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Introduction

Investment in the development of human capital is one of the most effective ways to promote a country's continued economic growth and social equity. For Taiwan, this is especially true as it faces new challenges such as slowed economic growth, an aging population, human capital flight, shifting economic and industrial priorities, and other issues as addressed in this country report. The broad focus of this chapter is on public policy innovation for human capital development in Taiwan. In particular, it investigates key issues related to the promotion and implementation of Science, Technology, Engineering, and Mathematics (STEM) education and Technical and Vocational Education and Training (TVET) for the purposes of cultivating human capital. It begins by giving an overview of the relevant historical context; demographic changes affecting society; and the economic, educational, and public policy landscape in terms of developing human capital. Official government statistics and relevant industry and economic indicators are used to shed light on wide-ranging public policy and human capital issues affecting Taiwan's economy, institutions, and people. These are synthesized to address the following research questions: What institutions and programs exist to promote STEM education, TVET, human capital development, and productivity in Taiwan? What key challenges do these initiatives try to address? How successful have these initiatives been at promoting human capital development and productivity? The findings presented in this study address three major themes: organizational structures tasked with human capital development; related public policies, plans, and programs, especially for promoting STEM and TVET education; and the emerging human capital needs of and skills prioritized by government, industry, and civil society. Based on the findings, the report then discusses the key challenges faced and the local responses to these challenges. Broadly speaking, those responses have aimed to foster interest in STEM, improve existing and implement new TVET programs, facilitate twenty-first century skills in education, and attract and retain highly skilled domestic and foreign talent. The report concludes by highlighting important lessons learned and offering recommendations for policy makers and industry leaders.

Background

Human capital plays an important role in the economic development of countries around the world [1]. Taiwan, for its part, has long placed a heavy emphasis on education, which has been a key aspect of its rapid social and economic progress for over half a century [2]. This focus has persisted through several different historical eras and continues to this day through government agencies' policies and other programs for promoting Science, Technology, Engineering, and Mathematics (STEM) education, Technical and Vocational Education and Training (TVET), and human capital development more broadly. To effectively engage with issues related to human capital

development and productivity in Taiwan and serve as a foundation for the subsequent sections in this report, this section provides an overview of the relevant historical context, demographic changes affecting society, and the economic, educational, and public policy landscape related to human capital development in Taiwan.

Recent history has brought about a series of major political upheavals in Taiwan. At the end of the Japanese colonial era from 1895 to 1945, the island was ceded to the Republic of China (ROC), which was embroiled in a struggle for the Chinese mainland. Following defeat by communist forces in the late 1940s, the ROC government and about two million nationalist supporters, soldiers, and others fled the mainland to Taiwan. Taiwan remained under Kuomintang (KMT) single-party rule through the end of the martial law era in 1987. The 1990s were a pivotal moment for Taiwan as it liberalized and democratized, developing an active civil society which continues to play an important role in Taiwan's political context today. Throughout this history of momentous political changes, education and human capital development have remained a key focus for Taiwanese society and its various governing authorities. Education has contributed in a major way to its national economic development, helping it to be recognized as one of the four Asian tigers, along with Hong Kong, Singapore, and South Korea [3]. Rapid industrialization led to Taiwan's emergence as an advanced economy from the 1960s to the 1990s, and today it grapples with many of the same challenges facing other highly developed countries in Asia, Europe, and North America.

Having seen three peaceful transitions of power between democratically elected leaders, Taiwan is now widely recognized as a mature democracy [4]. Moreover, its thriving civil society has come to play an influential role in the formulation of policy related to political, economic, and social issues. In all democratic societies, there can be friction between what the people want and what the government thinks is good for development. Taiwanese policy makers have to contend with the will of the Taiwanese people, which does not always neatly coincide with policies intended to foster human capital development and spur economic growth.

The rapid economic growth Taiwan has enjoyed since the late 1970s gradually transformed the island's manufacturing-based economy into an increasingly high-tech and knowledge-based economy. Having previously been concerned mainly with industrial manufacturing, Taiwan, like the other three Asian Tigers, followed Japan's economic leadership during this period. During that time and after, Taiwan gained a reputation for highly efficient investment, a trend that was explored by many scholars in the 1990s [5]. For this reason, high expectations are placed on the return of investments of any kind on the island. Legislation related to public spending and investment is, as a result, often highly scrutinized for accountability and expected to produce results quickly. Taiwan, Singapore, South Korea, and Hong Kong invested heavily in human capital over these decades through both public, private, and household spending on various forms of education and training. That said, public spending on education was significantly lower in Taiwan than the other three Asian Tigers, yet it was still successful in terms of economic development [5].

However, this rapid and unprecedented rate of economic growth would not last. The Asian financial crisis of the 1990s coincided with the slowing of the Taiwanese economy, which has since stabilized at a rate consistent with other countries at a similar level of development. The

subsequent global financial crisis of 2008 may have reinforced this relative slowdown and encouraged a number of austere business practices that persist to this day. Wages, for example, have stagnated for many years in most of Taiwan's key industries, especially for young professionals in nascent careers.

Low wages in Taiwan are also coinciding with a high demand for labor of almost every kind. Unskilled labor is often filled by migrant workers, but the slow drain of its most talented young graduates to Chinese firms in tech centers such as Shenzhen and in enterprises in other foreign countries around the world, coupled with an alarmingly low birth rate, is exacerbating an already severe shortage of young and capable human capital. Overseas companies in mainland China, the United States, and elsewhere tend to offer better pay and benefits to new graduates than do Taiwanese firms, and many of these businesses covet well educated Taiwanese graduates.

Over the course of Taiwan's recent history – through the Japanese colonial era to this day – education has been prioritized by governments and Taiwanese citizens. The imperial Japanese government during the first half of the twentieth century tried to promote education at the primary and secondary levels and established Taihoku Imperial University (known today as National Taiwan University) in 1928. After Taiwan was ceded to the ROC in 1945 and the ROC government relocated from mainland China to Taiwan in 1949, education continued to be a primary consideration, particularly because of its importance in promoting national economic development. Yet by 1950, there were still only seven higher education institutions (HEIs) in the country with a total enrollment of 6,665 students [6]. In the years that followed, Taiwanese education continued to expand under the authoritarian rule of the KMT, which focused heavily on the economic development of the island. In 1968, the Taiwanese government instituted nine-year compulsory education [7], which was extended to twelve years of guaranteed education in 2014 [8]. The 1990s saw an explosion in the number of HEIs in Taiwan. This was largely influenced by demands of civil society for universal access to higher education. There are over 150 HEIs today on an island with a population of 23.34 million.

The four democratically elected administrations of Lee Teng-hui with the KMT, Chen Shui-bian with the Democratic Progressive Party (DPP), Ma Ying-jeou with the KMT, and Tsai Ing-wen with the DPP have all made education and human capital development a top priority. Today, the government continues to do so and has enacted legislation and reforms to improve Taiwanese human capital and improve productivity in various ways. Since 2014, the expressed goals of the MOE through 2023 have been to re-orient the education system to address the changing needs of contemporary Taiwanese and global society. Specifically, reforms target four domains: “(1) preparing more outstanding and dedicated professional teaching personnel, (2) narrowing discrepancies between schooling and the job market, (3) strengthening students' international competitiveness, and (4) empowering students' future productivity” [6].

Today, Taiwan hosts an active civil society and an engaged electorate. For this reason, policymakers must respond to the demands of their constituents, which at times can give the appearance of a volatile and haphazard policy agenda. Policymaking related to education and human capital development is no exception. Economic development still takes priority in national policy making, but there is an increasing focus on social, cultural, and other issues. Policies such as the New Southbound Policy initiated by the Tsai administration are characteristic of DPP attempts to liberate Taiwan's economic destiny from the sphere of the Peoples Republic of China's

(PRC) influence. The two principal parties have competing priorities, particularly with regard to mainland China. Whereas the KMT tends to see China as an economic partner, DPP supporters typically view closer relations with the PRC as a serious threat to Taiwan's economic and national security in the future. This is not uniformly true, but the division is enough to prompt opposing and often confrontational policy decisions, leading to inconsistency in the policies implemented during different administrations. China and cross-strait relations remain a serious consideration when making policy decisions of any kind, as does the fact that Taiwan is still barred from participating in most international organizations due to Chinese pressure on those institutions.

Methodology

Official government statistics and relevant indicators from both academic and media sources are used to shed light on the public policy and human capital issues affecting Taiwan. Primary government sources include official publications such as *The Republic of China Yearbook 2017*, an annual publication released by the Executive Yuan (executive branch of government) that covers a wide variety of demographic issues related to Taiwan's domestic society and relations with other countries [9]. Other publicly available government sources, including policy documents, statistical indicators, and relevant whitepapers, are also used to provide empirical evidence supporting the findings and discussion in the following sections. Given Taiwan's commitment to making government data open and accessible to the public [10] documents released by government agencies and programs related to public policy innovation and human capital development are updated regularly and contain detailed information about organizational structures, funding, and procedures. All of these sources are used to illuminate the extent of the Taiwanese government's involvement in human capital development.

Academic and media sources are then used to evaluate the impact of these public policies aiming to promote STEM education, TVET, and the development of human capital more broadly in Taiwan. Scholars have been involved in this endeavor since Taiwan's rapid economic growth began. Where needed, insights are drawn from studies going back to the late 1990s regarding educational reform policies and investment in human capital development. Media sources which have compiled data and conducted interviews with industry representatives are used to gain insight where otherwise unavailable.

All sources are synthesized in the discussion section, where the key challenges facing human capital development in Taiwan are identified, and local responses to these challenges and policies are evaluated. Lessons learned from the history of human capital development are highlighted, and policy recommendations are then offered related to domestic policy innovation to address relevant challenges. Although the findings of this report are not comprehensive, they are intended to illuminate the larger picture of human capital development in Taiwan. The most influential organizational structures, policies, plans, and programs have been considered and evaluated based on the above sources, and challenges, responses, and recommendations that are identified are based on these.

Findings

Taiwan has placed great emphasis on human capital development through various means, including STEM education and TVET. Its economic development over the years is evidence that the country has been remarkably successful in this regard, suggesting that there are important lessons to be learned from the Taiwanese experience. Even so, given the wide range of relevant policy options, optimizing human capital development based on the context of a society and the resources available to it is no simple task. The findings presented in the following subsections address three major themes: (1) organizational structures tasked with human capital development; (2) related public policies, plans, and programs, especially for promoting STEM and TVET education; and (3) the emerging human capital needs of and skills prioritized by government, industry, and civil society.

Organizational Structures

Taiwan has a democratic but relatively centralized political structure, and government agencies are the most influential actors involved in promoting human capital development. The most prominent governmental actors include the Executive Yuan, Ministry of Education, Ministry of Science and Technology, Ministry of the Interior, Ministry of Labor, Ministry of Economic Affairs, and National Development Council. These agencies, either independently or in collaboration with relevant partners, are each responsible for managing programs related to different aspects of human capital development in line with their institutional aims. Figure 1 shows the relationships among the agencies discussed in the following subsections.

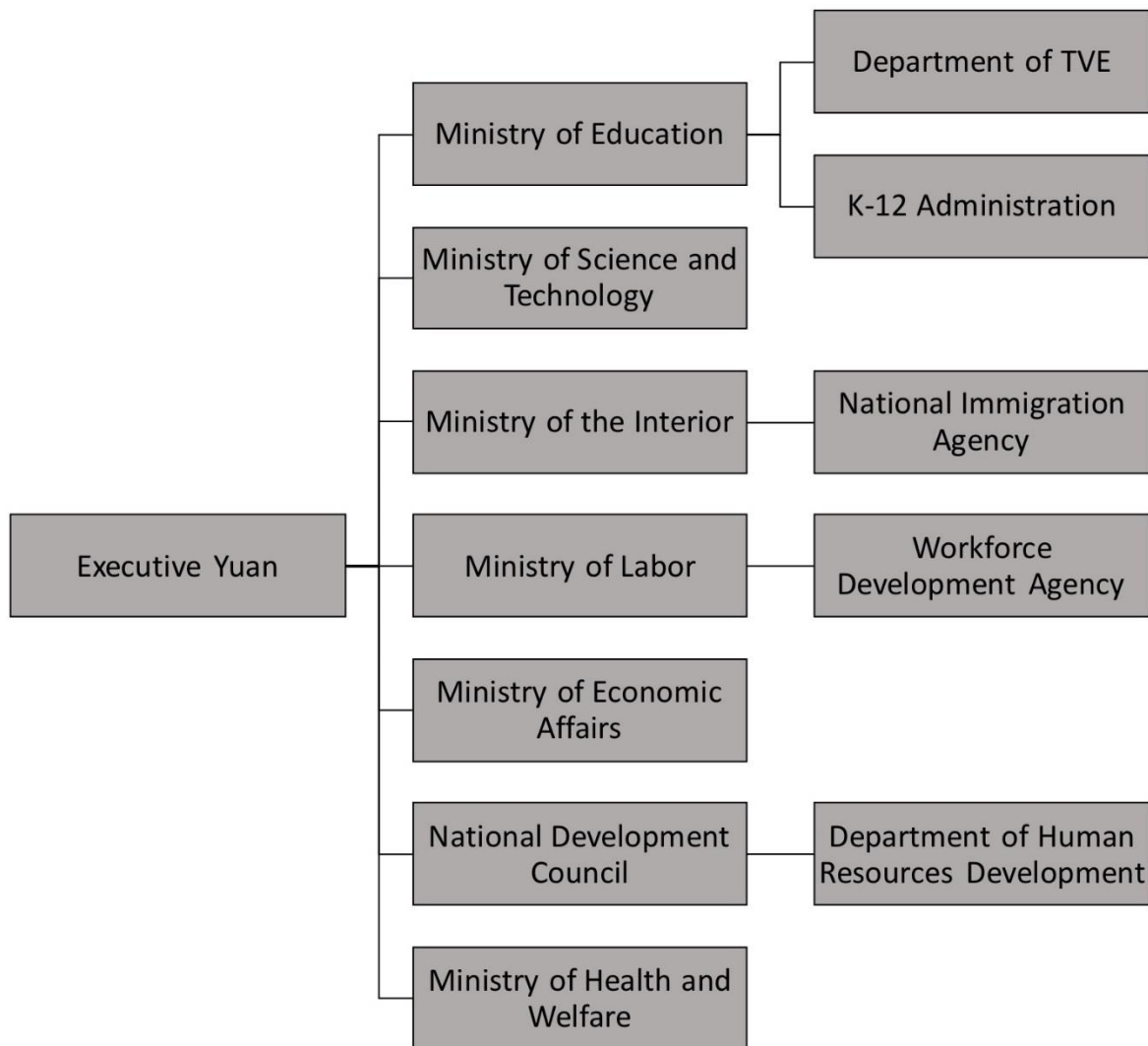


Figure 1: Agencies and institutions involved in human capital development

Source: Adapted from Executive Yuan (2016)

Executive Yuan

The Executive Yuan wields the authority to set the policy agenda for many of the governmental organizations concerned with human capital development. The current Tsai administration generally falls in line with the policy platform of the DPP, which gravitates toward a few general predispositions, including a shift of focus away from China (sometimes coupled with the rhetoric of independence), domestic policy that appeals to Taiwanese sense of cultural and social identity, and social issues such as equality and workers' rights. The Tsai administration, however, was elected on less divisive, more centrist attitudes toward many of these issues [11]. Regarding human capital development, the Tsai administration and its predecessors, including both KMT- and DPP-led administrations, have set up myriad programs, investment funds, and policies (both long- and short-term) to address the need for developing human capital in Taiwan. This remains one of the key concerns of the Executive Yuan, as improving human capital development through education

and training, and strengthening productivity in key sectors of the economy is a major demand of Taiwanese voters, industry, and workers [12].

Ministry of Education

The Ministry of Education (MOE) is responsible for a wide range of policies and institutions related to academic education at all levels, professional training, and human resource development. Like all ministry-level government agencies in Taiwan, it is under the Executive Yuan and its minister is appointed by and reports to the president. In terms of promoting STEM and TVET education specifically, it has enacted or been tasked with implementing various policies and programs. The most notable of these include the comprehensive primary and secondary education system; TVET programs in high schools, middle schools, and junior colleges; programs for strengthening Taiwanese universities and institutions of higher education; and initiatives like the Forward-Looking Infrastructure Development Program. These are either directly managed by MOE or under the auspices of the Department of Technological and Vocational Education, the K-12 Administration, or other subordinate agencies. Legislation and activities for which human capital and productivity is a primary focus include the Youth Employment Program, the Intelligent Taiwan Manpower Cultivation Project, and the Taiwanese education system in general. Although human capital is a priority, the education system for any country also serves the less tangible purpose of nurturing the intellectual and social wellbeing of young citizens, and even when a given policy or program does not specifically mention STEM, TVET education, or human capital development, it may serve to benefit these in indirect but nevertheless important ways [13].

Ministry of Science and Technology

The Ministry of Science and Technology (MOST) is responsible for the promotion of Science and Technology development by linking industrial development more closely to scientific research. In the realm of STEM and TVET investment, MOST is primarily concerned with the facilitation of research and development with programs such as the National Science and Technology Development Fund and the Taiwan Silicon Valley Tech Fund (which it manages in cooperation with the National Development Council). Activities specifically devoted to the promotion of science education include the “Sci-Tech Vista” website, *Science Development* magazine, and programs such as the High Scope Project (HSP). More generally related to human capital development, MOST provides scholarships to foreign university students interested in an education in Taiwan. Overseas students have the potential to contribute to human capital development domestically by strengthening and diversifying the local academic environment as well as becoming employed in Taiwan after graduation [14].

Ministry of the Interior

The Ministry of the Interior (MOI) is responsible for a range of different tasks related to infrastructure, law enforcement, immigration, and civil services. Of those, the regulation of immigration is the most related to STEM education and TVET. The National Immigration Agency (NIA) under MOI is authorized by the Nationality Act to allow foreign professionals in certain fields to obtain temporary or permanent resident status or even become naturalized citizens of the ROC [15]. The NIA has also submitted an amendment to the Immigration Act with the aim of

retaining more foreign talent. The NIA is also involved in policymaking and other programs more generally related to the development and acquisition of human capital. Through the NIA, the Taiwanese government assists in the integration of recent immigrants, through programs such as the Overseas Empowerment Program for Children of New Immigrants, which encourages children of immigrants to Taiwan to connect with the extended families in their parents (usually the mother's) home country. Other policies are in line with the goals of the New Southbound Policy, such as the recent amendment of the Online Application for ROC Travel Authorization Certificate of Southeast Asian Countries, which makes it easier for nationals of Cambodia, India, Indonesia, Laos, Myanmar and Vietnam to apply for a travel authorization certificate from the ROC [16].

Ministry of Labor

The Ministry of Labor (MOL) performs a large number of government functions related to the Taiwanese workforce. As with all ministerial agencies in Taiwan, the expressed goals of MOL are tied to the policy agenda of the incumbent administration, currently led by President Tsai and the DPP. As of now, those goals are centered on labor interests such as employment services, safety, and pensions, but the first goal stated on the MOL website is to “[p]romote and implement diverse vocational training programs, and encourage industries to apply occupational competency standards” [17]. Principal among the agencies associated with these goals is the Workforce Development Agency (WDA), which offers vocational training for the unemployed and regulates numerous skill certification trainings. The MOL also participates in international organizations related to labor and labor development as much as it is able to given the obstacles presented by the context of cross-strait relations. Due to Chinese pressure on the United Nations and other international organizations not to allow Taiwanese involvement, however, Taiwan and MOL have limited capacity to do so. Four organizations that Taiwan works with in some capacity are the International Labor Organization (ILO), the World Trade Organization (WTO), the Asia Pacific Economic Cooperation (APEC), and the Organization for Economic Cooperation and Development (OECD) [18]. Participation in each of these organizations must be done on an informal, observer, or other limited basis, as anything more is seen by Beijing as a violation of the Chinese claim to sovereignty over Taiwan.

Ministry of Economic Affairs

The Ministry of Economic Affairs (MOEA) is responsible for promoting sustainable and innovative economic development in the ROC through a number of programs and agencies as well as a few national corporations. As for those related to human capital development on the island, MOEA engages in a many initiatives including the Contact Taiwan Program, Youth Entrepreneurship Program, International Entrepreneur Initiative Taiwan, and Taiwan Productivity 4.0 Initiative. These and other programs are typically handled through the ministry's Industrial Development Bureau, the Department of Investment Services, and other administrative entities. Although the MOEA itself does not engage specifically in the promotion of TVET and STEM, it is one of the most influential top-level agencies engaged human capital development in general, and its programs and policies effect STEM and TVET indirectly [19].

National Development Council

The National Development Council (NDC) serves mainly as “the chief of staff for the Executive Yuan for policy coordination and implementation,” [20]. In 2014, the NDC superseded the Council for Economic Planning and Development (CEPD), which had previously been responsible for equivalent aspects of the policy process. More recently, the Tsai administration has made ten explicit priorities for the NDC, most of which center on the evaluation of existing policies for maximum efficiency and facilitating further growth in the industries comprising the 5+2 Industrial Innovation Plan in Taiwan, which include the internet of things, biomedical, green energy, smart machinery, and defense, plus high-value agriculture and the circular economy. Regarding STEM and TVET development in Taiwan, the NDC oversees programs and agencies such as Contact Taiwan, the Head Start Taiwan Project, and the Asian Silicon Valley Development Plan. More generally, the NDC promotes human capital development through its subordinate agency, the Department of Human Resources Development, which projects population and employment trends and coordinates a variety of policies related to “population, education, vocational training, employment, international talent, and elderly economic security” [20].

Other government-funded or operated organizations involved in the productivity and human capital are the Ministry of Health and Welfare, the Science and Technology Advisory Group, the Ministry of Culture, the Ministry of National Defense, and Academia Sinica. The various government organizations, agencies, and ministries mentioned in the subsections above do not constitute an exhaustive list, but they do highlight the key government actors involved in human capital development and offer a foundation for researchers interested in further understanding the roles of these various institutions.

Non-Governmental Institutions

While government agencies remain the most influential and most highly funded actors in the Taiwanese system, there are some non-governmental institutions that play important roles in promoting human capital development through STEM education, TVET, or other means. Although an exhaustive list of such institutions is beyond the scope of this chapter, two that are worth highlighting include the Industrial Technology Research Institute, and the Epoch Foundation. The Industrial Technology Research Institute (ITRI) is a non-government research and development institution in Taiwan from which over 270 companies have emerged. Generally, ITRI focuses its research on the areas of “Smart Living, Quality Health, and Sustainable Environment” [21]. The Epoch Foundation is a strategic partnership between industry, research institutions, academia, and government with the express goals of promoting the industrial development of Taiwan and the economic prosperity of the Asia-Pacific region more broadly. The foundation is engaged in a number of projects related to entrepreneurship and innovation education, including Young Entrepreneurs of the Future, the Epoch Internship Program, the Search for Talent Program, and Entrepreneurial Training for Mainland Returnees [22].

Private investment is also an important contributor to overall human capital development in Taiwan. Through the promotion of STEM education, TVET, and education more broadly, private investment by individuals and households as well as investment in various programs by local and foreign companies and others in the business community all contribute to the creation and strengthening of human capital in the country. Taiwan is particularly unique, in that household spending on education is one of the world’s highest. Taiwanese parents spend more on their

children's education than all but four of the world's nations according to a report by HSBC. The report, titled *The Value of Education*, claims that an average of US\$56,424 is spent on every Taiwanese child, a figure behind only Hong Kong, the United Arab Emirates, Singapore, and the United States [23]. The high amount of spending can be attributed to several factors, including private primary and secondary school tuition and fees, after-school programs called *buxiban* (補習班), and college expenses such as tuition, fees, books, and accommodation. Taiwanese businesses are also spending more money on training and coaching employees as well, but many outsource such activities to specialty training and certification firms [24]. Several foreign companies have also made major contributions to human capital development in Taiwan. A prime example of this is Google, for which Taiwan is its "largest R&D center in Asia" [25]. The company has contributed large amounts of financial resources to relevant programs over the years, including committing in 2018 to "train 50,000 Taiwanese businesses and students in digital marketing over the next year through a combination of online and offline initiatives" and "holding a train-the-trainers program for teachers in locations across Taiwan ... to educate a new generation of Taiwanese students in AI" and machine learning [26]. Other prominent foreign businesses that have invested in human capital development in Taiwan include Microsoft, which has launched an AI R&D center, and Amazon, through its investment in a "joint innovative center" [25].

Public Policies, Plans, and Programs

In recent years, many public policies, plans, and programs with the aim of encouraging human capital development in the Taiwan have been proposed and implemented. These are managed by various government agencies and institutions, as highlighted above, and they have varying timeframes with some having been completed and others ongoing. Although the overall agenda of the Taiwanese government is set by the current administration, many individual programs and policies that remain in effect were put in place by previous administrations. For the purpose of coherent discussion, this report sorts them into four categories: policies, plans, and programs for promoting the STEM fields in Taiwanese businesses and education; those facilitating the development of TVET; those concerned with developing entrepreneurial skills and opportunities; those that support human capital development in general.

STEM

Universities are responsible for the bulk of STEM development in Taiwan, both in terms of human capital development and R&D. According to the statistical yearbook released each year, 1,309,670 individuals were enrolled in higher education programs in Taiwan in 2016–2017, 545,601 of them in STEM-related fields [9]. Problematically, STEM programs in Taiwanese HEIs struggle to gain international recognition, and the Taiwanese government has initiated the Aim for the Top University Project (邁向頂尖大學計畫) with the intended result of elevating at least one institution into the top 100 universities in the world. Many of the universities targeted by this program, which involves 5-year plans for institutions receiving funding, have created offices specifically related to using that funding to improve their institutions [27]. Another plan, the Multi-Star Project (繁星推薦) gives students the opportunity to apply for admission to STEM university programs through means other than examination. It has been seen as a successful program in spite of initial backlash, and 'Star' students, as they are sometimes called, tend to reach high levels of

achievement [28]. However, alarmingly low birthrates in Taiwan have become an existential threat to many HEIs, a problem which is discussed further below.

The current National Science and Technology Development Plan (S&T plan 2017–2020), which occurs every four years, focuses on four major goals, one of which specifically targets human capital development, aiming to “foster and recruit talent with diverse career paths.” To address this goal, the plan references the digital economy as its major focus, while also aiming to support the highlighted “5+2 industries,” and explicates four specific strategies, which include: “(1) Foster Interdisciplinary Talent in the Digital Economy; (2) Reinforce Technical Expert Training Mechanisms for Industries; (3) Diversify Career Paths to Invigorate the Cultivation of High-Caliber Scientific Research Professionals; and (4) Recruit and Retain International Top Talent” [29]. The Taiwan Productivity 4.0 Initiative results from the same policy motivations, and targets eight sectors in Taiwanese industry, including agriculture, food manufacturing, information technology, logistics, machinery equipment, retailing, textile, and transportation [30]. The program promotes human capital development by cultivating experience and talent through cooperation between domestic industries and academic institutes, interdisciplinary learning, and international linkages [31].

TVET

As mentioned previously, the promotion of TVET in Taiwan is largely managed by MOE through the implementation of relevant programs in middle schools, high schools, and junior colleges. Students seeking a vocational education have a number of pathways available to them, and specific opportunities may depend on what educational resources are available in their community. One option is comprehensive junior-senior high school, which combines middle school and high school and contains both vocational and academic tracks. Students attending these schools have the choice of either one of the two tracks or pursuing a combination track mixing academics and vocational training. Typically, though, students opt for only one of the two tracks. Upon graduation from middle school, students in the vocational track are presented with the option of going on to 3-year vocational secondary school, where they choose a specialty such as engineering, business, or fine arts, or advancing immediately to a junior college offering a 5-year program, after which they will have obtained the equivalent of an associate’s degree. The other option, a 3-year vocational secondary school, also enables students to go on to junior college where they can enter a 2-year program resulting in the same associate-level degree.

It should be noted that none of the above options “lock” a student into a particular track for the entirety of their education. After completion of the junior college track, for example, students can go on to a 2-year technical institute, or even decide to transfer to a 4-year university. Although attention has been focused more on expanding access to 4-year programs in recent decades, especially in STEM fields, some attention has begun to shift back toward TVET education in Taiwan, as can be seen by projects such as the Forward-Looking Infrastructure Development Program [8]. Broadly, that program’s goals are to increase government investments in “green energy, digital infrastructure, water environments, rail systems, and urban and rural development,” [12] but the program also includes a special section related to human capital development, which includes investment in childcare, food safety, and “develop[ment of] human resources to create jobs” [12]. Part of the investment (NT\$8 billion between 2017 and 2021) attached to this program

is bound for the MOE, where it will be allocated to vocational colleges and universities to “optimize environments for Job Ready Skills Programs” [32].

Entrepreneurship

Skills and opportunities associated with entrepreneurship are among the top priorities in terms of developing human capital in Taiwan. A few of the most important initiatives associated with these goals are the Innovation and Startups Taskforce, the Taiwan Innovation and Entrepreneurship Center, and the HeadStart Taiwan Program. The Innovation and Startups Taskforce is an organization under the Executive Yuan and administered through the NDC, which works collaboratively with the HeadStart Taiwan Project and the Asia Silicon Valley Development Agency to promote entrepreneurial ventures in Taiwan, especially those related to STEM. By the beginning of 2016 (two years after its establishment), the task force had overseen the allocation of over US\$303 million in investment of Taiwanese business [12]. The Taiwan Innovation and Entrepreneurship Center was established by MOST in partnership with well-known “accelerators” in Silicon Valley and venture capital groups. The center’s three stated purposes are to (1) link Taiwanese startups to the global market, (2) set up the Tai Si investment fund, and (3) establish the Taiwan Rapid Innovation Prototyping League for Entrepreneurs (TRIPLE). The HeadStart Taiwan Project, created in 2014 employs a three-fold strategy of deregulation, building of support structures for startups and entrepreneurs, and attracting foreign investment, [34].

Human Capital Development in General

Investment in human capital development is recognized as a vital activity for national competitiveness and prosperity in Taiwan both by individuals and society at large. Investment in education and training is as much a priority across the rest of society as it is for sectors related to STEM, vocational, and technical fields. These programs are typically well funded and tend to enjoy enthusiastic participation from their participants. Since 2014, twelve years of education have been available to all by law [35], but students enjoy a significant degree of choice within that period of compulsory education during which resources are available. As mentioned above, there are two tracks, vocational and comprehensive, that students can choose to take. Each of these tracks lead students to careers or additional educational opportunities and allows enough flexibility for students to change tracks at certain points. Students at comprehensive schools receive a broad, liberal arts-style education that prepares them for a four-year bachelor’s program in university [36].

Beyond the national primary and secondary education system, other programs and policies, such as the Youth Education and Employment Programs, were initiated to promote young Taiwanese people’s opportunities to broaden their education to settings beyond the. One in particular allows students interested in pursuing a trade skill before entering higher education can apply for an education and employment savings account. Accepted applicants receive NT\$5,000 per month from the MOE and MOL each for up to three years while they learn a trade [37]. Another program, the Intelligent Taiwan – Manpower Cultivation Project was implemented between 2009 and 2016 to improve equity in literacy and IT education, quality and access to vocational education, and cultivate a “world-class” higher education system [38].

In order to attract and retain more talent, the NDC created the Contact Taiwan Program in 2015. The program created a recruitment services center with both a physical office and virtual platform, which connects foreign experts to employment in Taiwan and vice versa. The program also works to improve conditions for foreign talent working in Taiwan by advocating for the easing of some restrictions on foreigners and providing services to facilitate the transition to a long-term stay in Taiwan [39]. Focusing primarily on highly qualified talent, the program mainly serves the biomedicine, tech, and defense industries [40]. The Taiwanese government also offers international higher education scholarship programs that attract students from all over the world to conduct their undergraduate and graduate studies in Taiwanese universities. These scholarships often include all university expenses as well as a generous monthly living stipend. Scholarships offered include the Huayu Mandarin Enrichment Scholarship, the MOFA Taiwan Scholarship, the MOE Taiwan Scholarship, the Academia Sinica Taiwan International Graduate Program, and TaiwanICDF international scholarships. Each program has its own goals and standards, but generally, all of them aim to improve cultural understanding and economic cooperation between Taiwan and partner countries [41] and contribute to human capital development in Taiwan through education in STEM and other fields.

The training and education of civil servants is also a priority in Taiwan. Rather than being managed by a national administration, departments of civil service development (DCSDs) are primarily on the municipal level. The Taipei city government, for example, began training civil servants through a temporary program in the late 1960s, and this has since become a permanent feature of the municipality in its efforts to develop human capital responsible for managing all aspects of the services and infrastructure provided by the city government. Like other DCSDs, Taipei's focuses on advancing the skills necessary for efficient management and execution of government policies [42].

Starting in 1990, experimental education began gaining ground in Taiwan in order to promote twenty first century skills, growing to include a total of almost 5,000 students in 61 institutions across the island today [43]. In recent years, the MOE has proposed a number of different laws to expand experimental education and give parents and students more choices. The cornerstones of the current paradigm on experimental education are three government acts: the Enforcement Act for Non-school-based Experimental Education Across Levels Below Senior High School (高級中等以下教育階段非學校型態實驗教育實施條例) [44], the Enforcement Act for School-based Experimental Education (學校型態實驗教育實施條例) [45], and the Act Governing the Commissioning of the Operation of Public Elementary and Junior Secondary Schools to the Private Sector (公立國民小學及國民中學委託私人辦理條例) [46], all of which were promulgated in 2014. The most recent laws have raised the ratio of students allowed to be in experimental programs and extended experimental education opportunities to higher education. Most experimental education schools are small, private institutions, but demand for these types of programs is growing quickly, and legislators are adjusting laws accordingly [47].

Emerging Needs and Skills

Recent and ongoing economic changes stemming from industry 4.0, globalization, and other global and domestic forces are prompting governments all over the world, including that of Taiwan, to prioritize a particular set of skills and competencies in their national workforces. Taiwanese labor

is especially vulnerable due to demographic changes, cross-strait economic and political pressure, and international competition in industries that Taiwan has previously excelled. The “5+2” industries identified by the Tsai administration are officially prioritized in public policy, but other industries, both white and blue-collar, also have human capital development needs. The seven industries in the 5+2 Major Innovative Industries policy specified by the Tsai administration are “intelligent machinery, Asia Silicon Valley, green energy, biomedicine, national defense and aerospace, new agriculture, and the circular economy” [48]. These industries all require a shift in the skills and knowledge that are taught in educational and professional training institutions across Taiwan to be more technical, creative, and entrepreneurial.

Chief among the needs of the key industries in Taiwan is talent with knowledge and skills applicable to artificial intelligence, internet of things, and information technology. In order to facilitate the growth of these fields, government policy in Taiwan has a multi-billion-dollar budget in investment funds to target specific industries, which includes the “NT\$100 billion (US\$3.3 billion) Industrial Innovation and Transformation Fund to be used for investment in new technologies, with another NT\$10 billion [US\$300 million] from the newly established National Investment Corporation” [49]. Much of this money is directed toward educational and training programs, as well as structural support for small and medium-sized enterprises, which are often referred to as the backbone of the Taiwanese economy. The need for these kinds of skills, however, is recognized by more than just the government and business community. Parents and young professionals are very much aware of the skill set required for success in Taiwan today. Of the total 1,309,670 students enrolled in Taiwanese universities in 2016–2017, 545,601 were studying fields related to STEM, accounting for nearly 42% of the total student body, and thousands more were enrolled in business programs [9].

The general trends in the Taiwanese labor force have been changing for decades as the economy has shifted from one based on manufacturing to one based on the higher-tech industries mentioned above. Recent indicators have shown some change in the sectors targeted by major policies. As a percentage of the total structure of employment, blue-collar craft and machine workers still accounted for just over 31% of the total labor force, while white-collar work, defined as professionals, technicians, clerical workers, managers, and officials, accounted for nearly 45%. Taiwan enjoys a low unemployment rate of 3.64% as of April 2018 [50], but the changing demographics associated with an aging population and declining birth rates are cause for alarm for Taiwanese industries struggling to recruit young talent [9].

Discussion

Taiwanese efforts to develop the human capital resources necessary for greater productivity and sustainable, equitable growth have had mixed results. There are a number of factors at play that work in Taiwan’s favor, but equally influential are the forces which confound the efforts of policy makers and business leaders on the island. Taiwan enjoys many advantages through its close economic ties to large markets like China and the United States and the economic development it achieved in the 1970s and 1980s. However, the limits of these advantages without significant changes in the way human capital is developed have become apparent since the slowing of economic growth beginning in the 1990s. Among the chief concerns of Taiwan at this point is how

to capitalize on its existing advantages and facilitate the growth of talent in other areas so as to compete in an ever-globalizing world [51].

Key Challenges

In terms of human capital needs and strategies to increase productivity, Taiwan is in a unique situation globally because of a host of factors that are both international and domestic. The changes in economic conditions affecting Taiwan's human capital development have been both global and domestic in nature. Since the Asian financial crisis in the 1990s, capital investment has shown slowed returns in Taiwan, and many argue that the best prospect for continued economic growth will come from increased development of human capital [52]. Many Taiwanese businesses and policy makers agree, as is evident from the many plans and programs discussed above, but recent graduates often still find it difficult to obtain quality employment despite recent investments and initiatives [53]. When jobs are available to young professionals they typically offer low wages and minimal benefits. There is some sign that wages are beginning to rise slowly [54], but they have a long way to go if they are to compete with the draw of many Chinese and other overseas firms.

These changes in economic conditions are generally recognized by Taiwanese society, and measures are being taken by government agencies, educational institutions, non-governmental organizations, domestic and foreign enterprises, and households to improve the quality of human capital in Taiwan. TVET programs at secondary and tertiary levels, for example, remain well-funded and prolific across the island, but in recent years, emphasis has shifted in favor of liberal arts and STEM education, sometimes at the expense of vocational and TVET training. The 2017 MOE report broke down educational spending, saying, "in [school year] 2015, the total education budget was NT\$719.0 billion, of which preschool education accounted for 7.94%, elementary and junior high education accounted for 42.14%, senior secondary education accounted for 15.17%, higher education accounted for 34.15% (junior colleges 0.78%, universities and colleges 33.37%), and 0.61% went to other institutions" [36].

In the years since Taiwan's rapid growth in the 1970s and 1980s, the island has been undergoing considerable demographic changes, including rising immigration, especially from Southeast Asia and the Pacific, and a rapidly aging population associated with a sharply declining birthrate. Taiwan now has the third-lowest birthrate in the world, behind only Singapore and Macao [55]. In terms of productivity, this has a number of alarming implications. Because of the movement toward massification of higher education in the 1990s, Taiwan now has an overwhelming surplus of colleges and universities leading to a higher-than-average proportion of high school graduates continuing on to higher education, a college acceptance rate that reveals the level of desperation experienced by some universities failing to attract enough applicants, and a resulting decrease in the overall quality of the higher education provided by these institutions. As many schools struggle to maintain sufficient student enrolment, they are considering mergers with other institutions or even facing the threat of complete closure if they are unable to meet government-imposed standards for continued operation. HEIs have been steadily decreasing their standards for acceptance and academic performance over the last several decades. The general acceptance rate for university across the country has increased from, "around 20 percent before the 1970s to 49 percent in 1996 and over 90 percent since 2006, among the highest in Asia" [6]. Taiwan also actively recruits foreign students to strengthen and diversify its universities, improve their

standings in international rankings, and make up for the dwindling numbers of domestic students attending its numerous universities [13]. The number of foreign students in Taiwanese universities increased from about 45,000 in 2010 to over 111,000 by 2015 [56]. According to a survey conducted by the MOI in 2016, more than five million Taiwanese hold a college degree or higher, accounting for 45% of the population between the ages of 25 and 64. That figure is significantly higher than the Organization for Economic Cooperation and Development (OECD) average of about 33% [57]. Although it is promising as a sign of the level of access to higher education in Taiwanese society, the reality is that the Taiwanese economy is not prepared to absorb such a large number of college graduates. Government responses to popular demand in the 1990s and early 2000s to increase that accessibility were largely successful, but Taiwanese businesses lament the decreasing number of vocationally trained workers that resulted from that expanded access [58].

One of the most significant problems facing Taiwan's ability to develop its human capital is the draw of overseas career opportunities for young graduates. Wages are low for graduates in Taiwan, which leads them to seek opportunities elsewhere. China actively courts young Taiwanese professionals to work in its burgeoning tech firms or pursue graduate studies in Beijing, Shenzhen, and other cities around the mainland. These incentives manifested themselves in public policy in the first half of 2018 when China announced 31 preferential policies that it would extend to the people of Taiwan (三十一項惠台政策). These policies allow Taiwanese to take certification exams for a host of professions, gain preferential access to Chinese HEIs, and even become members of "grassroots" industry and trade groups in China. The policy also includes a wide variety of benefits for Taiwanese businesses, including, "...permitting Taiwanese firms to invest in Chinese businesses, receive tax breaks, participate in the 'Made in China 2025' initiative and National Key Research and Development Programs, bid for government procurement contracts, and manage semi-public enterprises" [59]. The political fear expressed by some is that this is one of many policies initiated by Beijing to seduce Taiwan into trading political recognition for economic opportunity [60], but many have rejected this as a viable strategy, even if it is Beijing's intention. As a result, many in Taiwan still view the new policies as an "opportunity, not a threat" [61].

China stands looming in another of the major issues facing Taiwanese productivity and human capital development. The "One China Policy" has, since even before the 1970s when the ROC lost its diplomatic recognition by the US and other countries, slowly eroded Taiwan's ability to participate in the international community. MOL has outlined the organizations with which Taiwan is able to participate to some extent. It should be noted, however, that with few exceptions Taiwan is only able to engage with these organizations in an unofficial capacity, sometimes being reduced to working only with retired administrators and experts. This is a recurring motif in Taiwanese policy making which frequently stands in the way of Taiwan's national goals and divides popular opinion. Nonetheless, the international organizations related to human capital development that Taiwan actively tries to engage with include the ILO, International Trade Union Confederation (ITUC), the International Organization of Employers (IOE), the WTO, the Asia Pacific Economic Cooperation's (APEC) Human Resources Development Ministerial Meeting and Human Resources Development Working Group (HRDWG), and the Organization for Economic Cooperation and Development (OECD) [62].

Local Responses

As is evident from the discussions above, Taiwanese engagement in the development of its human capital resources has invariably been direct and active. Government agencies, private enterprises, and individuals invest heavily in education and training with an eye on trends shaping the global economy. As of 2016, public expenditure per student is at the highest level it has ever been [9]. Results from these activities have been varied, however, and new approaches will be needed if Taiwan is to remain competitive.

Seen as a means to maintain and improve national competitiveness, Taiwan has promoted human capital development by fostering interest in STEM. As detailed above, some of these programs include STEM programs in Taiwanese HEIs, the National Science and Technology Development Plan, and the Taiwan Productivity 4.0 Initiative. Although they can be difficult to evaluate, these programs have shown mixed results in terms of their effect on productivity. STEM programs in universities tend to receive a high level of funding and enjoy relatively high enrollment at Taiwanese institutions, compared to the humanities, social sciences, and other fields. However, as mentioned above, graduates from Taiwanese schools often seek employment abroad, which diminishes the returns on this important investment [63]. STEM in primary and secondary schools has been reformed numerous times in recent years with the intention of improving student engagement and critical thinking skills, but as of now, little progress has been documented on that front in terms of students' performances on international tests such as TIMSS and PISA. As a top priority for Taiwanese society, STEM education will likely continue to be a primary concern for policymakers and private enterprises alike, but unless conditions improve for motivated graduates of four-year STEM programs, Taiwan will continue to lose its most capable talent to more promising markets in China.

Taiwan has gone to great lengths to develop and support TVET opportunities for its citizens. As discussed in this report, examples of those initiatives include TVET programs in secondary and tertiary education and the Forward-Looking Infrastructure Development Program. TVET education in Taiwan has been strong for decades, but since public demand for more access to the highest levels of educational attainment grew in the late 1990s and early 2000s, some focus has shifted away from junior colleges, vocational secondary schools, and technical programs in favor of academic programs. Per student spending on education is highest at academic HEIs at NT\$187,271 (US\$6,287) in 2016, while spending at junior colleges was NT\$105,393 (US\$3,538) [9]. The emphasis on four-year degree programs produces an endless supply of quality graduates, but many firms in Taiwan complain of a lack of technically skilled labor produced by vocational programs [58]. Taiwan produces plenty of graduates from quality four-year programs, but low pay and sparse opportunity means they often seek work abroad or end up employed in positions that are not relevant to their university studies. In the meantime, Taiwan should not let its standard for TVET deteriorate.

Taiwanese policymakers have shown an awareness of the need to develop twenty first century skills in Taiwan's workforce, and have taken strides to address that need. Some of the policies and programs directed toward that objective, as discussed above, include the Innovation and Startups Taskforce, the HeadStart Taiwan Program, and experimental and alternative education programs

across the country. Although many recent reforms to the Taiwanese education system have focused on massification of secondary and tertiary education, considerable effort has also been directed toward the development of knowledge and skills associated with the 5+2 industries, entrepreneurship, and other innovative fields. In terms of productivity, these efforts have produced mixed results. As mentioned above, many of Taiwan's most talented graduates and innovators opt for the better opportunities available in China and elsewhere. Beyond that, even as these reforms are going into effect, Taiwanese education still suffers from a lack of creative problem-solving skills despite the prolific availability of technical knowledge. Some have attributed this to a test-driven educational culture, wherein students are well prepared to pass tests but unable to apply much of that knowledge to practical situations [64]. If Taiwan is to foster a more innovative and engaged workforce, more emphasis will need to be placed on higher-level critical and entrepreneurial thinking skills that are difficult to assess on standardized tests.

Taiwanese policymakers and businesses have been trying to bolster the country's capacity to recruit and retain quality talent in recent years. Among these efforts are the Contact Taiwan Program, scholarship programs such as the Taiwan Scholarship offered by MOE and MOFA, and the International Cooperation and Development Fund. Other legislation such as the Act for the Recruitment and Employment of Foreign Professionals [65], and special programs designed to facilitate foreigners' transition to Taiwan make immigration to the island easier and more desirable. Currently, the total number of foreign residents in Taiwan is 715,080, most of whom come from Southeast Asian countries, with a significant number also coming from Japan, Korea, the US, Canada, the UK, India, and France [66]. Although Taiwanese wages are relatively low, some foreign talent are won over by the low cost and high quality of living compared to many other potential destinations globally. Even so, it remains inevitable in the current context that some of the most desirable talent is likely to seek more lucrative compensation and opportunities available elsewhere. Policymakers and businesses need to focus at home as well, though. The flood of talented young graduates leaving Taiwan for better opportunities on the continent could be slowed, but only if young people feel that they have a future at home that compares. If Taiwanese firms don't offer graduates better wages, more benefits, and a clear path for career advancement, it will continue to lose its most promising talent to foreign markets.

Conclusion

The cultivation of quality human capital is a top priority for Taiwan. Ever since the economic miracles of the 1970s and 1980s, a strong, well-trained workforce has been an essential part of continued success. Specifically, STEM education and TVET continue to be prioritized by policymakers, enterprises, and individuals as a means to ensure that Taiwanese human capital resources can contribute to the realization of continued economic growth and higher productivity. Government agencies, non-governmental institutions, and private interests all contribute to this endeavor in important ways in order to meet the difficult challenges facing Taiwanese society today. However, an aging, highly educated population facing slowed economic growth in a globally changing industrial and technological landscape must work harder than ever to maintain a healthy economy that guarantees equitable opportunities for its population.

If Taiwan is to succeed, significant effort is needed to give Taiwanese scientists, engineers, machinists, and professionals of all kinds the tools they need to bring Taiwan's society into the

twenty first century. Specifically, Taiwanese businesses, institutions, and government need to work together to make the country more attractive to the talented young professionals produced by its universities and colleges. In terms of TVET, Taiwanese society cannot overlook the importance of innovative and accessible vocational and technical training. Taiwan's highly educated population will be squandered if it runs short of qualified trades people. The education system in Taiwan also needs to continue to shift away from a traditional rote learning style and towards a methodology that promotes critical thinking and skills that are relevant now, and that will be relevant in the future. Overemphasis on testing will continue to undermine those efforts until major changes are made. Beyond that, Taiwanese businesses and policymakers need to devise new ways to attract more top minds from abroad, and to retain them, and their native talent, for longer.

Taiwan has made immense progress in terms of human capital development and it has served as a model for others in the region, and indeed, the world. That said, Taiwan is faced with new demographic, economic, educational, and policy-related challenges that continue stand in the way of progress and growth. Many initiatives have aimed to address these, but more must be done if Taiwan is to optimize its development of human capital and continue to compete globally with the world's most advanced economies.

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