation program**.**

To facilitate implementation, MIDA should create a System Integrator Program to facilitate diagnosis of production processes requiring automation among frontier manufacturers. The objective of this program is to centralise the determination of processes that can be automated. The System Integrators can apply for the automation allowance on behalf of the manufacturer using standard practices across industries. There is a need to prioritise frontier industries for the reasons discussed above.

Malaysia is not alone in considering automation as a way out of the problem of low labor productivity and wage pressures. Rising wages and an aging population have been propelling Chinese manufacturers to automate[42]. China, the biggest buyer of robots in 2013, is now encouraging domestic players to capture market share from established foreign brands (see Appendix III(f)). Government officials, worried that productivity growth may have turned negative since 2009, see the promotion of automation as a policy that will increase efficiency. Chinese manufacturers, struggling with increasing costs of labor, also favor more use of robots where

[42] Source: http://www.reuters.com/article/2014/10/28/china-robots-idUSL3N0RB2WX20141028

possible. In its five-year economic plan for 2011-2015, Beijing specifically targeted robotics as a key sector for development, hoping to create four or five domestic robotics "champion" firms to meet an annual production target of about 13,000 robots. China now has 420 robot companies, and more than 30 industrial parks devoted to robotics are either being built or are already functioning around the country. Local governments have adopted a variety of different stimulus tactics in robotics. For example, Dongguan, a manufacturing center in Guangdong, has been particularly aggressive, creating a 200 million yuan (US$33 million) investment fund to subsidise robotics investments by local firms.

Strategy 2.2: Fostering Industry-led Centers of Excellence

Opportunities

As shown in the case studies there appears to be a lack of skill and training intensity to ensure that firms entering new product areas have access to the inputs needed to upgrade production capabilities. Skill intensity in M&E (defined as the share of workers with diploma or above) is lowest among three sectors studied. Training intensity (defined as training spending over total sales) in M&E establishments is lowest among the three sectors and lower than manufacturing across all sectors in the economy. With regards to the skills gap in M&E in Penang, for example, there exists a shortage of mechanical engineers, mechanical design engineers, automation, instrumentation, machinery, precision engineering, tooling and machining (see page 83, Table 6 for the Penang Industrial Talent Requirement Study, 2012).

Recommendations

MIDA should survey producers of frontier products, industry associations and academic institutions to determine willingness and capacity to take part and invest in centers of excellence (CoEs) in frontier industries. Given that CoEs largely already exist it would be important to map their location and scope based on findings of MIDA's stakeholder engagement. The next step would be to allocate resources, where necessary, including to co-finance industry-led CoEs to support firms producing target products. Such centers would provide the space and facilities to aid the transfer of knowledge from academic institutions to industry, support commercial R&D, incubate new firms, and distribute public and private funds. The example below illustrates how such an organisation can be integral in spawning new ventures.

Appendix III(g) discusses the case of the Buffalo Center for Excellence in Bioinformatics & Life Sciences Technology. The center serves as a hub for high-tech research and development, connecting the resources of local academic institutions with private enterprises and offering companies state-of-the-art research facilities, expertise on business management as well as access to various sources of funding. Through the center, dozens of new companies have been launched, thousands of new jobs have been created or retained and millions of dollars have been attracted to the region. Empire Genomics is an example of the success the center has enjoyed. The molecular diagnostic company took advantage of the access to equipment and financing to build its business while receiving R&D, business development and

marketing support. The company has saved more than US$2 million through participating in the program, received US$1.3 million in private investment and captured more than US$3.2 million in new product revenues.

Strategy 2.3: Bridging the Existing Skills Gap in Targeted Sectors

Opportunities

Evidence shows a shortage of workforce ready graduates despite the prevalence of vocational training offered by both private and public centers, as shown in Figure 66.

Figure 66:Accredited Training Centers by State, 2012.

Source: Ministry of Human Resources, 2012

There is a lack of welding technology experts and structural integrity engineers in the electrical segment of the E&E sector due to limited training courses on welding, oxy-fuel cutting and engineering machinery, engineering sciences. It has already been shown that in the case of Penang, there is a 10-40% shortage of talent in the M&E industry including mechanical engineers and mechanical design engineers. This constrains the production of power tools as skilled human capital is required in automation, instrumentation and machinery; precision engineering, tooling and machining.

Accordingly, local firms are often denied the chance to participate in the MNCs' global supply chain. Dissemination of technological know-how from the MNCs to local vendors or suppliers is rare as most of the MNCs keep their product development activities at their headquarters. Take the case of power drill servicing works of a local M&E company already discussed in the previous chapter. The five most important components of the drills, namely motor (with armature as the heart of the motor), gear, switch, holder and casing are all sourced from manufacturing

plants abroad. The secret of manufacturing armature and gear are kept in the headquarters in Japan.

Likewise, for the chemical sector, global expansion into the bio-lubricant market would require chemists with skills in blending and formulation of the lubricants. But according to interviews with companies, this type of training is currently not offered in the curriculums of local universities.

Recommendations

The objective of this recommendation is to address the immediate skills gap identified in the various frontier industries. The Ministry of Education (MOE) should take the lead in inviting industry associations to help outline a skills framework for technical and vocational training related to frontier industries**.** This is to ensure that current and future offerings are shaped by industry demand.

To address the paucity of industry-ready graduates, it is important to learn from the example of Germany, the global leader in technical and vocational education. In the German model, trainees attend vocational school one or two days per week, studying the theory and practice of their occupation as well as economics and social studies, foreign languages, and other general subjects. They also do a working apprenticeship in their chosen field. During apprenticeships, trainees receive about one-third of the salary of a trained skilled worker for a successful transition to full-time employment. It also offers qualifications in a broad spectrum of professions and flexibly adapts to the changing needs of the labor market. A major strength of the German dual system is the high degree of engagement and ownership on the part of employers and other social partners (See more on the German model in Appendix III(h)).

To that end, it would be useful to expand the Human Resource Development Fund (HRDF)Apprenticeship Program[43] to include missing skills in frontier industries. These include abilities in sales and marketing, project management and testing and inspections, as well as sector specific abilities in formulation of lubricants, welding and blasting and painting. At present, the programs offered under this HRDF Apprenticeship Program include Mechatronics, Hotel Industry, Wood Based (Furniture), Plastics Injection Moulding, Tool & Die (Mould), Tool & Die (Press Tool), Industrial Sewing Machine Technician, Multimodal Transport Operator. There is very little overlap with the identified skills needs in this study.

[43] http://www.skillsmalaysia.gov.my/index.php/fund/human-resources-development-fund/

The Ministry of Human Resources (MOHR) in collaboration with MOE should also encourage the refinement of the TEVT curricula to encourage trainees to study adjacent fields to their key areas of focus as identified by anchor companies. The coordinating body for this would ideally be the Department of Skills Development (DSD) at MOHR through the implementing body, *SkillsMalaysia*[44].

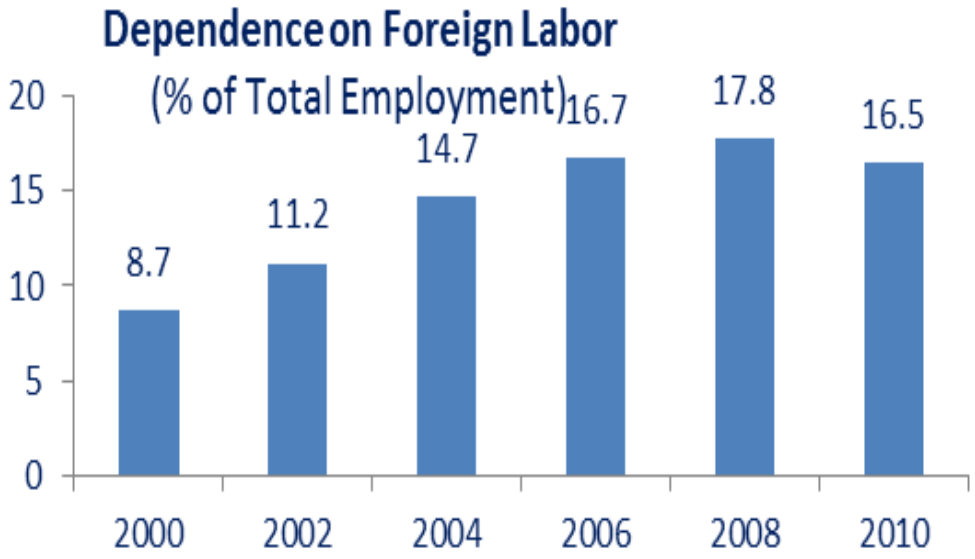
[44] The objective of *SkillsMalaysia* is to create awareness of the opportunities in skills training and job related to TEVT that can contribute towards developing a high-income nation and in making skills training the first choice for school leavers.

Strategy 2.4: Strategic Workforce Planning for an Increasingly Complex Economy

Opportunities

Human capital shortage and the prevalence of low training intensity by firms is a well-documented constraint to growth in Malaysia. The previous recommendations pertain to specific aspects of skills shortages and the need to improve labor productivity. According to the World Bank[45] (see Figure 67), the expressed demand by industry for skilled labor in Malaysia has not changed industry's continued reliance on cheap and unskilled labor about which little has been done to shift away from. There is, therefore, a need for a more centralised and coordinated effort to align workforce development with national development goals leveraging the work by the Cabinet Committee on Human Capital (CCHC).

Figure 67: Dependence on Foreign Labor



Source: World Bank, 2013

[45]http://wbgfiles.worldbank.org/documents/hdn/ed/saber/supporting_doc/CountryReports/WFD/SABER_WfD_Malaysia_CR_Final_2013.pdf

Recommendations

CCHC, MOHR and the Institute of Labor Market Information & Analytics (ILMIA) should be tasked with producing an annual State of the Workforce Report, which analyses Malaysia's skills gap and outlines recommendations with attention to frontier sectors. It would be important to rearrange ILMIA to not only be the source of market analytics but also a job clearing platform, matching workers with companies.

It would be advisable to learn from South Korea, whose experience is an example of an effective government-led model for WfD (WB, 2013). The highest levels of government leaders have consistently asserted WfD's importance as a means to provide an appropriately skilled workforce for advancing strategic economic development objectives. For instance, in the face of rapid economic change and ambitious economic development targets, Korea has, for most of the past several decades, relied on a centralised approach to governing the TEVT system. All training providers operating in the country must complete a rigorous accreditation process and depend to varying degrees on government subsidies to finance their operations. The government's insistence on detailed spending plans and adherence to a national curriculum have given it considerable influence over TEVT providers (Appendix III(i).

Strategy 2.5: Promote *Entrepreneurship-in-Residence* Programs to Facilitate Discovery

Opportunities

Findings from case study interviewees show concerns over lack of entrepreneurship, which in turn limits discovery of potential new engines of growth to propel the economy toward a new industrial transformation. Efforts already exist under the Malaysian Global Innovation and Creativity Center (MaGIC) to create Entrepreneurship-in-Residence (EIR) programs, which has been successful in Chile and in San Francisco. Entrepreneurship is particularly needed at the intersection of M&E and E&E where linkages present opportunities for discovery.

Recommendations

The first step would be to identify entrepreneurs from places that are key exporters of frontier products. The pre-selection of the business plans can be made by a company that specialises in assessing business plans (e.g. Younoodle[46] in California). This can be done through a focused EIR program coordinated by MaGIC. Relevant government-linked companies will host entrepreneurs either domestic or foreign and SME Corp. would provide comprehensive professional services to the EIR program participants including market intelligence reports, customer targeting support, export market access programs and integrate existing programs across ministries/administrations. This focused EIR program will also be supported by initiatives already discussed above including the Pioneer Incentive Scheme discussed under recommendation 1.1.

The San Francisco Entrepreneurship-in-Residence program is a voluntary, sixteen-week collaboration to bring together the private sector and City departments to explore innovative solutions to civic challenges that can lower costs, increase revenue, and enhance productivity. Launched in March 2012, the program attracted nearly 200 start-ups from 25 different cities and countries. Selected civic tech startups were paired with city departments to craft tech tools to improve services. Among these were smartphone apps, notification systems and advanced platforms to assist planning departments in predictive analysis. San Francisco's Department of Emergency Management was eager to highlight a new app created by the mass notification company regroup. Still in development, the app uses data from seismic

[46]YouNoodle is a San Francisco-based company, founded in 2010, building a platform for entrepreneurship competitions all over the world.
https://www.younoodle.com/

fault sensors that predict earthquakes in seconds and minutes, traditionally only available to governments, and could send immediate alerts to residents with safety tips before quakes hit as public warnings. Chile offers a country example of the EIR program in Appendix III(j).

Strategy 3.1: Coordinate Government Venture Financing To Targeted Frontier Products

Opportunities

Private equity is an ideal source of financing for private companies in the frontier industries in Malaysia. Private equity, inclusive of seed, venture capital (VC), growth and late-stage buyout financing, offers long term, patient capital to finance the growth of unlisted companies across a range of sectors. In addition to capital, private equity investors provide their portfolio with a wealth of knowledge, mentoring companies to create value in their investment.

For many SMEs, debt and public equity financing is almost impossible to obtain. For these companies, private equity is one of the few available sources of capital to fuel growth. As a type of risk capital, private equity financing matches the risk profile of the target industries identified in this study.

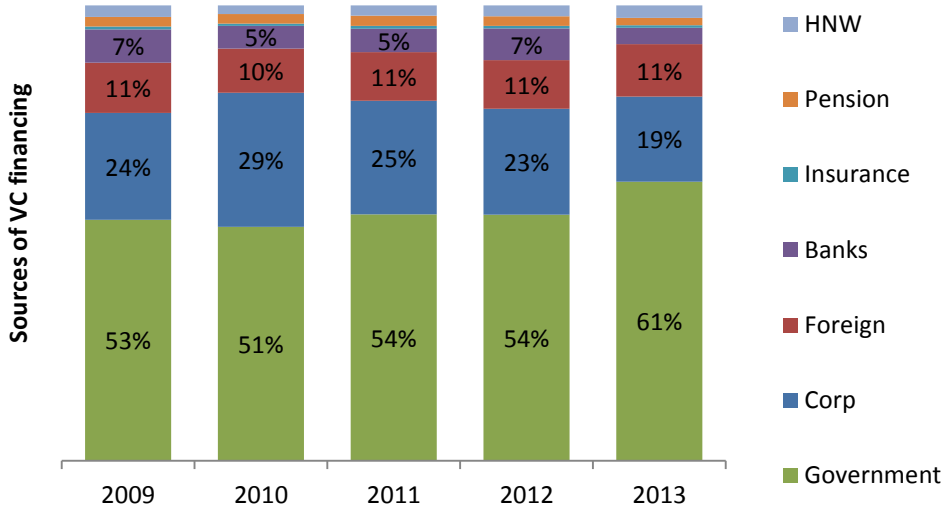
Financial constraints were found to be an important factor inhibiting growth in the E&E, M&E and C&P sectors. Chemical companies in particular were found to suffer from a lack of adequate financing due to the relative capital intensity in the sector. This lack of financing prevents many such businesses from reaching the scale needed to compete globally.

Government financing is a major source of capital for the Malaysian private equity industry, accounting for 61% of commitments to the asset class in 2013 as shown in Figure 68. To finance the development of the target industries, this important pool of capital must be coordinated and targeted to producers of target products.

Currently, difficulties arise in organising the government's policy towards venture firms because support to the industry is not performed from one specific department. Coordination is needed to ensure this important source of funds reaches frontier industries. As outlined in Appendix III(k), the Government of Canada tackled a similar problem in 2013, launching the Venture Capital Action Plan to coordinate government resources in the development of a domestic venture capital industry[47].

[47] http://actionplan.gc.ca/en/initiative/venture-capital-action-plan-0

Figure 68: Sources of VC Financing, 2009–2013



Source: MVCDC website

Recommendations

MIDA should designate a portion of the Domestic Investment Strategic Fund to invest in the 238 products selected and companies with related production capabilities. In addition, MIDA should identify target recipients of government funding to facilitate and coordinate assistance thereto. This will serve as an important signal to the managers of government funds and as a resource for investors to use when building a pipeline of investable companies in the target industries.

Next, MoF should expand the priority areas of government-linked venture financiers to include companies in the target sectors and with the capabilities designated by MIDA. An expanded mandate for Malaysia Debt Ventures, for example, will extend beyond ICT, Biotech, and Green Technology to include Machinery and Equipment etc.

Though these initiatives do not force fund managers to invest in target industries, the strong signaling effect they will have, combined with the attractiveness of target products and the cumulative effect of the recommendations outlined in this report on the growth of target industries, will strongly incentivise managers of government funds to act upon this new mandate.

Strategy 3.2: A VC-Industry-led Strategy to Increase the Supply of Investable Opportunities in the Frontier Sectors.

Opportunities

Since 2010, Malaysia has climbed steadily up the World Bank's Doing Business ranking (see Figure 69). This has, in part, been due to Malaysia's strong position in the ranking's 'getting credit' sub-index. During this time, however, the provision of private equity financing in Malaysia has not achieved commensurate growth.

Figure 69: Malaysia's Position in the World Bank, Doing Business Ranking

Source: Pemudah

During our engagement with stakeholders, we discovered that a lack of intermediation between private equity investors and potential portfolio companies has been a factor holding back growth in the private equity industry. Throughout our discussions, private companies attributed a lack of understanding of target industries and an unwillingness to assume the required levels of risk among private equity investors in Malaysia as the main cause of limited private equity investment in target industries.

Many private equity investors in Malaysia, on the other hand, cited a perceived lack of investible opportunities as preventing the industry from reaching its potential as a source of financing for strategic diversification. Investors cited the nascent state of companies' internal controls and the inability of firms to present compelling investment pitches as factors limiting their activity in target industries.

Furthermore, a lack of understanding of the private equity industry among entrepreneurs is likely an additional roadblock preventing the escalation of private investment in producers of the 238 products in Malaysia.

Recommendations

To help improve intermediation and catalyse private equity investment in frontier industries, MoF should sponsor a series of workshops organised by the Malaysia Venture Capital Association (MVCA) and focused on enabling manufacturers of the 238 products to access private capital markets. The workshops would consist of two distinct programs. The first would focus on helping companies in the target sectors improve their internal controls and pitch their business to investors. The second workshops would then advance investors' understanding of how to value businesses in the E&E, M&E, and C&P sectors. Both workshops would include presentations by accountancies, consultancies, established private enterprises in the target industries and private equity firms with experience in these sectors.

Similar workshops have been successful in other countries seeking to develop a domestic venture capital industry. Per Appendix III(l), in 1999 Brazil identified poor intermediation as a constraint affecting its venture capital industry. The government initiated a series of workshops with investors and SMEs in partnership with the Multilateral Investment Fund. These workshops laid the foundation for a series of initiatives that helped the early-stage industry raise US$2 billion and finance more than 56 companies between 2001 and 2011[48].

A unique feature of the proposed workshops would be a model whereby government funding is matched by private sector contributions and phased out after the second year of operations. Private sector contributions would come from firms interested in presenting their expertise during the workshops and advertising their services to potential clients.

[48]Lerner, J., Leamon, A. and Garcia-Robles, S. (n.d.). Best Practices in Creating a Venture Capital Ecosystem. Washington: Multilateral Investment Fund.

Strategy 3.3: Encourage Private Participation through a Fund of Funds Model

Opportunities

The Malaysian Government's efforts to build a domestic private equity industry have been very successful and government financing accounted for 61% of capital committed to the industry in 2013. To build upon this foundation, institutional sources of financing must be leveraged and increased as a percentage of total capital committed. Government policy that is designed to attract private investment is crucial to the development of a sustainable, globally competitive industry.

For many large institutional investors, limits on the minimum amount they can commit to a single fund and restrictions on the maximum percentage of a fund's capital for which they can account combine to prevent them from investing directly into all but the largest, most established private equity markets. Additionally, many institutional investors lack the personnel to source a pipeline of single-country funds, relying instead on regional vehicles.

Fund of funds are vehicles that raise capital to invest in private equity funds. Fund of funds often play an important role in the private equity industry, enabling large institutional investors to commit to a single, large vehicle while gaining access to many smaller funds and harder to reach markets. Fund of funds can also help build a network of fund manager for limited partners just beginning to invest in private equity.

Recommendations

To help attract international investors to Malaysia's private equity market, MoF should initiate a call for proposals from domestic and international fund managers interested in managing a fund of funds seeded with government capital. Funds should be screened based upon their investment track record and network of global limited partners.

A joint venture fund of funds should be established in partnership with, and under the management of, the fund manager selected from the call for proposals. The fund should be focused on commercial private equity vehicles that include the E&E, M&E and C&P sectors, both domestically and internationally, in their remit. The fund manager should take full responsibility for raising and managing the fund.

The government's contribution to the fund should be limited to a significant minority stake. As an anchor investor, the government should mandate a percentage

of the fund be invested in Malaysian vehicles. This would guarantee a portion of the capital committed remains in Malaysia, while still allowing for the international remit that is necessary to increase the scale of the fund.

Precedent for such an approach is outlined in Appendix III(m), which details the Mexican government's attempts to promote its domestic industries among international investors. In 2006, the Mexican government launched a series of fund of funds including a venture capital vehicle managed by an American fund manager. The venture capital fund was mandated to invest in Mexico and the region and was seeded with US$80 million from the government. The fund sought to match government financing with US$40 million from private investors. [49]

[49]Lerner, J., Leamon, A. and Garcia-Robles, S. (n.d.). Best Practices in Creating a Venture Capital Ecosystem. Washington: Multilateral Investment Fund.

Strategy 3.4: Expand the Mandate for Government VC/PE Funds to Include Target Sectors and Overseas Funds

Opportunities

The active role that private equity investors play in adding value to their portfolio companies can be an important source of capacity development and knowledge transfer for SMEs. With an equity stake in their portfolio, private equity investors are incentivised to increase the value of their investments, often doing so by taking an active managerial or consultative role and helping companies grow their business and expand internationally.

For private equity investors in Malaysia to mentor their portfolio, they must have substantial exposure to best practices in frontier industries and possess strong networks and track records overseas. Local government backed fund managers do not have the mandate to invest in target industries throughout Asia, which would expand their portfolio in the target sectors and create beneficial linkages between domestic and overseas portfolio companies.

Expanding their investment activity overseas also has the potential to introduce domestic fund managers to new pools of institutional capital, enabling them to increase the scale of their domestic lending in target sectors.

Recommendations

As a first step towards improving the ability of domestic investors to create value in their portfolio, MoF should assess the capacity of government-backed fund managers to expand their investment activities overseas.

Private equity requires a great deal of local knowledge and resources to identify and structure profitable investments. An effective way to enter a new market is to invest in a domestic fund and obtain co-investment rights to gain access to the investor's pipeline of potential deals. MoF's review of local fund managers' capacity to invest overseas should distinguish which markets fund managers can begin investing directly into and which would require investors first commit capital to local funds.

Subject to managers' ability, the mandate of fund managers such as MAVCAP and MDV should be increased to enable them to pursue investments in E&E, M&E and C&P focused funds or private businesses in Malaysia and regionally.

Limits should be placed on the percentage of a firm's assets under management that can be invested overseas and fund managers should be required to submit annual reports detailing how overseas investments have benefited domestic portfolio companies.

Strategy 3.5: Establish a Seed Fund for Start-ups to Encourage of SMEs in Targeted Sectors

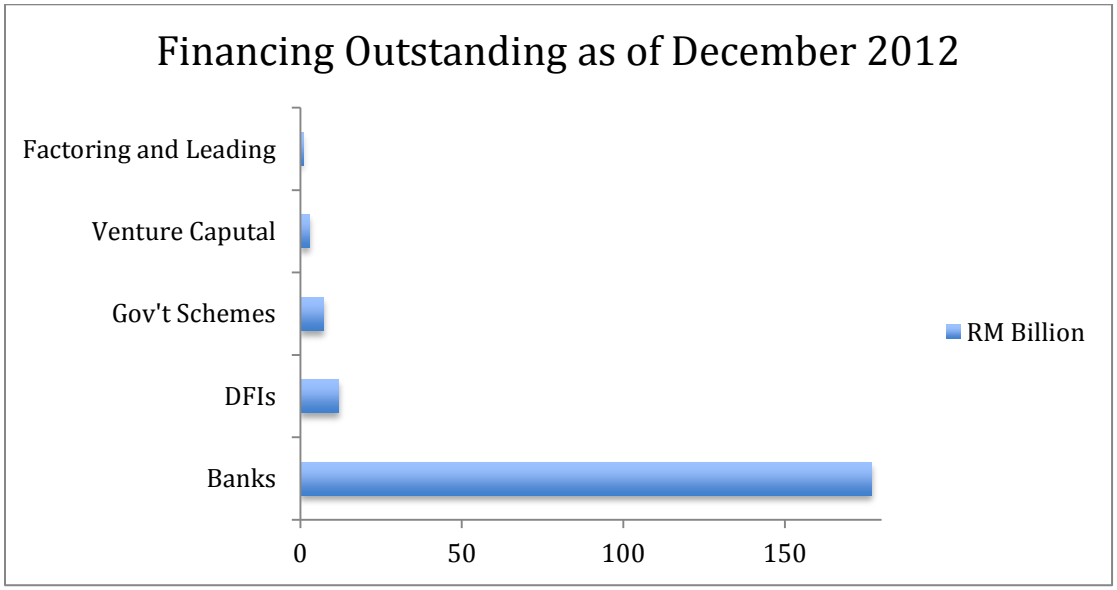
Opportunities

For early-stage companies that have exhausted their founders' personal savings and have outgrown government grants, financing can be costly and collateral requirements prohibitive.

Banks, the main source of SME financing in Malaysia (see Figure 70), are often too risk averse to finance a product that has no track record or invest in an industry in which they have limited experience.

Government policies that distort inputs can also cause a significant burden for startup businesses and must either be amended or compensated for by other sources of funding. According to our interviews, steel prices in Malaysia present an example of prices inflated by policies. In our conversations with stakeholders in the M&E industry, Malaysian government's policies [50] that protect domestic manufacturers of steel were cited as increasing the costs of steel inputs and placing a significant burden on early-stage M&E manufacturers.

Figure 70: Sourcing of Financing for SMEs in Malaysia



Source: National SME Development Council, *SME Annual Report 2012/2013*

[50] Ministry of International Trade and Industry. (2009, October 21). *Policy Review of Iron Steel Industry*. Retrieved fromhttp://www.miti.gov.my/cms/content.jsp?id=com.tms.cms.article.Article_75d3bb7c-c0a81573-3edb3edb-2330a1e4

Recommendations

Within the recommended Centers of Excellence for frontier products, SME Corp. should establish and manage a seed fund targeting early-stage producers of frontier products.

The seed fund should provide capital and facilities to early-stage companies. The strategic locations of these funds would help frontier businesses access relevant network resources and potential future investors. The vehicle should be structured as an evergreen fund, recycling the initial capital committed to the fund with each successful exit.

To avoid a dependence on seed financing, SME Corp. should facilitate investee companies' access to venture capital investors and seed financing should be phased out over a certain period of time.

To understand the potential costs and benefits of such a program it is useful to look at international comparisons. The Maryland state government in the United States of America has achieved success managing an evergreen venture capital fund that invests in startup businesses in the state (see Appendix III(o)). The fund, the Maryland Venture Fund, received an initial allocation from the Maryland State Legislature. The fund's capital resources have since been augmented by federal stimulus programs, state tax credit auctions and by the recycling funds from legacy investments. From its inception in 1994 to June 2013, the fund has invested a total of US$51.9 million in 114 ventures. This outlay by the government has had an important impact on the development of startups in the state while the success of the initiative's evergreen structure has made it a sustainable program. Exits in the portfolio have achieved total returns of US$67.8 million and the estimated value of the unexited portfolio companies stands at US$12.3 million[51]. All profits are channeled back into the fund's investment activities thereby increasing the potential impact of the initial government outlay while reducing the burden on state resources.

[51] Maryland Office of Equity Programs, *2013 Maryland Venture FundAnnual Report* Retrieved from http://business.maryland.gov/Documents/ProgramReport/MarylandVentureFundAnnualReport2013.pdf

Conclusion

This report presents a systematically constructed mapping of the frontier export opportunities for Malaysia and suggests policy priorities to promote the goals of strategic diversification and higher economic complexity. We have tried to convey the advantages of using the complexity lens when thinking about economic transformation strategies, as well as the limitation of this approach. The extent of economic benefit from adopting these recommendations should be weighed against the costs of adopting the aforementioned recommendations. It should be noted that many of the recommendations do not introduce new institutions but leverage existing capabilities (as the frontier industries do). We see cost savings from refocusing attention toward the identified sectors and withdrawing support from those sectors that are no longer adding to Malaysia's overall economic complexity.

As the GoM prepares to move from analysis to policy design, a fundamental fact should be kept in mind: economic diversification is intrinsically a risky endeavor. No individual investor, government official, or analyst is able to anticipate with certainty which investments will be successful in Malaysia. The way forward will involve trial and error. Our report aims to outline the opportunity space in a way that makes this learning process more directed and less costly but it does not eliminate the intrinsic risks.

In this context the single most important characteristic that Malaysia's economic transformation strategy is bound to have is flexibility. The commitment to support frontier activities *must* be matched with a similar predisposition to remove that support when activities do not prove successful. Taking risks is equally important as letting go. The implementation of this principle is not easy in most cases and explicit strategies, such as incentives with sunset provisions tied not only to specific dates but also to specific outcomes, need to be in place to achieve them. But it is a worthy challenge if what is at stake is achieving the vision of a knowledge-driven, diversified, and prosperous Malaysia.

Some Thoughts on Implementation

A solid vision with well-conceived strategies will not deliver results if they do not translate into effective policy design and implementation. While a detailed set of targets and execution plans are well beyond the scope of this report, we would like to suggest two criteria that we believe should be part of the implementation of a successful diversification strategy.

First, the GoM should seek to leverage their existing institutional set-up while upgrading some of the existing policy instruments and incentives. Malaysia has a remarkable institutional set-up already in place, including agencies specialised in promoting exports, investment, human capital development, general and industry specific research and development, etc. Moreover, the Performance Management Delivery Unit (PEMANDU) has developed valuable expertise in promoting public-private collaboration, moving from goals into concrete executable projects, and monitoring key performance indicators. An effective diversification strategy does not require the creation of new entities, but the refinement of the priorities and instruments that are currently in use, and an improvement of the coordination among the different government agencies**.** In this context some of the ideas that emerged during our research and are consistent with what we observe in both quantitative and anecdotal evidence include:

- Moving from standardised to customised incentives that prioritise the supply of "missing capabilities" required by firms in frontier sectors. For example, Singapore's development board has been very successful in establishing fluid communication with potential investors, which allows them to anticipate their human capital, infrastructure and other ecosystem requirements, and to invest in generating appropriate conditions and addressing an investor's specific needs ahead of time.

- Focalising the most attractive incentives on investments explicitly related to the policy goals of innovation, inter-industry linkages, and strategic diversification. This includes investment in higher-value activities and new products by already established firms, inter and intra industry collaborative initiatives, and general investment by firms in prioritised frontier products. The Malaysian experience shows that innovation grants and tax exemptions can be effective instruments in promoting such ventures if properly targeted. The existing schemes could be complemented with other policy mechanisms like special provisions encouraging the re-investment of profits, making R&D and frontier-products

investment tax-deductible or allowing R&D and frontier-products losses to be shared among related firms for accounting purposes.

- Enhancing the use of government procurement as a mechanism of support to new industries. The idea here is not to make the government the primary source of demand for these firms, but to play a role in demonstrating the quality of the products, which is critical to some new industries that depend largely on reputation such as some chemicals and medical devices.

Second, all diversification policies and implementation plans should have a clear geographical dimension. Industries tend to cluster for good reasons: a crucial condition for the emergence of inter-and-intra industry linkages is physical proximity. Incentives should incorporate clear geographical targets, evaluating how local conditions can provide a competitive edge to the industries that are considered strategic. This also implies that national and regional development planning should not be dissociated, and explicit efforts should be put in place to ensure the alignment of goals and strategies at different geographic levels.

Appendix I – Supplementary Tables for Chapter V

Current, Selected, and "Neither" Products in Machinery & Equipment and Precision Instruments

Table 12: Transportation Equipment

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
Motor vehicles and parts										
8714	Parts and accessories of motorcycles, bicycles or carriages	1	2.19	1.76	0.00	0.59	473.6	6%	16,592	6%
8709	Works trucks, self-propelled	1	1.30	2.41	0.00	0.59	20.7	21%	1,038	5%
8708	Parts and accessories of the motor vehicles	2	0.19	2.68	0.36	0.62	808.3	16%	279,322	6%
8703	Cars	2	0.02	2.20	0.35	0.65	243.6	0%	645,181	6%
8701	Tractors	2	0.03	2.51	0.37	0.67	21.3	14%	51,631	7%
8707	Vehicle Bodies	2	0.03	2.57	0.34	0.66	4.3	14%	10,143	8%
8702	Motor vehicles for the transport of > 10 persons	3	0.30	0.51	0.14	0.65	73.4	25%	15,961	6%
8716	Trailers and semi-trailers	3	0.15	1.62	0.16	0.62	49.7	3%	21,993	8%
8704	Motor vehicles for transporting goods	3	0.01	1.28	0.17	0.63	23.8	9%	126,383	6%

8712	Bicycles	3	0.08	0.58	0.09	0.67	8.6	1%	8,548	8%
8705	Special purpose motor vehicles	3	0.04	1.44	0.22	0.68	8.0	8%	13,997	8%
8706	Vehicle chassis fitted with engines	3	0.10	2.52	0.31	0.75	5.7	12%	3,598	2%
8711	Motorcycles	3	0.01	2.22	0.28	0.76	3.7	-7%	18,975	6%
8713	Carriages for disabled persons	3	0.05	2.28	0.30	0.74	0.8	7%	1,194	8%
8715	Baby carriages (inc strollers) and parts thereof	3	0.01	2.04	0.21	0.73	0.5	5%	2,142	7%
8710	Tanks and other armored fighting vehicles	3	0.01	1.01	0.16	0.65	0.2	2%	1,722	0%
Air and water transport vehicles										
8904	Tugs and pusher craft	1	3.52	-1.90	0.00	0.54	167.8	11%	3,261	12%
8803	Parts of goods of other aircraft	2	0.45	2.58	0.40	0.71	466.2	11%	67,911	6%
8802	Aircraft, spacecraft & launch vehicles	3	0.08	1.60	0.24	0.81	157.6	-8%	134,828	6%
8901	Cruise ships and similar vessels for the transport of persons	3	0.13	1.35	0.10	0.68	100.1	15%	53,640	4%
8905	Floating or submersible drilling platforms	3	0.19	-0.30	0.10	0.67	45.2	-12%	18,059	10%
8903	Yachts	3	0.28	1.91	0.23	0.68	40.2	13%	10,789	7%
8906	Other vessels,	3	0.32	1.36	0.15	0.72	21.2	36%	4,383	6%

	including warships and lifeboats other than row boats									
8805	Aircraft launching gear	3	0.21	2.56	0.28	0.75	4.7	26%	1,455	7%
8908	Vessels and other floating structures for scrapping	3	0.11	0.23	0.09	0.65	2.6	-3%	1,758	12%
8907	Other floating structures (for example, rafts, tanks, buoys and beacons)	3	0.05	0.84	0.13	0.66	0.6	-7%	876	6%
8801	Balloons & dirigibles, gliders etc	3	0.30	1.82	0.24	0.68	0.2	-3%	43	-2%
8804	Parachutes	3	0.01	1.02	0.18	0.63	0.1	-2%	251	6%
8902	Fishing vessels	3	0.00	-0.83	-0.04	0.69	-	0%	850	-1%
Railway equipment										
8609	Containers for carriage by one or more modes of transport	1	0.65	0.55	0.00	0.56	37.7	-4%	3,854	7%
8603	Self-propelled railway or tramway coaches, vans and trucks	2	0.07	2.39	0.39	0.72	7.5	35%	6,842	12%
8608	Railway or tramway track fixtures and fittings; safety equipment	2	0.44	1.76	0.25	0.65	5.6	19%	831	7%

8607	Parts of railway locomotives	2	0.02	2.21	0.31	0.66	3.3	3%	11,907	9%
8605	Railway passenger coaches	2	0.00	2.36	0.35	0.68	-	-100%	1,147	2%
8606	Railway freight cars, not self-propelled	3	0.00	1.25	0.14	0.70	0.3	30%	5,612	14%
8604	Railway or tramway maintenance or service vehicles	3	0.00	1.22	0.22	0.74	0.1	-25%	967	5%
8602	Other rail locomotives; locomotive tenders	3	0.00	0.45	0.11	0.73	0.0	-2%	1,930	4%
8601	Rail locomotives powered from electricity	3	0.00	1.37	0.23	0.73	-	-100%	1,076	4%

Table 13: Office Machinery

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8471	Automatic data processing machines	1	2.11	2.23	0.00	0.54	12,325.4	2%	392,811	6%
8473	Parts and accessories for office machines	1	5.35	2.48	0.00	0.51	8,147.4	2%	109,192	0%

8470	Calculating machines, cash registers	1	4.79	2.24	0.00	0.58	294.2	1%	4,487	1%
8472	Other office machines	1	1.14	2.77	0.00	0.60	93.1	5%	5,319	2%
8469	Typewriters other than printing machinery	1	12.71	1.47	0.00	0.58	12.3	10%	65	-13%

Table 14: General Purpose Machinery

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
Heating and cooling equipment										
8415	Air conditioners	1	2.20	2.66	0.00	0.57	1,252.3	4%	36,991	8%
8414	Air or vacuum pumps; ventilating or recycling hoods	1	0.57	2.80	0.00	0.55	601.9	9%	68,980	7%
8419	Machinery, plant or laboratory equipment involving a change of temperature such as heating, cooking, roasting	1	0.69	2.81	0.00	0.58	389.8	18%	37,032	6%
8416	Furnace burners for liquid fuel	1	1.17	2.98	0.00	0.58	44.8	17%	2,464	4%
8413	Pumps for liquids	2	0.12	2.89	0.40	0.65	116.1	13%	61,541	8%
8418	Refrigerators, freezers	3	0.45	1.38	0.09	0.58	256.8	8%	37,755	7%
8417	Industrial or laboratory furnaces and	3	0.23	1.81	0.16	0.61	18.7	6%	5,263	4%

	ovens, including incinerators									
Lifting, moving, & excavating machinery										
8431	Parts for use with hoists and excavation machinery	1	0.59	1.33	0.00	0.53	529.6	14%	59,034	8%
8426	Ships' derricks; cranes	1	0.63	1.11	0.00	0.55	142.1	16%	14,773	8%
8428	Other lifting, handling, loading or unloading machinery (for example, elevators, escalators, conveyors, teleferics)	2	0.36	2.59	0.32	0.61	137.5	5%	24,805	6%
8430	Other moving, excavating, extracting or boring machinery for earth, minerals or ores; pile-drivers; snowplows and snowblowers	2	0.37	1.25	0.27	0.67	93.6	16%	16,563	11%
8424	Mechanical appliances for dispersing liquids or powders; fire extinguishers; spray guns; steam or sand blasting machines	2	0.32	2.85	0.38	0.63	82.9	12%	16,713	7%
8429	Self-propelled bulldozers, excavators and road rollers	2	0.07	1.88	0.37	0.71	59.0	2%	55,437	9%
8425	Pulley tackle and hoists; winches and capstans; jacks	2	0.22	3.10	0.45	0.66	23.3	14%	7,125	8%
8427	Fork-lift trucks	2	0.05	3.44	0.49	0.72	12.6	8%	15,031	7%
Engines										
8412	Other engines and motors	2	0.50	2.32	0.27	0.61	143.5	29%	18,874	11%
8409	Parts suitable for use with spark-ignition engines	2	0.08	2.56	0.31	0.61	83.9	9%	66,539	7%
8407	Spark-ignition reciprocating or rotary internal combustion piston engines	2	0.08	2.85	0.39	0.66	52.2	-2%	42,816	4%
8408	Compression-ignition internal	2	0.04	3.27	0.47	0.66	27.4	14%	49,657	9%

	combustion piston engines									
8402	Steam or other vapor generating boilers	1	0.87	1.85	0.00	0.57	79.5	15%	5,927	6%
Boilers and turbines										
8411	Turbojets, turbo propellers and other gas turbines	2	0.13	2.46	0.40	0.68	193.1	7%	99,528	7%
8406	Steam turbines and other vapor turbines	2	0.26	2.87	0.43	0.66	29.0	6%	7,134	6%
8403	Central heating boilers	2	0.08	2.28	0.29	0.64	8.8	5%	6,926	8%
8405	Producer gas or water gas generators	2	0.50	2.29	0.30	0.64	7.7	2%	1,002	3%
8404	Auxiliary plant for use with boilers; condensers for steam or other vapor power units	2	0.22	2.43	0.25	0.60	7.2	5%	2,092	5%
8410	Hydraulic turbines, water wheels	3	0.12	1.32	0.15	0.66	2.9	23%	1,599	6%
Machine tools										
8462	Machine tools for working metal by forging; machine tools for working metal by bending, folding, straightening or flattening	1	0.70	2.48	0.00	0.60	113.8	10%	10,937	4%
8467	Tools for hand working, pneumatic, hydraulic motors	2	0.29	3.21	0.48	0.67	35.0	17%	8,533	6%
8465	Machine tools for working wood	2	0.28	2.56	0.34	0.68	25.8	4%	6,420	2%
8459	Machine tools for drilling, boring or milling by removing metal	2	0.20	1.77	0.25	0.64	14.2	8%	5,011	4%
8460	Machine tools for finishing metal or cermets	2	0.13	3.25	0.42	0.69	10.1	7%	5,450	5%
8461	Machine tools for planing, shaping, slotting, gear cutting, or sawing	2	0.21	3.33	0.42	0.72	8.9	4%	2,920	5%
8463	Other machine tools for working metal or cermets, without removal	2	0.24	2.56	0.37	0.69	7.4	2%	2,136	3%

8464	Machine tools for working stone	2	0.15	2.29	0.31	0.66	5.6	6%	2,540	2%
Other										
8479	Machines and mechanical appliances having individual functions nes	1	1.04	3.33	0.00	0.60	1,194.4	12%	76,174	5%
8482	Ball or roller bearings	1	0.81	2.91	0.00	0.57	393.2	9%	32,115	6%
8481	Appliances for thermostatically controlled valves	2	0.32	3.02	0.38	0.63	394.3	18%	82,074	9%
8483	Transmission shafts	2	0.13	3.10	0.44	0.65	99.7	9%	49,979	8%
8485	Ships or boats propellers and blades	2	0.28	2.59	0.36	0.62	34.6	7%	8,305	6%
8484	Gaskets and similar joints of metal sheeting	2	0.52	3.06	0.44	0.64	28.6	8%	3,719	6%

Table 15: Specific Purpose Machinery

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
Washing and pressing machinery										
8423	Weighing machinery	1	0.90	2.79	0.00	0.58	51.9	20%	3,827	5%
8421	Centrifuges	2	0.48	2.33	0.28	0.60	388.8	13%	53,001	9%
8422	Dishwashing machines; machinery for cleaning or drying containers; machinery for filling, closing, sealing or labeling	2	0.24	2.56	0.34	0.66	95.5	15%	26,126	5%

	containers									
8420	Calendering or other rolling machines	2	0.32	2.61	0.39	0.67	6.0	7%	1,299	3%
8443	Printers and copying machines	1	2.29	3.37	0.00	0.61	2,306.1	38%	67,752	12%
8442	Machinery for making printing components	1	0.83	3.15	0.00	0.62	30.7	17%	2,436	2%
8439	Machinery for making pulp of cellulosic material or for making paper	2	0.13	1.99	0.35	0.72	10.1	4%	5,166	1%
8441	Other machinery for making paper pulp, paper or paperboard	2	0.11	3.13	0.45	0.65	8.5	2%	5,399	2%
8440	Bookbinding machinery	2	0.10	2.42	0.35	0.68	1.9	3%	1,265	1%
8480	Molding boxes for metal foundry	1	0.71	2.78	0.00	0.60	167.0	6%	15,889	5%
Metal working machinery										
8468	Machinery and apparatus for soldering, brazing or welding, whether or not capable of cutting	1	0.69	2.65	0.00	0.57	12.0	5%	1,169	4%
8466	Parts and accessories for metal working machines	2	0.28	2.99	0.41	0.64	71.1	11%	17,567	5%
8456	Machines for the removal of material by laser or other optic means	2	0.20	2.99	0.43	0.68	27.8	5%	9,722	7%
8457	Machining centers for working metal	2	0.09	3.77	0.40	0.72	17.5	12%	13,682	8%

8454	Converters, ladles and casting machines used in metallurgy	2	0.10	2.24	0.30	0.67	5.0	0%	3,262	4%
8458	Lathes for removing metal	2	0.04	3.12	0.42	0.72	4.6	2%	8,110	6%
8455	Metal-rolling mills	2	0.05	2.07	0.30	0.67	4.6	8%	6,512	3%
Agricultural machinery										
8436	Other agricultural, horticultural, forestry equipment; poultry incubators and brooders	1	1.14	2.31	0.00	0.59	117.6	31%	6,671	9%
8435	Presses, crushers used in the manufacture of wine, cider, fruit juices	1	1.02	1.04	0.00	0.61	5.3	12%	340	2%
8433	Harvesting or agricultural machinery	2	0.02	2.47	0.33	0.65	6.8	4%	19,616	7%
8434	Milking and dairy machines	2	0.09	2.08	0.25	0.65	2.8	13%	2,011	5%
8438	Machinery, not specified for the industrial preparation or manufacture of food or drink	3	0.16	1.34	0.18	0.64	29.1	5%	12,152	5%
8437	Machines for cleaning, sorting or grading seed; machinery used in the milling industry or for the working of cereals or dried leguminous vegetables	3	0.42	0.96	0.11	0.65	15.2	11%	2,331	6%
8432	Agricultural, forestry machinery for soil preparation	3	0.06	1.42	0.15	0.63	7.2	10%	7,638	8%

Machinery for working specific materials										
8474	Machinery for working earth, stone, and other mineral substances	1	0.61	1.12	0.00	0.58	181.3	14%	19,405	7%
8475	Machines for assembling electric lamps	1	1.61	3.44	0.00	0.62	59.9	19%	2,553	2%
8478	Machinery for preparing or making up tobacco	1	1.54	1.76	0.00	0.60	34.2	22%	1,433	0%
8477	Machinery for working rubber or plastics	2	0.42	3.33	0.46	0.69	150.3	7%	24,214	4%
8476	Automatic goods-vending machines	2	0.15	2.22	0.32	0.66	3.8	16%	1,785	4%
Machinery used for textiles										
8444	Machines to extrude, cut manmade textile fibres	1	2.88	3.72	0.00	0.60	39.9	32%	895	-1%
8448	Auxiliary machinery for use with knitting and textile machines	2	0.39	2.79	0.40	0.69	26.6	10%	4,560	0%
8452	Sewing machines	2	0.33	1.76	0.29	0.68	20.1	6%	4,509	1%
8450	laundry-type washing machines	2	0.06	2.01	0.25	0.65	13.4	-1%	14,073	7%
8451	Machinery for washing, cleaning or drying fabrics	2	0.10	2.36	0.32	0.66	10.2	1%	6,560	3%
8445	Machines for preparing textile fibers	2	0.11	2.46	0.35	0.76	5.5	2%	3,259	-2%
8447	Knitting machines	2	0.05	1.65	0.31	0.73	1.8	-6%	2,756	-1%
8449	Machinery to manufacture or finish felt or nonwovens	2	0.05	3.11	0.45	0.71	0.7	-4%	820	7%
8446	Looms	2	0.00	2.48	0.35	0.74	0.1	-12%	1,965	-1%

8453	Machinery for preparing, tanning or working hides, skins or leather	3	0.08	1.45	0.23	0.69	0.9	1%	786	-1%
8401	Nuclear reactors and related equipment	3	0.01	2.13	0.25	0.78	0.6	9%	4,843	5%

Table 16: Precision Instruments

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
Medical and scientific appliances										
9018	Medical, surgical, dental or vet instruments	1	0.66	2.34	0.00	0.56	907.4	12%	89,300	9%
9011	Compound optical microscopes	1	1.71	3.27	0.00	0.57	132.9	28%	6,244	14%
9021	Orthopedic appliances, including crutches; splints and other fracture appliances; artificial parts of the body; hearing aids	2	0.41	2.24	0.37	0.76	276.0	21%	45,151	13%
9022	Apparatus based on the use of X-rays or of alpha, beta or gamma radiations	2	0.45	3.58	0.53	0.71	150.4	27%	21,504	8%
9019	Mechano-therapy appliances	2	0.40	2.84	0.39	0.67	51.2	13%	8,483	10%

9012	Microscopes other than optical microscopes	2	0.38	3.60	0.41	0.70	12.9	11%	2,207	9%
9020	Other breathing appliances and gas masks	2	0.24	2.38	0.32	0.70	4.1	1%	1,126	6%
9013	Liquid crystal devices	3	0.12	3.80	0.18	0.67	83.9	7%	45,567	16%
Surveying, measuring, and testing devices										
9030	Oscilloscopes, spectrum analyzers and other instruments and apparatus for measuring or checking electrical quantities	1	8.63	3.23	0.00	0.58	2,771.6	32%	21,797	5%
9032	Automatic regulating or controlling instruments and apparatus	1	1.25	2.87	0.00	0.55	628.7	12%	33,014	7%
9031	Measuring or checking instruments, appliances and machines	1	1.26	2.76	0.00	0.57	624.8	20%	33,734	7%
9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases	1	1.34	3.22	0.00	0.62	378.2	24%	18,612	9%
9015	Surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances	1	1.46	-0.06	0.00	0.57	204.0	33%	9,409	8%
9014	Direction finding compasses	1	0.94	2.18	0.00	0.61	105.8	14%	7,458	4%
9028	Gas, liquid or electricity	1	0.97	1.53	0.00	0.58	90.1	16%	6,123	9%

	supply or production meters									
9029	Revolution counters; speedometers and tachometers	1	0.69	2.81	0.00	0.58	69.7	11%	6,766	8%
9033	Parts and accessories for machines, appliances, instruments or apparatus	1	0.79	1.87	0.00	0.54	30.9	10%	2,646	6%
9024	Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of materials	1	0.65	2.87	0.00	0.62	21.7	-6%	2,206	4%
9027	Instruments and apparatus for physical or chemical analysis	2	0.44	2.86	0.41	0.70	219.4	26%	34,559	9%
9025	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers	2	0.43	2.58	0.39	0.66	27.6	-6%	4,319	7%
9017	Drafting tables and machines	2	0.43	3.24	0.46	0.70	14.7	9%	2,273	3%
9023	Instruments, apparatus and models, designed for demonstrational purposes	2	0.33	2.36	0.30	0.63	13.4	8%	2,648	7%
9016	Balances of a sensitivity of 50 milligram or better	3	0.20	2.54	0.26	0.69	1.0	2%	305	2%
Optical										

9001	Optical fibers	1	1.04	2.66	0.00	0.56	414.2	14%	28,346	12%
9002	Lenses, prisms, mirrors and other optical elements	1	1.60	2.61	0.00	0.53	285.4	20%	12,382	11%
9004	Spectacles, goggles, corrective, protective	2	0.44	2.94	0.40	0.73	49.8	20%	7,923	9%
9003	Frames and mountings for spectacles, goggles or the like	2	0.07	3.05	0.43	0.69	5.4	1%	4,855	4%
9005	Binoculars, monoculars, other optical telescopes, and mountings	2	0.22	2.75	0.37	0.67	4.2	-2%	1,259	3%
Watches and clocks										
9114	Other clock or watch parts	1	6.99	2.62	0.00	0.45	200.5	5%	2,151	2%
9108	Watch movements, complete and assembled	1	1.34	3.19	0.00	0.46	40.3	3%	2,889	4%
9111	Watch cases and parts	1	1.88	2.71	0.00	0.51	31.4	12%	1,292	4%
9109	Clock movements, complete and assembled	1	6.37	2.19	0.00	0.58	7.1	15%	79	-5%
9106	Time of day recording apparatus and apparatus for measuring	2	0.29	2.44	0.35	0.67	1.6	-7%	370	2%
9104	Instrument panel clocks and clocks of a similar type for vehicles, aircraft, spacecraft or vessels	2	0.35	1.50	0.30	0.71	0.7	-11%	132	1%
9102	Wrist watches and pocket watches	3	0.06	2.25	0.25	0.77	21.8	-13%	23,517	6%
9101	Wrist watches and pocket watches in cases of precious	3	0.08	1.18	0.28	0.76	14.0	0%	12,958	10%

	metal									
9110	Complete watch or clock movements	3	0.49	2.49	0.16	0.61	2.4	-10%	341	-3%
9105	Other clocks	3	0.09	2.44	0.24	0.77	2.0	-14%	1,498	1%
9113	Watch straps	3	0.08	1.07	0.16	0.70	1.8	-5%	1,630	4%
9107	Time switches with clock or watch movement	3	0.03	2.10	0.27	0.71	0.2	-15%	537	-1%
9103	Clocks with watch movements	3	0.14	2.14	0.28	0.76	0.2	-5%	109	-2%
9112	Clock cases	3	0.18	2.05	0.26	0.76	0.1	-9%	22	-4%
Photographic and imagining devices										
9006	Photographic cameras	1	3.29	2.12	0.00	0.56	154.3	-7%	3,341	-6%
9007	Cinematographic cameras and projectors	1	2.45	0.57	0.00	0.58	36.1	11%	1,000	5%
9008	Image projectors, other than cinematographic; photographic enlargers and reducers	1	2.76	3.33	0.00	0.60	10.1	11%	276	-6%
9009	Electrostatic photo-copyers	1	1.64	1.51	0.00	0.49	1.1	-24%	60	-31%
9010	Equipment for photographic laboratories	2	0.08	4.24	0.42	0.74	27.1	6%	23,127	11%
Musical instruments										
9207	Musical instruments amplified electrically	1	0.56	2.95	0.00	0.61	19.1	-6%	2,211	4%
9201	Pianos	1	0.71	2.59	0.00	0.46	8.9	3%	806	3%
9205	Wind musical instruments	1	0.70	2.86	0.00	0.60	8.2	32%	812	6%
9209	Parts and accessories of musical instruments	2	0.08	3.09	0.48	0.69	1.6	-10%	1,399	4%
9202	Other string musical	3	0.19	2.23	0.27	0.73	2.7	17%	927	6%

	instruments (for example, guitars, violins, harps)									
9206	Percussion musical instruments	3	0.25	-0.80	0.11	0.66	1.8	0%	494	5%
9208	Music boxes, fairground organs, mechanical street organs and other musical instruments	3	0.14	0.92	0.21	0.71	0.2	-14%	97	-3%
9203	Harmoniums, pipe organs, etc	3	0.00	3.78	0.32	0.83	-	-100%	0	-38%
9204	Accordions and similar instruments	3	0.00	3.02	0.20	0.91	-	-100%	0	-47%

Current, Selected, and "Neither" Products in Chemicals & Plastics

Table 17: Plastics and Articles Thereof

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3923	Packing of goods	1	1.63	0.23	0.00	0.54	1,038.0	9%	41,835	8%
3901	Polymers of ethylene, in primary forms	1	0.91	1.15	0.00	0.53	937.5	13%	69,723	10%
3920	Other not reinforced	1	1.15	1.56	0.00	0.54	891.5	13%	52,393	7%

	plastic plates, sheets, film, foil and strip									
3907	Polyacetals	1	1.16	2.03	0.00	0.60	865.1	13%	53,703	8%
3903	Polymers of styrene, in primary forms	1	2.69	2.36	0.00	0.58	778.3	9%	24,376	6%
3926	Other articles of plastic	1	0.73	2.45	0.00	0.56	672.6	8%	61,748	7%
3902	Polymers of propylene or of other olefins, in primary forms	1	0.76	0.87	0.00	0.55	453.2	18%	41,671	10%
3915	Plastic waste, parings and scrap	1	2.39	-0.33	0.00	0.54	253.5	22%	7,856	16%
3921	Other plastic plates, sheets, film, foil and strip	1	0.55	1.56	0.00	0.53	182.0	12%	22,053	7%
3919	Self-adhesive plates, sheets, film, foil, tape	1	0.56	3.10	0.00	0.62	146.0	14%	18,176	9%
3908	Polyamides in primary forms	1	0.60	2.83	0.00	0.61	122.3	29%	14,602	8%
3906	Acrylic polymers in primary forms	1	0.57	3.00	0.00	0.63	122.0	20%	14,896	8%
3909	Amino-resins, phenolic resins and polyurethanes, in primary forms	1	0.55	2.73	0.00	0.58	110.7	13%	13,607	8%
3905	Other vinyl polymers in primary forms	1	0.67	2.10	0.00	0.64	44.4	12%	4,660	6%
3904	Polymers of vinyl chloride or of other halogenated olefins, in	2	0.40	2.17	0.30	0.63	109.9	16%	18,669	6%

	primary forms									
3911	Petroleum resins, coumarone-indene resins, polyterpenes, polysulfides, polysulfones	2	0.28	2.90	0.50	0.74	24.9	11%	5,821	7%
3910	Silicones in primary forms	2	0.19	3.67	0.43	0.70	19.3	15%	6,701	7%
3918	Floor coverings of plastics	2	0.26	2.48	0.35	0.66	18.5	8%	4,611	6%
3912	Cellulose not elsewhere specified	2	0.05	2.88	0.42	0.68	4.5	12%	5,673	6%
3913	Natural polymers	2	0.09	2.78	0.45	0.71	3.1	12%	2,145	7%
3914	Ion-exchangers based on natural and ethylene polymers	2	0.02	2.74	0.41	0.72	0.4	0%	1,274	5%
3917	Tubes, pipes and hoses and fittings	3	0.49	1.10	0.06	0.60	154.3	13%	20,727	8%
3924	Plastic tableware, kitchenware or other household products	3	0.50	0.05	-0.01	0.60	93.8	6%	12,522	7%
3925	Plastic builders' ware	3	0.42	1.41	0.07	0.59	55.3	11%	8,559	7%
3916	Monofilament	3	0.26	1.61	0.19	0.63	18.6	10%	4,736	7%
3922	Baths, shower baths, sinks, washbasins, bidets, lavatory pans, seats and covers	3	0.34	1.76	0.18	0.62	18.4	8%	3,444	7%

Table 18: Pharmaceutical Products

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3004	Medicaments, packaged	2	0.04	2.12	0.25	0.66	187.1	10%	330,843	13%
3006	Pharmaceutical goods	2	0.04	2.34	0.35	0.70	7.6	-1%	12,552	9%
3005	Wadding, gauze and bandages	2	0.07	2.04	0.28	0.65	7.5	0%	6,618	7%
3002	Human or animal blood prepared for therapeutic uses	2	0.00	2.55	0.43	0.75	5.8	8%	97,021	18%
3001	Glands and other organs	2	0.00	2.08	0.37	0.75	0.1	-16%	5,012	13%
3003	Medicaments, not packaged	3	0.06	1.26	0.18	0.66	9.1	0%	10,396	7%

Table 19: Organic Chemicals

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
2905	Acyclic alcohols	1	2.50	0.01	0.00	0.54	1,221.2	16%	35,203	10%
2915	Saturated acyclic monocarboxylic acids	1	4.08	1.92	0.00	0.62	754.1	14%	12,840	6%
2902	Cyclic hydrocarbons	1	0.90	1.51	0.00	0.54	678.5	27%	52,787	12%
2901	Acyclic hydrocarbons	1	0.93	1.38	0.00	0.55	410.7	15%	29,991	12%
2916	Unsaturated acyclic monocarboxylic acids	1	2.31	2.56	0.00	0.61	349.0	36%	10,453	6%
2917	Polycarboxylic acids	1	0.87	2.16	0.00	0.61	246.0	9%	20,675	9%
2909	Ethers	1	0.74	1.41	0.00	0.62	177.3	2%	16,063	9%
2903	Halogenated derivatives of hydrocarbons	1	0.92	3.12	0.00	0.61	130.9	24%	9,422	4%
2932	Heterocyclic compounds with oxygen hetero-atom(s) only	1	1.12	2.10	0.00	0.62	115.1	62%	7,497	4%
2938	Glycosides	1	4.05	0.72	0.00	0.63	54.6	87%	955	7%
2911	Acetals and hemiacetals	1	0.96	2.10	0.00	0.62	1.2	4%	84	4%
2922	Oxygen-function amino-compounds	2	0.48	2.24	0.28	0.66	96.3	16%	20,333	8%
2924	Carboxyamide-function compounds	2	0.21	2.22	0.32	0.71	24.9	15%	7,665	4%
2941	Antibiotics	2	0.08	2.65	0.35	0.67	16.9	5%	13,719	4%

2931	Other organo-inorganic compounds	2	0.17	2.59	0.34	0.77	16.2	2%	6,056	6%
2929	Compounds with other nitrogen function	2	0.15	2.79	0.41	0.74	13.3	27%	5,929	5%
2937	Hormones	2	0.07	2.84	0.43	0.77	12.0	20%	11,962	10%
2907	Phenols; phenol-alcohols	2	0.10	2.87	0.39	0.74	10.2	1%	8,011	8%
2933	Heterocyclic compounds with nitrogen hetero-atom(s) only	2	0.01	2.36	0.36	0.74	8.5	11%	75,454	10%
2930	Organo-sulfur compounds	2	0.05	3.00	0.42	0.72	5.9	13%	8,884	7%
2942	Other organic compounds	2	0.33	1.55	0.24	0.65	5.6	23%	1,163	7%
2934	Nucleic acids and their salts	2	0.02	2.75	0.37	0.72	5.1	25%	22,222	7%
2914	Ketones and quinones	2	0.04	2.55	0.37	0.72	4.1	8%	6,727	6%
2912	Aldehydes	2	0.10	2.06	0.35	0.68	3.0	11%	2,071	4%
2921	Amine-function compounds	2	0.02	2.28	0.37	0.67	2.9	10%	11,068	6%
2926	Nitrile-function compounds	2	0.03	2.63	0.35	0.76	2.8	13%	6,735	7%
2923	Quaternary ammonium salts and hydroxides	2	0.08	2.54	0.35	0.70	2.6	7%	2,064	8%
2910	Epoxides	2	0.03	2.91	0.39	0.74	2.2	11%	4,838	8%
2925	Carboxyimide-function compounds	2	0.03	2.90	0.40	0.69	0.5	17%	1,288	5%
2920	Esters of other inorganic acids of nonmetals	2	0.02	3.00	0.43	0.70	0.5	-5%	1,593	5%
2935	Sulfonamides	2	0.01	2.84	0.38	0.76	0.3	-2%	6,287	8%

2919	Phosphoric esters and their salts	2	0.01	2.42	0.38	0.75	0.2	-1%	856	6%
2940	Sugars, chemically pure, other than sucrose, lactose, maltose, glucose and fructose	2	0.01	2.17	0.30	0.67	0.2	-11%	937	9%
2908	Halogenated, sulfonated, nitrated or nitrosated derivatives of phenols or phenol-alcohols	2	0.00	2.78	0.35	0.73	0.0	-23%	639	1%
2928	Organic derivatives of hydrazine or of hydroxylamine:	2	0.00	2.59	0.34	0.72	0.0	1%	1,155	7%
2936	Vitamins	3	0.21	0.90	0.20	0.76	22.0	17%	6,963	3%
2918	Carboxylic acids with additional oxygen function	3	0.08	1.37	0.20	0.67	9.2	10%	7,713	4%
2939	Vegetable alkaloids	3	0.05	0.82	0.23	0.67	1.8	-3%	2,424	5%
2904	Sulfonated, nitrated or nitrosated derivatives of hydrocarbons	3	0.04	1.10	0.22	0.64	0.7	8%	1,193	4%
2913	Halogenated, sulfonated, nitrated or nitrosated derivatives of aldehydes	3	0.54	2.76	0.31	0.76	0.6	24%	74	0%
2906	Cyclic alcohols and their halogenated, sulfonated, nitrated or nitrosated derivatives	3	0.01	1.67	0.24	0.77	0.4	7%	2,179	7%
2927	Diazo-, azo- or azoxy-compounds:	3	0.00	2.16	0.23	0.70	0.0	-8%	563	4%

Table 20: Rubber and Articles Thereof

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
4015	Articles of apparel and clothing accessories of vulcanized rubber	1	36.42	0.24	0.00	0.55	3,490.4	10%	6,224	8%
4001	Natural rubber	1	6.24	-5.83	0.00	0.38	2,765.9	5%	29,176	11%
4005	Compounded rubber	1	5.43	0.92	0.00	0.58	788.8	31%	9,431	13%
4016	Other articles of vulcanized rubber	1	0.70	2.12	0.00	0.54	241.5	5%	22,762	7%
4007	Vulcanized rubber thread and cord	1	23.00	-1.13	0.00	0.18	219.8	3%	632	6%
4009	Tubes, pipes and hoses, of vulcanized rubber	1	1.02	2.84	0.00	0.56	151.8	14%	9,702	7%
4014	Hygienic or pharmaceutical articles of vulcanized rubber	1	7.64	1.68	0.00	0.59	145.6	10%	1,263	6%
4008	Plates, sheets, strip, rods and profile shapes, of vulcanized rubber	1	1.42	2.60	0.00	0.57	90.7	8%	4,185	6%
4012	Retreaded or used	1	0.97	2.19	0.00	0.56	41.3	15%	2,801	7%

	pneumatic tires of rubber									
4003	Reclaimed rubber	1	4.11	1.22	0.00	0.58	19.9	14%	317	13%
4006	Other forms of unvulcanized rubber	1	1.45	1.73	0.00	0.54	12.0	0%	559	5%
4017	Hard rubber	1	1.66	1.61	0.00	0.55	6.5	8%	258	3%
4004	Waste, parings and scrap of rubber	1	0.79	0.66	0.00	0.55	3.1	12%	261	8%
4002	Synthetic rubber	2	0.37	2.74	0.43	0.71	153.0	10%	28,105	10%
4011	New pneumatic tires, of rubber	3	0.15	1.62	0.13	0.61	202.5	8%	85,899	9%
4010	Conveyor or transmission belts of vulcanized rubber	3	0.29	2.03	0.21	0.60	27.9	9%	6,285	7%
4013	Inner tubes of rubber	3	0.39	0.94	0.07	0.63	7.7	4%	1,332	5%

Table 21: Miscellaneous Chemical Products

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3823	Industrial monocarboxylic fatty acids; acid oils from refining; industrial fatty alcohols	1	1.01	2.19	0.00	0.57	713.7	13%	47,265	10%

3808	Insecticides, rodenticides, fungicides, herbicides	1	0.72	0.53	0.00	0.61	328.6	11%	29,791	7%
3818	Chemical element/compound wafers doped for electronic	1	1.84	3.77	0.00	0.56	275.4	-3%	12,639	7%
3812	Prepared rubber accelerators	1	1.60	2.59	0.00	0.64	103.8	13%	4,479	6%
3802	Activated carbon	1	1.25	0.64	0.00	0.62	45.8	5%	2,367	7%
3810	Metal pickling preparations	1	0.80	3.14	0.00	0.60	20.2	6%	1,821	7%
3815	Reaction initiators, reaction accelerators and catalytic products	2	0.37	2.46	0.42	0.73	86.6	21%	15,175	9%
3816	Refractory cements, mortars	2	0.47	2.05	0.28	0.63	16.1	5%	2,205	7%
3811	Anti-knock	2	0.10	1.56	0.31	0.73	15.8	18%	12,143	6%
3809	Finishing agents for dyeing	2	0.26	1.71	0.28	0.65	15.2	10%	4,051	5%
3801	Artificial graphite	2	0.36	2.21	0.32	0.71	12.0	28%	2,184	7%
3822	Diagnostic or laboratory reagents	2	0.03	2.78	0.46	0.72	9.7	17%	21,567	10%
3819	Hydraulic brake, transmission fluid <70% petroleum oil	2	0.22	1.81	0.29	0.71	2.7	13%	790	7%
3813	Preparations and charges for fire-extinguishers	2	0.32	2.53	0.33	0.75	1.4	18%	277	6%
3820	Antifreezing preparations and deicing fluids	2	0.04	2.38	0.32	0.67	0.8	8%	1,291	9%
3803	Tall oil	2	0.16	2.40	0.32	0.75	0.7	34%	292	7%
3821	Prepared culture media for development or maintenance of micro-organisms (including viruses and the like) or of plant, human or animal cells	2	0.03	2.32	0.37	0.75	0.6	26%	1,267	9%
3814	Organic composite solvents	3	0.17	1.48	0.24	0.68	11.0	10%	4,201	14%

	and thinners									
3817	Mixed alkylbenzenes and mixed alkylnaphthalenes	3	0.07	0.13	0.18	0.73	2.8	13%	2,711	9%
3806	Rosin and resin acids	3	0.10	0.92	0.15	0.72	2.7	12%	1,757	4%
3804	Residual lyes from wood pulp	3	0.17	1.98	0.31	0.75	1.1	23%	440	5%
3805	Gum, wood or sulfate turpentine	3	0.17	0.47	0.04	0.68	0.6	11%	216	4%
3807	Wood tar, oils, creosote, naphtha; vegetable pitch	3	0.21	1.80	0.31	0.76	0.4	15%	134	10%

Table 22: Inorganic Chemicals & Metal Compounds

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
2814	Ammonia	1	1.45	-2.25	0.00	0.49	235.5	26%	10,418	10%
2836	Carbonates; peroxocarbonates (percarbonates); commercial ammonium carbonate containing ammonium carbamate	1	0.75	0.75	0.00	0.57	67.3	13%	5,832	6%
2811	Other inorganic acids and other inorganic oxygen compounds of nonmetals	1	0.81	1.93	0.00	0.57	53.6	11%	4,426	7%
2842	Other salts of inorganic acids or	1	2.40	2.06	0.00	0.61	15.1	35%	429	5%

	peroxoacids									
2821	Iron oxides and hydroxides	1	0.93	1.96	0.00	0.60	14.9	21%	1,064	3%
2840	Borates; peroxoborates	1	0.68	0.98	0.00	0.60	10.2	24%	953	3%
2824	Lead oxides	1	3.43	0.14	0.00	0.62	9.3	22%	188	0%
2823	Titanium oxides	1	0.55	1.42	0.00	0.59	8.7	-4%	1,020	1%
2806	Hydrogen chloride (Hydrochloric acid); chlorosulfuric acid	1	1.20	1.52	0.00	0.56	6.5	7%	351	7%
2802	Sulfur, sublimed or precipitated	1	1.29	-0.40	0.00	0.45	6.1	9%	320	11%
2851	Inorganic compounds, liquid or compressed air	2	0.28	3.32	0.45	0.70	3.2	17%	733	10%
2812	Halides and halide oxides of nonmetals	2	0.06	3.25	0.39	0.76	0.7	32%	701	8%
2850	Hydrides, nitrides, azides, silicides and borides	2	0.04	3.25	0.38	0.72	0.4	17%	618	5%
2816	Hydroxide and peroxide of magnesium; oxides, hydroxides and peroxides, of strontium or barium	2	0.03	1.80	0.30	0.71	0.1	6%	212	7%
2803	Carbon, nesoi	3	0.32	1.21	0.19	0.66	25.4	23%	5,131	11%
2804	Hydrogen, rare gases and other nonmetals	3	0.11	0.59	0.11	0.67	20.6	13%	12,064	10%
2833	Sulfates; alums; peroxosulfates (persulfates)	3	0.35	0.48	-0.01	0.62	16.3	10%	3,161	7%
2835	Phosphinates and phosphonates	3	0.27	1.48	0.23	0.67	16.3	7%	3,913	5%
2849	Carbides	3	0.35	1.38	0.18	0.67	13.0	21%	2,447	7%
2809	Diphosphoruspentaoxide;	3	0.16	0.66	0.11	0.76	12.1	8%	4,763	6%

	phosphoric acid; polyphosphoric acids									
2825	Hydrazine and hydroxylamine, inorganic salts	3	0.17	0.76	0.21	0.68	11.5	16%	4,442	8%
2827	Chlorides, chloride oxides and chloride hydroxides; bromides and bromide oxides; iodides and iodide oxides	3	0.29	1.63	0.27	0.70	11.1	14%	2,465	7%
2817	Zinc oxide and peroxide	3	0.48	0.50	0.07	0.68	7.4	10%	1,029	7%
2807	Sulfuric acid; oleum	3	0.30	1.29	0.18	0.67	7.2	18%	1,572	10%
2818	Artificial corundum	3	0.04	-0.88	0.07	0.72	6.2	21%	11,563	5%
2839	Silicates; commercial alkali metal silicates	3	0.54	0.72	0.07	0.64	6.1	-3%	734	4%
2815	Sodium hydroxide; potassium hydroxide; peroxides of sodium or potassium	3	0.06	0.54	0.17	0.63	5.1	8%	5,282	9%
2846	Compounds, inorganic or organic, of rare-earth metals	3	0.11	1.33	0.29	0.75	3.6	33%	2,119	10%
2828	Hypochlorites; commercial calcium hypochlorite; chlorites; hypobromites	3	0.36	0.76	0.06	0.61	3.0	12%	542	5%
2805	Alkali or alkaline-earth metals; rare-earth metals, scandium and yttrium	3	0.16	0.35	0.13	0.79	2.9	31%	1,291	10%
2820	Manganese oxides	3	0.38	0.99	0.10	0.76	2.3	39%	400	4%
2808	Sulfonitric acids	3	0.47	1.45	0.23	0.65	2.2	16%	303	6%
2801	Fluorine, chlorine, bromine and iodine	3	0.08	-1.03	0.05	0.75	2.2	7%	1,847	8%

2834	Nitrites; nitrates	3	0.09	-0.11	0.15	0.71	2.0	6%	1,398	7%
2822	Cobalt oxides and hydroxides	3	0.22	0.19	0.07	0.78	1.9	27%	584	4%
2844	Radioactive chemical elements and radioactive isotopes	3	0.00	-0.17	0.13	0.81	1.3	25%	19,420	9%
2810	Oxides of boron; boric acids	3	0.06	0.09	0.05	0.77	0.6	14%	617	7%
2843	Colloidal precious metals; inorganic or organic compounds of precious metals	3	0.01	1.24	0.25	0.74	0.5	17%	6,227	10%
2819	Chromium oxides and hydroxides	3	0.04	0.76	0.10	0.81	0.4	13%	598	6%
2829	Chlorates and perchlorates; bromates and perbromates; iodates and periodates	3	0.02	-1.19	-0.01	0.79	0.3	8%	900	6%
2841	Salts of oxometallic or peroxometallic acids	3	0.01	0.65	0.14	0.73	0.3	0%	1,660	8%
2832	Sulfites; thiosulfates	3	0.05	0.48	0.16	0.73	0.3	9%	363	6%
2826	Fluorides; fluorosilicates, fluoroaluminates	3	0.01	1.08	0.19	0.64	0.2	16%	1,084	5%
2813	Sulfides of nonmetals	3	0.06	1.63	0.22	0.77	0.2	4%	206	5%
2847	Hydrogen peroxide	3	0.01	0.71	0.18	0.64	0.1	0%	725	5%
2831	Dithionites and sulfoxylates	3	0.02	2.13	0.16	0.78	0.1	9%	305	5%
2830	Sulfides; polysulfides	3	0.01	0.52	0.16	0.75	0.1	2%	617	8%
2837	Cyanides	3	0.00	0.62	0.23	0.73	0.0	0%	1,329	9%
2845	Isotopes not elsewhere specified	3	0.00	1.99	0.30	0.78	0.0	-5%	237	2%
2848	Phosphides	3	0.01	2.13	0.28	0.77	0.0	7%	79	8%
2838	Fulminates, cyanates and thiocyanates	3	0.00	2.67	-0.04	0.69	-	-100%	1	-20%

Table 23: Essential Oils, Perfumes, Cosmetics, Toiletries

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3307	Shaving products	1	0.64	1.54	0.00	0.55	99.1	11%	9,993	7%
3304	Beauty or make-up preparations	2	0.25	1.01	0.22	0.60	106.9	14%	27,873	9%
3305	Hair products	3	0.24	0.88	0.04	0.58	43.5	6%	11,781	9%
3306	Dental hygiene products	3	0.37	0.40	0.08	0.62	25.6	10%	4,449	7%
3302	Mixtures of odoriferous substances and mixtures	3	0.05	0.40	0.18	0.74	13.7	6%	19,221	9%
3303	Perfumes and toilet waters	3	0.04	0.43	0.17	0.64	9.5	6%	14,583	8%
3301	Essential oils	3	0.07	-1.07	-0.18	0.66	3.6	7%	3,575	6%

Table 24: Fertilizers

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3102	Mineral or chemical fertilizers, nitrogenous	1	0.86	-0.85	0.00	0.50	402.7	13%	30,469	11%
3101	Animal or vegetable fertilizers	1	0.57	0.23	0.00	0.56	6.4	15%	724	13%
3105	Mineral or chemical fertilizers, mixed	3	0.35	-0.79	-0.17	0.58	131.3	13%	24,131	9%
3104	Mineral or chemical fertilizers, potassic	3	0.07	-0.48	0.06	0.79	22.1	13%	19,598	11%
3103	Mineral or chemical fertilizers, phosphatic	3	0.04	-0.75	-0.14	0.76	1.5	6%	2,514	7%

Table 25: Tanning, Dyeing, Coloring Extracts

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3208	Paints and varnishes, nonaqueous	1	1.07	1.02	0.00	0.55	219.6	15%	13,438	6%
3215	Ink	1	1.11	2.69	0.00	0.59	208.7	13%	12,665	8%
3206	Other coloring matter	1	0.85	2.50	0.00	0.61	172.3	8%	13,681	7%
3214	Glaziers' putty	1	0.77	2.18	0.00	0.56	84.7	11%	7,115	7%
3212	Pigments, nonaqueous	1	2.21	2.40	0.00	0.59	76.4	18%	2,282	6%
3209	Paints and varnishes, aqueous	1	0.62	1.12	0.00	0.55	54.1	10%	5,750	8%
3210	Other paints and varnishes	1	0.81	0.98	0.00	0.54	9.4	10%	797	4%
3202	Synthetic organic tanning substances	1	0.74	0.11	0.00	0.65	9.1	39%	830	3%
3211	Prepared driers	1	0.56	0.85	0.00	0.61	1.8	19%	212	5%
3204	Synthetic organic coloring matter	2	0.08	2.14	0.30	0.65	14.8	8%	11,993	0%
3207	Prepared pigments	2	0.18	2.24	0.35	0.72	10.6	6%	4,045	6%

3213	Artists' colors	2	0.15	1.86	0.31	0.70	1.2	-3%	522	5%
3203	Coloring matter of vegetable or animal origin	3	0.47	1.44	0.24	0.73	9.2	24%	1,264	8%
3201	Tanning extracts of vegetable origin	3	0.05	-1.97	-0.18	0.73	0.3	14%	369	4%
3205	Color lakes	3	0.03	1.13	0.28	0.71	0.1	7%	251	5%

Table 26: Soaps, Lubricants, Waxes, Candles

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3401	Soap	1	4.55	-1.32	0.00	0.55	435.2	10%	6,226	8%
3402	Cleaning products	1	0.66	0.56	0.00	0.54	297.3	12%	29,326	8%
3404	Artificial and prepared waxes	1	2.94	1.74	0.00	0.63	118.1	11%	2,657	7%
3403	Lubricating products	2	0.27	2.84	0.45	0.70	39.4	16%	9,417	10%
3407	Model and dental pastes and waxes	2	0.30	3.07	0.45	0.70	2.7	-3%	595	7%
3406	Candles	3	0.32	1.20	0.14	0.65	13.6	3%	2,746	8%
3405	Polishes and creams	3	0.21	1.30	0.13	0.60	6.6	-1%	2,115	6%

Table 27: Starches, Glues, Enzymes

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3506	Glues and adhesives	1	0.76	1.92	0.00	0.58	107.2	10%	9,583	8%
3507	Enzymes	2	0.25	1.55	0.31	0.73	17.7	27%	4,610	6%
3505	Dextrins and other modified starches	2	0.14	2.10	0.30	0.68	7.8	7%	3,572	6%
3504	Peptones	2	0.02	2.36	0.36	0.71	0.7	18%	2,233	8%
3503	Gelatin	3	0.05	0.99	0.16	0.70	1.4	11%	1,923	6%
3501	Casein	3	0.03	1.01	0.10	0.78	1.3	16%	2,548	4%
3502	Albumins (water soluble proteins)	3	0.00	1.89	0.27	0.73	0.1	13%	1,401	10%

Table 28: Photographic or Cinematographic Goods (Film, Paper, Plates, Chemicals)

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3701	Photographic plates	1	1.86	3.22	0.00	0.66	154.9	17%	5,399	2%
3702	Photographic film in rolls	1	2.30	3.69	0.00	0.59	78.3	11%	2,226	-7%
3704	Photographic plates, film, paper, exposed but not developed	1	1.42	1.42	0.00	0.58	0.8	10%	37	-7%
3707	Chemical preparations for photographic uses	2	0.29	3.70	0.52	0.73	29.8	2%	6,847	3%
3705	Photographic plates and film, exposed and developed, not motion-picture film	2	0.10	3.58	0.42	0.77	1.1	3%	751	3%
3703	Photographic paper	2	0.03	3.17	0.45	0.76	0.5	-13%	1,237	-6%
3706	Motion-picture film, exposed and developed	3	0.08	1.60	0.19	0.74	0.2	2%	157	-5%

Table 29: Explosives, Powders, Matches

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
3606	Ferrocerium and other pyrophoric alloys	2	0.48	1.65	0.28	0.65	2.4	8%	324	6%
3601	Propellant powders	2	0.01	2.38	0.35	0.72	0.0	9%	415	8%
3602	Prepared explosives	3	0.34	-1.34	-0.15	0.59	4.8	6%	919	6%
3603	Safety or detonating fuses	3	0.19	-0.35	0.05	0.64	4.1	13%	1,402	8%
3604	Fireworks	3	0.11	1.93	0.28	0.73	1.9	-2%	1,185	6%
3605	Matches	3	0.13	-1.64	-0.14	0.65	0.5	-7%	224	2%

Current, Selected, and "Neither" Products in Electrical & Electronics

Table 30: Semiconductors, Circuits and Related

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8542	Electronic integrated circuits	1	3.93	2.65	0.00	0.56	13,314.4	-1%	306,062	4%
8541	Diodes, transistors, semiconductor devices; photosensitive semiconductor devices, including photovoltaic cells	1	4.42	2.61	0.00	0.58	4,937.2	6%	81,791	8%
8536	Apparatus protecting electrical circuits for < 1k volts	1	1.38	2.07	0.00	0.53	1,719.9	9%	83,963	6%
8537	Electrical Boards and panels for protecting electrical circuits	1	1.96	2.40	0.00	0.53	1,316.0	16%	44,254	11%
8534	Electronic printed circuits	1	1.80	2.50	0.00	0.50	928.1	4%	40,622	8%
8532	Electrical capacitors	1	3.13	2.34	0.00	0.54	865.8	5%	19,735	4%
8543	Electrical machines and apparatus with individual functions not elsewhere	1	1.62	2.56	0.00	0.53	570.4	7%	23,395	4%

	specified									
8538	Parts for use with apparatus for protecting electrical circuits	1	0.60	2.47	0.00	0.55	280.3	12%	31,507	8%
8533	Electrical resistors	1	1.77	2.23	0.00	0.53	212.9	1%	8,641	3%
8540	Thermionic, cold cathode or photocathode tubes	1	4.08	2.89	0.00	0.57	161.6	-13%	2,608	-13%
8539	Electrical filament	2	0.07	2.04	0.29	0.64	20.0	2%	17,523	5%
8535	Apparatus protecting electrical circuits for > 1k volts	3	0.39	1.85	0.18	0.59	53.3	2%	8,999	6%

Table 31: Telephones, Sound, and Video Devices

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8517	Telephones	1	2.74	2.36	0.00	0.52	8,139.8	12%	205,366	10%
8521	Video recording apparatus	1	1.90	2.11	0.00	0.52	1,512.3	0%	54,961	10%
8529	Parts of radios, telephones and TVs	1	1.31	2.73	0.00	0.54	1,368.7	3%	71,803	7%
8523	Storage devices, smart cards, discs, tapes etc	1	3.94	2.25	0.00	0.58	1,309.8	6%	30,079	7%

8518	Microphones; loudspeakers; headphones	1	1.74	2.36	0.00	0.57	773.9	2%	29,711	7%
8522	Parts and accessories for video or sound equipment	1	2.55	2.04	0.00	0.50	218.8	-11%	5,999	-4%
8519	Sound recording apparatus	1	2.53	2.78	0.00	0.62	164.1	-11%	4,327	-2%
8520	Dictating machine	1	1.05	2.19	0.00	0.61	0.3	-36%	23	-27%
8524	Recorded gramophone records	2	0.21	2.90	0.40	0.68	58.6	-3%	20,208	1%

Table 32: Transmission and Reception Devices

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8528	Monitors and projectors; reception apparatus for television	1	3.00	1.79	0.00	0.53	3,956.5	5%	87,246	10%
8525	Transmission apparatus for radio, telephone and TV	1	1.25	1.95	0.00	0.54	3,789.6	21%	208,707	13%

8527	Reception apparatus for radio broadcasting	1	6.09	2.18	0.00	0.54	1,736.4	-4%	18,689	-1%
8526	Radar and radio navigational aid apparatus	1	1.13	2.80	0.00	0.58	294.7	7%	19,303	11%
8528	Monitors and projectors; reception apparatus for television	1	3.00	1.79	0.00	0.53	3,956.5	5%	87,246	10%

Table 33: Motors, Generators, Transformers, Batteries

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8504	Electrical transformers	1	0.82	2.13	0.00	0.53	974.3	0%	79,059	6%
8505	Electromagnets	1	2.51	2.93	0.00	0.57	355.6	13%	9,393	8%
8506	Primary cells and primary batteries	1	1.00	2.34	0.00	0.59	94.5	6%	6,684	3%
8548	Waste and scrap of batteries; used batteries	1	1.05	2.58	0.00	0.57	52.3	-4%	3,553	1%
8503	Parts for use with	2	0.50	2.17	0.23	0.60	147.1	11%	19,377	9%

	electric generators or converters									
8511	Electrical ignition or starting equipment	2	0.36	2.39	0.28	0.62	103.5	13%	18,736	6%
8502	Electric generating sets and rotary converters	2	0.21	2.11	0.30	0.62	86.6	20%	26,701	11%
8507	Electric storage batteries	3	0.52	1.46	0.17	0.63	251.6	8%	32,173	8%
8501	Electric motors and generators	3	0.23	2.01	0.20	0.59	169.6	-7%	47,829	7%

Table 34: Wire, Insulators, Fittings

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8544	Insulated wire; optical fiber cables	1	0.62	0.42	0.00	0.54	954.0	7%	100,593	7%
8546	Electrical insulators of any material	1	0.91	1.94	0.00	0.56	35.7	4%	2,536	4%
8545	Carbon electrodes or other articles of graphite or carbon used for electrical purposes	2	0.53	2.17	0.30	0.71	52.6	20%	6,514	6%

8547	Insulating fittings for electrical machines, appliances or equipment	2	0.34	2.98	0.44	0.64	22.3	1%	4,353	5%

Table 35: Electrical Appliances

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8509	Electromechanical domestic appliances	1	3.65	2.44	0.00	0.59	1,009.5	18%	18,034	8%
8516	Electric instantaneous or storage water heaters	1	1.11	2.57	0.00	0.58	679.8	9%	40,100	7%
8508	Vacuum cleaners	1	1.80	2.63	0.00	0.59	366.1	10%	13,141	5%
8514	Industrial or laboratory electric furnaces	1	0.77	2.54	0.00	0.58	61.8	15%	5,297	5%
8510	Shavers, hair clippers and hair-removing appliances	2	0.01	3.15	0.38	0.70	0.5	-17%	3,324	7%

Table 36: Electrical lamp, lighting and signaling devices

HS4 product code	HS4 product name	1=has RCA, 2=selected, 3=neither	RCA	PCI	Opp. gain	Distance	Total exports, Malaysia (US million)	Avg. annual growth Malaysia (1997-2012)	Total exports, world (US million)	Avg. annual growth world (1997-2012)
8512	Electrical lighting or signaling equipment used for motor vehicles	1	0.81	2.43	0.00	0.57	235.7	12%	19,298	9%
8531	Electric sound or visual signaling apparatus	1	1.04	2.14	0.00	0.53	220.1	-1%	14,765	4%
8515	Electric laser or other light or photon beam	2	0.31	3.09	0.45	0.65	49.3	6%	10,435	4%
8513	Portable electric lamps designed to function by their own source of energy	3	0.48	1.78	0.15	0.78	22.0	12%	3,036	7%
8530	Electric signal, safety & traffic controls, railways, waterways, parking or airfields	3	0.37	1.72	0.17	0.63	12.8	-2%	2,272	6%

Appendix II: Sample List of Official Meetings Held by the International Team

Official Counterpart

Economic Planning Unit (EPU)

Manufacturing Industry Science and Technology Section

Ms. Liew Siew Lee, Director
Ms. Arsuhaila Musha, Principal Assistant Director
Mr. Abd Rahim Abd Hamid, Principal Assistant Director
Ms. Jeannie Christie Robert, Assistant Director
Mr. Noorhidayat Salman, Assistant Director
Mr. Mohammad Syafiq Toha, Assistant Director
Mr. Tan Kay Kiang, Principal Assistant Director, Macroeconomics Section

Public Sector

Malaysian Investment Development Authority (MIDA)
Ms. Rashidah Othman, Director, Strategic Planning & Policy Advocacy
Mr. Safwan Nizar Johari, Executive, Strategic Planning & Policy Advocacy
Ms. Faridah Abdullah, Director, Machinery & Equipment Division
Ms. Azlina Hamdan, Senior Deputy Director, Machinery & Equipment Division
Ms. Umarani Muniandy, Director, Chemical and Advanced Material Division
Ms. Zabidah Saud, Senior Deputy Director, Chemical and Advanced Material Division
Ms. Surayu Susah, Deputy Director, Life Sciences & Medical Technology Division
Ms. Wahida Abdul Rahman, Senior Deputy Director, Electrical & Electronics

Ministry of International Trade and Industry (MITI)
Ms. Noor Wahida Noordin. Director, Sectoral Policy I.
Ms. Khoo Eu Wen

Performance Management and Delivery Unit (PEMANDU)
Mr. Yong Yoon Kit, Director, NKEA Electrical & Electronic
Mr. Rizal Nainy, Associate Director, NKEA Electrical & Electronic
Ms. Jade E. Swan, Manager, NKEA
Mr. Hanif Hamzah, Analyst, NKEA Electrical & Electronic

Khazanah Nasional

Mr. Hisham Hamdan, Executive Director of Investments

Mr. Hamdan Abdul Majeed, Director of Investments Penang Office

Private Sector

Sime Darby Berhad
Mr. Azli Razali, Head of Sime Darby Renewables

Chemical Industries Council of Malaysia (CICM)
Mr. Abd Hapiz Abdullah, Chairman
Mr. Akbar Md Thayoob, CEO, Petronas Chemicals Marketing Sdn Bhd
Mr. Giorgio Noli, General Manager of Nuplex Malaysia
Ms. Surina Ismail, Global Director, Emery Oleochemicals Group
Mr. Mohamed Noor Sany, CEO, E-response Alert & E-response Management

SilTerra Malaysia Sdn Bhd
Mr. Firdaus Abdullah, Executive Director

Globetronics Technology Bhd
Mr. Ng Kok Choon, Chief Financial Officer

Intel Microelectronics Malaysia
Mr. Amran Mohamad Dom, Director of Corporate Affairs
Mr. Gurdeep Singh Randhay, Head of Tax (Malaysia and ASEAN)

Collaborative Research in Engineering, Science & Technology Centre (CREST)
Dr. Nor Azmi Alias, Senior Vice President, Talent Development

SRM Integration (M) Sdn. Bhd.
Mr. Sim Ah Yoong, Managing Director

CMS Opus Private Equity
Mr. Azam Azman, Managing Director
Mr. Shaun C.K. Chan

Malaysia Venture Capital Management Berhad (MAVCAP)
Mr. Mohamed Fariz Bin Ghazali, Manager, Investment Monitoring

In addition to the above list, various stakeholders were interviewed during the case study research.

Appendix III. Best Practices Discussed in Chapter VIII

Appendix III(a): Lessons from Chile on Enlisting Pioneers in Exploring New Sources of Growth[52]

In 1985, Chile implemented a simplified drawback system where in lieu of reimbursements for tariffs paid on imported inputs (drawbacks), exporters received a subsidy of up to 10 percent of their export value, as long as total exports of the sector did not exceed $ 7.5 million. Once this threshold was breached, export subsidies in the sector were automatically eliminated. One strength of this intervention is that it did not require picking winners. Subsidies were assigned automatically to every exporting firm in a new sector, thus making the development of new or incipient sectors more attractive to pioneers and early followers. Those that experimented but failed would not receive support.

Appendix III(b): Lessons from Vendor Development Initiatives by MNCs based in Malaysia

Within Malaysia, prior experience suggests that *large impacts are likely to come from providing strong incentives to local spinoffs started by former MNCs employees.* Clear examples of this can already be found in various sectors. In E&E a number of local firms that do contract manufacturing for MNCs have been created by former engineers or other knowledge workers that started their careers at an MNC. This is the case of Globetronics, which was created in Penang 25 years ago by former Intel employees. The company started with Intel as its sole customer, a single-product line, and working with consigned equipment and material. Nowadays they have diversified their client base to a number of multinationals (not only those based in Malaysia), they own sophisticated equipment, have a workforce of 2,300 people out of which 15% are knowledge workers, and have developed assembling expertise in a number of high-technology products beyond integrated circuits, including temperature-compensated crystal oscillators, motion sensors, and special-purpose LED lighting solutions. Various government agencies (especially Penang's local development agency) played a key role in supporting this company's establishment and first years of operation through the provision of investment incentives, licensing support, etc.

[52] Source: Inter-American Development Bank, (2014-09-04). Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation (Kindle Locations 983-993). Palgrave Macmillan. Kindle Edition

A remarkable, though still not representative example from the M&E sector is SRM Integration, a highly successful medium-size enterprise based in Penang who specialises in the design and manufacturing specialised machines for quality testing of IC components and sensors, mainly for the US and European markets. A local professional who had worked as a design engineer at Hewlett-Packard for 10 years founded the company (originally called SIMECA) 16 years ago. The operation started in a small shop and over time moved to a larger shop and eventually to its own manufacturing facility. Over the last decade the business boomed, with annual growth rates topping 20%. This trend is expected to continue as SRM continues to invest in new machines, more engineers, and as they move forward the construction of a new large manufacturing facility.

In many ways SRM illustrates the large potential contained in Malaysia's existing productive capabilities. The firm initially staffed its operations by hiring engineers that had worked at MNCs and had specialised design know-how and experience. Over time the firm created enough capacities to develop their own human resources. Nowadays the incoming skilled labor is composed mostly of newly-graduated engineers who are then trained in-house. The existence of local firms specialised in precision manufacturing has allowed SRM to subcontract the fabrication of most machine parts, and focus their efforts in design and the assembling of the final product. From their 150 employees 35 are design engineers, and none are unskilled operators (the lowest qualification found in employees of the company is technician). Nowadays the firm has reached a level of maturity in which its success is not dependent on government support. However its founder emphasised that they benefited greatly from the pioneer status during the challenging initial years, and that the existence of innovation matching grants opportunities may allow the company to expand their investment in equipment upgrading.

Appendix III(c): Lessons from Germany's "Innovation Clusters" Concept

Germany's unique "innovation cluster" concept has created an environment in which actors in all industry sectors are able to flourish in close proximity with other industry actors and investors, academic institutions, and research centers. The GO-CLUSTER GERMANY Initiative of the Federal Ministry of Economics and Technology brings together the best-performing innovation clusters and networks in Germany and promotes cooperation with other international excellence clusters. As part of Europe's largest applied science research organisation, institutes belonging to the

Fraunhofer-Gesellschaft are active in developing new technologies for industry and the public sector. Twenty thousand Fraunhofer employees develop cutting-edge technologies in over 80 research institutions spread across Germany. Of these, 17 Fraunhofer research institutes specialise in matters purely M&E related. The Fraunhofer Innovation Clusters are based on established networks of research institutions, investors and companies that lead to new business ideas and start-ups. Regional innovation clusters help close the gap between science and industry. Successful clusters stimulate competition while creating productive collaboration.

Appendix III(d): Lessons from Mexico's TechBA Program

- Mexico's TechBA program was launched in 2004 to help Mexican small and mid-sized tech companies meet the challenge of penetrating the rest of the North American Free Trade Area (NAFTA) and position Mexican firms as providers of world-class technology.
- It has locations in five cities in the United States and two in Canada, as well as one in Spain (Madrid), as a stepping stone for the European market.
- The program brings Mexican entrepreneurs to these locations and facilitates their interaction with local actors, leading to sales, strategic alliances, and investments. TechBA is financed by the Mexican Ministry of the Economy and the Mexico-U.S. Foundation for Science.

Appendix III(e): Lessons learned from Korea Machine Tool Manufacturers' Association (KOMMA)

Armed with a firm dedication and commitment to advance Korean machine tool enterprises and beyond, Korea Machine Tool Manufacturers' Association (KOMMA) has declared Global Vision 2020, aiming to support Korea to become a world top-four machine tool industry nation with annual production of US$18 billion, US$5 billion of which to come from overseas production, by 2020.

KOMMA's activities:

- **Promoting Market Opportunities at Home and Abroad -** KOMMA designs and executes sales promotion programs embracing exhibitions as well as overseas trade missions.
- **Umbrella for International Cooperation & Collaboration -** KOMMA plays the role of shepherd for engaging in international cooperation activities for common benefit, generating opportunities for exchanges of information related to technology and management strategies, etc.
- **Building & Operating Networks for Information Exchange and Policy Development -** KOMMA is operating and maintaining networks designed to facilitate information exchanges among member companies and to pool available knowledge and expertise.
- **Generating Opportunities to Upgrade Technical Competitiveness -** KOMMA provides a variety of opportunities for member companies to sharpen their competitive edge with technological innovations and upgrades. This includes seminar/forum on technology trends and prospects for machine tools and robots.
- **Publicity & Publications Related to Machine Tool Industry -** KOMMA consistently carries out publicity and publication projects related to the machine tool industry at home and abroad. It also surveys and publicises analyses of trends in machine tool industry orders, production, inventories, and trade (export-import) by machine type and country.

Appendix III(f): Lessons from China's Emerging Automation Support Policy Support

- **Rising wages and an aging population have been propelling Chinese manufacturers to automate**. China, the biggest buyer of robots in 2013, is now encouraging domestic players to capture market share from established foreign brands.
- **Government officials, worried that productivity growth may have turned negative since 2009, see the promotion of automation as a policy that will increase efficiency**. Chinese manufacturers, struggling with increasing costs of labour, also favor more use of robots where possible.

- **In its five-year economic plan for 2011-2015, Beijing specifically targeted robotics as a key sector for development**, hoping to create four or five domestic robotics "champion" firms to meet an annual production target of about 13,000 robots.
- China now has **420 robot companies**, and **more than 30 industrial parks devoted to robotics are either being built or are already functioning** around the country.
- Local governments have adopted a **variety of different stimulus tactics in robotics**. For example, Dongguan, a manufacturing center in Guangdong, has been particularly aggressive, creating a 200 million yuan (US$33 million**) investment fund to subsidise robotics investments by local firms**.

Appendix III(g): Lessons Learned from New York's High-Tech Centers of Excellence

- The Buffalo Center of Excellence in Bioinformatics & Life Sciences Technology was established as part of the Empire State Development Corporation's ambitious Centers of Excellence program that aims to foster collaboration between academic institutions and high-tech private enterprise.
- The centre serves as a hub for high-tech research and development in the city of Albany, connecting the resources of the city's academic institutions with private enterprises and offering companies state-of-the-art research facilities, expertise on business management as well as access to various sources of funding.
- Through the centre, dozens of new companies have been launched, thousands of new jobs have been created or retained and millions of dollars have been attracted to the region.

Empire Genomics is an example of the success the center has enjoyed. The molecular diagnostic company took advantage of the access to equipment and financing to build its business while receiving R&D, business development and marketing support. The company has saved more than US$2 million through participating in the program, received US$1.3 million in private investment and captured more than US$3.2 million in new product revenues.

Appendix III(h): Lessons from Germany's Vocational Education System

Federal Institute for Vocational Education and Training BIBB Researching Advising Shaping the future

- Administered by the **Federal Institute for Vocational Training and Education**, Germany's vocational education program is a **dual system**: **Students learn in the classroom, and they learn by doing**.
- **Trainees attend vocational school one or two days per week**, studying the theory and practice of their occupation as well as economics and social studies, foreign languages, and other general subjects. They also do a **working apprenticeship** in their chosen field.
- During apprenticeships**, trainees receive about one-third of the salary of a trained skilled worker for a successful transition to full-time employment**.
- It also offers qualifications in a **broad spectrum of professions and flexibly adapts to the changing needs of the labour market**.
- A major strength of the dual system is the **high degree of engagement and ownership on the part of employers and other social partners**.
- **But the system is also characterized by an intricate web of checks and balances at the national, state, municipal, and company levels that ensures that the short-term needs of employers do not distort broader educational and economic goals**.
- The VET system as a whole is **well-resourced, combining public and private funding**. Germany has maintained strong financial support and maintained the apprenticeship offer for the VET system even during the crisis. Germany has a well-developed and institutionalised VET research capacity, including the Federal Institute for VET, (BIBB), and a national network of research centres that study different aspects of the system to support continuous innovation and improvement in the VET system.

Appendix III(i): Lessons from Korea's Experience with Workforce Development

- The Korean experience is an example of an effective government-led model for WfD. The highest levels of government leaders have consistently asserted WfD's importance as a means to provide an appropriately skilled workforce for advancing strategic economic development objectives.
- **The government's large investments in gathering robust and accurate data on current and future economic conditions and their skills implications have been instrumental in aligning WfD to economic development goals**. This has been achieved both through the creation of numerous dedicated governmental and quasi-governmental research institutions and think tanks as well as by maintaining strong formal and informal government links to industry.
- Also necessary is a **collaborative approach to WfD**. The government recognised industry, training providers and labor unions as essential partners in activities ranging from implementing strategic reforms, to system oversight, to collaborating in ensuring that providers deliver desired outcomes.
- In the face of rapid economic change and ambitious economic development targets, Korea has, for most of the past several decades, relied on a **centralised approach to governing the TEVT system**. All **training providers operating in the country must complete a rigorous accreditation process** and depend to varying degrees on government subsidies to finance their operations. The government's insistence on detailed spending plans and adherence to a national curriculum have given it considerable influence over TEVT providers.

Appendix III(j): Lessons on Attracting Entrepreneurs from Chile

- *Start-Up Chile* is a program launched in 2010 by CORFO, Chile's development agency. **The idea was to bring entrepreneurs from abroad as a way to increase the deal flow of projects with high growth potential**, and to promote a culture of entrepreneurship by example. In order to become viable, the emerging venture capital industry in Chile needed to build up a critical mass of entrepreneurs with good ideas looking for finance. Moreover, **it was thought that bringing people with entrepreneurial attitudes into Chile would generate positive externalities**, as the change in culture would result in more start-ups by local entrepreneurs.

- **Candidates apply through a quick Internet-based business plan competition**. Once in Chile, selected entrepreneurs receive US$ 40,000 in nonrefundable seed money, with almost no strings attached, as well as physical space for their business.

- They are required to stay in Chile for at least six months. **The program ensures that the process of obtaining a work permit is fast and efficient**. Entrepreneurs receive training and feedback from both peers and other advisors. Ideally, during their stay, they should move their businesses into the prototype stage, and maybe start selling, but this is not required. As payment, they are asked to give a few talks in places like universities , to spread the culture of entrepreneurship.

- Despite its relatively modest budget, **the program has received massive attention from applicants as well as from the international media**. The last application round attracted **1,600 applicants from more than 50 countries.** While some firms left without leaving a footprint, others stayed or created real links by hiring local workers.

- While it is too soon to tell whether the program has been successful, and no impact evaluations have been performed, other countries like Peru and Brazil have launched programs with similar names, and Uruguay and Jamaica are planning to emulate them.

Appendix III(k): Lessons from Canada's Venture Capital Action Plan[53]

After consultations with relevant stakeholders, the Prime Minister announced in January 2013 the Venture Capital Action Plan, a comprehensive strategy for deploying **the US$400 million in new capital over the next 7 to 10 years, which is expected to attract close to US$1 billion in new private sector investments in funds of funds**.

The Venture Capital Action Plan is making available:

- US$250 million to establish new, large private sector-led national funds of funds (a funds of funds portfolio consists of investments in several venture capital funds) in partnership with institutional and corporate strategic investors, as well as interested provinces.
- Up to US$100 million to recapitalize existing large private sector-led funds of funds, in partnership with willing provinces.
- An aggregate investment of up to US$50 million in three to five existing high-performing venture capital funds in Canada.
- Additional resources to continue developing a robust venture capital system and a strong entrepreneurial culture in Canada.

The availability of venture capital financing is just **one driver of a successful private sector-led venture capital sector.** It is equally important to foster a strong entrepreneurial culture and well-established networks that link investors to innovative companies.

[53] Source: http://actionplan.gc.ca/en/initiative/venture-capital-action-plan-0

Appendix III(l): Lessons on Capacity-Building in the VC space from Brazil

- In 1999, the Brazilian Agency for Innovation (FINEP) identified 7 key constraints on the domestic early stage private equity ecosystem. Among these constraints was a lack of effective intermediation between investors and SMEs, with SMEs struggling to understand private equity financing or identify investors and fund managers lacking the skills to assess investment opportunities.

- FINEP Partnered with the Multilateral Investment Fund (MIF) of the Inter-American Development Bank and establish the INOVAR program to address these issues.

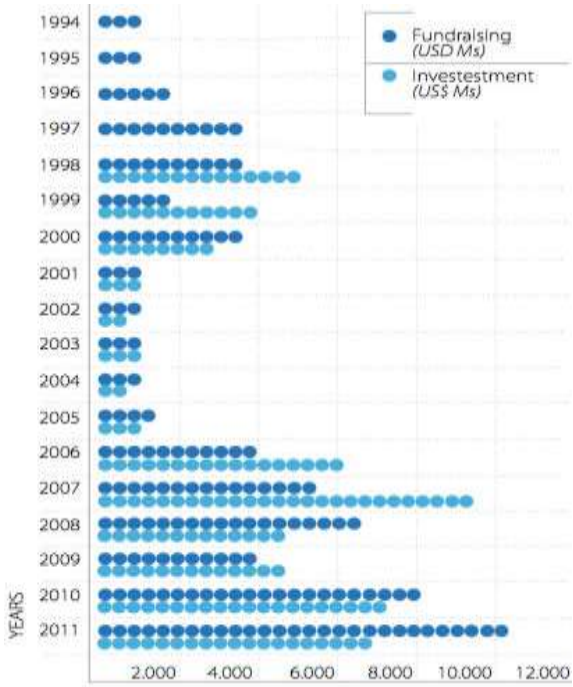
- FINEP and MIF established a Brazilian venture capital association (ABVCAP) and organised Venture Forums to educate entrepreneurs on securing private equity financing and investors on raising funds and assessing investment opportunities.

- This laid the foundation for subsequent iterations of the INOVAR program that helped the early-stage industry raise US$2 billion and finance more than 56 companies between 2001 and 2011.

Appendix III(m): Lessons on Fund Investment from Mexico and elsewhere[54]

- In 2008, the Mexican government embarked on a mission to catalyse a domestic VC/PE industry and raise the profile of Mexico among international investors. To this end, a series of joint venture fund-of-funds were established, co-managed and advised by international fund managers. The involvement of private investors in managing the funds helped ensure discipline and commercial viability while facilitating the transfer of best practices and providing a platform to attract international investors to Mexico.
- Similar programs in Brazil, Singapore and South Korea have leveraged government capital to increase private commitments to local VC industries, multiplying the impact of government investment in target industries. To increase incentives for private investor participation, the return requirements for government commitments have been limited, thereby boosting the gains to private investors and fund managers.
-

VC Fundraising and Investment in Latin America

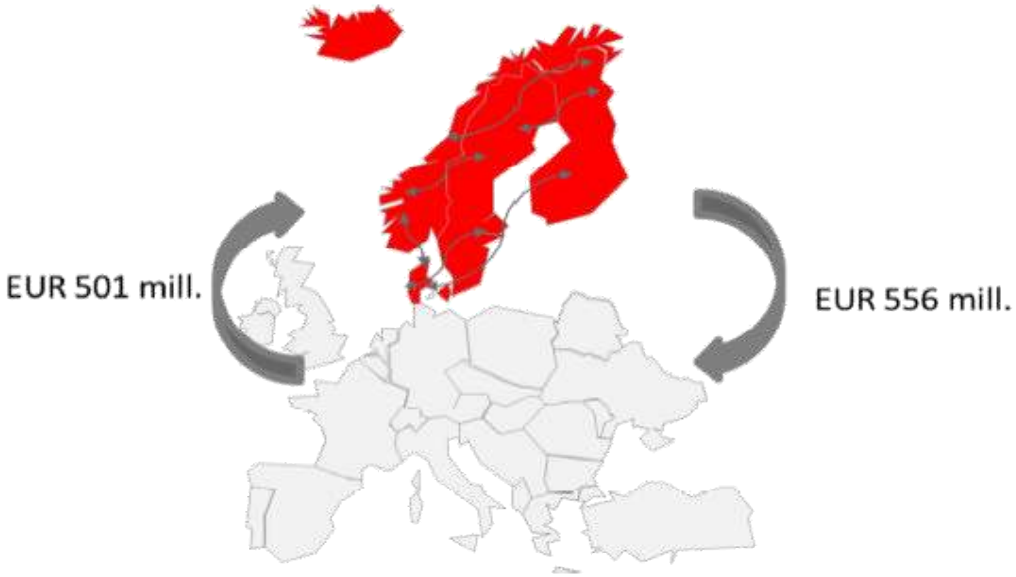


Source: SAVCA, 2013

[54]*Source: SAVCA Best Practices in Creating a Venture Capital Ecosystem, World Bank Malaysian Venture Capital Industry, Hoe Hoon Chung (Undated) Lessons from the Korean Venture Industry*

Appendix III(n): Lessons on Cross-Border VC Investing from the Nordics[55]

- The figure below shows **aggregated cross-border venture investments** in the period 2007–2010 from Nordic venture funds going into foreign SMEs and investments from foreign venture funds located outside the Nordic region going into Nordic early stage companies. We see that the flows nearly match in size, with a small net outflow of venture investments going out of the Nordics.



- Between 2007 and 2010, a total number of 108 Nordic SMEs received non-Nordic venture backed finance. On average, this amounts to EUR 4.6 mill per investment, a significant amount of equity for a venture case.
- This indicates that the Nordic SMEs receiving venture backed finance from abroad are dominated by more mature venture enterprises.
- In comparison, venture investments going from Nordic venture funds companies located outside the Nordic region were split among 303 enterprises, making it an average investment of only EUR 1.8 mill.

[55] *Source: Menon Business Economics No. 20/2010*

Appendix III(o): Lessons from Maryland's Venture Fund

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- A common challenge for early stage companies is securing the financing needed to bridge the gap between personal or grant funding and institutional VC/PE backing.
- The Maryland Venture Fund (MVF) of the Department of Business & Economic Development is a regionally recognised leader in seed and early stage investing and a national model for state supported investment programs.
- MVF invests in highly innovative technology companies across the full range of industry sectors including software, communications, cyber security and life sciences companies in the areas of healthcare IT, medical devices and diagnostics.
- "MVF makes investments in seed and early stage companies. We have found our sweet spot for investing has been between a company's seed funding round and its first round of institutional financing. Our ability to bridge this funding gap for our portfolio companies has better enabled them to raise their next round of capital."

Source: http://business.maryland.gov/mvf#sthash.qKABYoY7.dpuf