The Role of Science, Technology and Research in Economic Development

By

Ernesto M. Pernia, Ramon L. Clarete, and Gisela P. Padilla-Concepcion*

Abstract

Starting with the premise that technological innovation and economic growth are interactive and mutually reinforcing, this paper argues that in order to have a fighting chance in the Asean Economic Community (AEC), let alone global, competition, the Philippines (PH) needs to appreciably ramp up investment spending in science, engineering, and research and development. To the extent that this is achieved – along with the other ongoing policy and institutional reforms – the economy could in time be on a stronger platform to face up to AEC challenges. The paper first revisits PH's macro-economy, poverty, and economic sectors vis-à-vis its Asean and East Asian neighbors. Next, it examines PH's regional and global competitiveness. Then, it looks into the country's current human resource and intellectual capital investments, mainly in higher education and technical/vocational training, as well as in R&D and innovation. A more focused discussion on the University of the Philippines – the "National University", as well as a few select private universities, vis-à-vis its comparators in AEC, including ways to improve its competitiveness, follows. The final section concludes with some recommendations.

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I. Introduction and Overview

The traditional view had been that increases in capital and labor are key to the economic growth of nations. Long-term sustainable economic growth, however, requires advances in the general state of knowledge, as pointed out by 1987 Nobel laureate economist Robert M. Solow in his study of the United States. Other studies on economic growth ascribe a significant role to specific factors, such as education, improvements in efficiency, and shifts in the allocation of labor from less productive to more productive activities.

Subsequent research – leading to what is known as *endogenous growth theory* – essentially shows that technological innovation and economic growth are interactive and mutually reinforcing. That is to say, economic growth can be effectively sustained through technological innovation that results in new products, processes and markets, and innovation in turn can come about from research and development (R&D) facilitated by economic growth.

Substantial investments in science, technology and research are in fact what underlie the dynamic strides made by the East Asian miracle economies (Taiwan, South Korea, and Hong Kong). A pattern followed by the Philippines' Asean co-founding members – Singapore, Malaysia, Thailand, and Indonesia.

It is common knowledge that the Philippines (PH) has been a laggard in East and Southeast Asia in economic development and poverty reduction. This is often attributed to many factors such as bad governance, corruption, political instability, social inequality, poor infrastructure, and unfavorable investment climate. Hardly any mention is made of the country's neglect of science, technology, and R&D over the past several decades as a major factor as well. Such neglect continues to erode the country's international competitiveness in trade and investment besides education and health services. The upshot has been a vicious circle of scant technological innovation, eroding competitiveness, weak economic growth, middling investment in S&T/R&D, and so on, with the economy largely stuck in a low-level equilibrium.

It is time for PH to seriously recognize and resolutely deal with its scientific and technological shortcomings as there is no turning back from globalization. Indeed, the urgency is further underscored with the Asean Economic Community (AEC) integration set to be in full force by end-2015. As early as 2010, in fact, nearly all of the committed import tariff reductions to between zero and five per cent were already in effect among member countries. This means that come 2016 all goods, capital and labor (including high-level human resources) can flow unimpeded across national borders within AEC. Simply put, Asean's 10 member countries will become a single market and production base.

The ultimate aim of countries vis-à-vis globalization is typically to maximize the gains from it while minimizing the unavoidable costs. In this vein, this paper argues that in order to have a fighting chance in AEC competition, PH needs to appreciably ramp up investment spending in science, technology and R&D (or knowledge capability building [KCB]). If this is achieved along with the country's other ongoing policy and institutional reforms, the economy would in time be on a stronger platform to face up to AEC challenges.

This paper is organized as follows. The next section revisits PH's macro-economy, poverty, and economic sectors vis-à-vis its Asean and East Asian neighbors. Section III examines PH's regional and global competitiveness. Section IV looks into the country's human resource and intellectual capital investments, mainly in higher education and technical/vocational training, as well as in R&D and innovation. Section V discusses the University of the Philippines – the "National University", as well as a few select private universities, vis-à-vis its comparators in Asean, including ways to improve its competitiveness. The final section concludes with some recommendations.

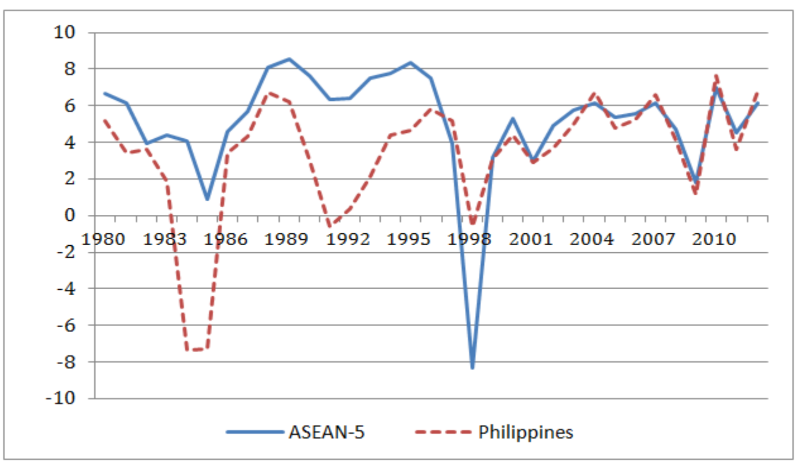
II. Philippine Economy vis-à-vis its ASEAN Neighbors

A. Macroeconomic performance

PH economy's performance over the last three decades was marked by boom-bust cycles, perceptively more so than the average for the Asean-5 founding members (Figure 1). The sharp downward swings in growth rates stemmed from political, financial, and external shocks in the mid-1980s, early and late 1990s, and in 2008-2009. The steepest decline occurred in the mid-80s when aggregate output contracted by 7.3 percent.

Figure 1. GDP growth rates,1980-2012: Philippines and ASEAN-5

at constant prices



Sources: IMF and World Bank.

The change in political regime resulted in a pickup of consumption and investment demand, interrupted however by the power crisis in the early 1990s and again by the Asian Financial Crisis in 1997-98.

The following decade saw a more buoyant macro-economy spurred by earlier trade liberalization and deregulation policies, followed by fiscal reforms in 2004. Growth performance dipped yet again with the global financial crisis in 2008 but has steadily improved since with the turnover to the Aquino administration committed to institutional and policy reforms. Table 1 presents a summary of GDP growth rates for PH vis-à-vis its Asian neighbors. Clearly, PH was a notable laggard for two full decades of the 1980s and 1990s, then barely matching the ASEAN-5 average in 2000-2009 before being at par or better beginning in 2010, and recording 7.2 percent GDP growth in 2013.

Looking now at GDP per capita growth rates – which account for differences in population growth rates – is even more telling about PH's performance. What with the economic contraction in the 1980s, followed by a modest recovery in the 1990s that picked up a bit more in the early 2000s, before being finally in the same league as its neighbors beginning in 2010 (Table 2). However, inadequate physical and human infrastructure, long delays in the roll-out of planned public-private partnership (PPP) projects, high costs of power and labour relative to regional competitors, persistent smuggling, legislative and judicial gridlocks, environmental vulnerability, and political uncertainty beyond 2016 remain major challenges to unleashing and sustaining the country's full potential.

Table 1. GDP growth rates, 1980-2012: ASEAN and East Asia

At constant prices

Economy	1980-89	1990-99	2000-09	2010	2011	2012
ASEAN-5	5.3	5.0	4.7	7.0	4.5	6.2
Indonesia	5.7	4.5	4.6	6.2	6.5	6.2
Malaysia	5.9	7.2	4.9	7.4	5.1	5.6
Philippines	**2.0**	**2.8**	**4.3**	**7.6**	**3.6**	**6.8**
Singapore	7.8	7.3	5.3	14.8	5.2	1.3
Thailand	7.2	5.3	4.1	7.8	0.1	6.5
Vietnam	5.0	7.4	6.7	6.4	6.2	5.2
East Asia						
China	9.8	10.0	10.0	10.4	9.3	7.8
Hong Kong	7.4	3.6	4.1	6.8	4.9	1.5
Rep. Of Korea	8.6	6.7	5.0	6.3	3.7	2.0
Taiwan	7.7	6.3	3.7	10.8	4.1	1.3

Sources: IMF, World Bank.

Table 2. GDP per capita growth rates, 1981-2012: ASEAN and E. Asia

At constant prices

Economy	1981-89	1990-99	2000-09	2010	2011	2012
ASEAN						
Indonesia	3.3	3.0	3.6	4.8	5.1[e]	4.8[e]
Malaysia	3.1	4.5	2.7	5.6	3.8	3.9
Philippines	-0.8	0.3	2.7	5.9	1.9	5.1[e]
Singapore	5.4	4.3	2.8	13.0	3.1	-1.2
Thailand	5.6	4.2	3.2	7.2	-0.4	6.0
Vietnam	4.0	5.7	5.7	5.4	5.2	4.2[e]
East Asia						
China	8.5	8.9	9.7	10.0	8.8	7.2
Hong Kong	5.7	2.1	3.7	6.0	4.0	0.6
Rep. of Korea	8.6	5.7	3.9	5.9	2.9	1.6[e]
Taiwan	6.4	5.4	3.0	10.6	3.8	0.9

Source: IMF

B. Per capita incomes and poverty

Table 3 shows how with its mediocre GDP per capita growth over the past three decades, PH has been quickly overtaken by Thailand and Indonesia (and possibly soon Viet Nam) in terms of GDP per capita. This, in turn, is reflected in or translates to slow poverty reduction in PH compared with its Asean neighbors, using either national official poverty lines or the U.S. two-dollar-a-day threshold, as shown, respectively, in Figures 2a and 2b.

Table3. GDP per capita, 1981-2010

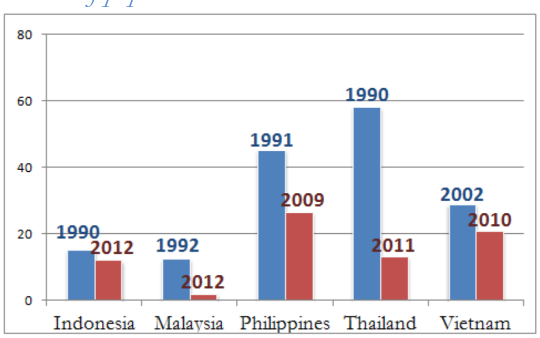
At current PPP U.S. dollars

Economy	1981	1990	2000	2010
ASEAN				
Indonesia	735.9	1,549.1	2,432.6	4,315.8
Malaysia	2,351.0	4,817.2	9,101.8	15,018.3
Philippines	**1,345.2**	**1,879.6**	**2,445.6**	**3,945.2**
Singapore	7,151.7	17,962.7	33,194.9	57,556.4
Thailand	1,099.5	2,921.1	5,014.7	8,673.7
Vietnam	302.1	660.2	1,426.1	3,334.0
East Asia				
China	253.0	799.1	2,382.4	7,487.4
Hong Kong	6,849.6	17,367.2	26,778.0	46,956.0
Taiwan	3,601.5	9,895.2	20,320.6	35,296.3
Rep. of Korea	2,322.2	7,858.4	16,527.8	29,457.5

Source: IMF.

Figure 2a Poverty headcount ratio using national official poverty lines

Percent of population

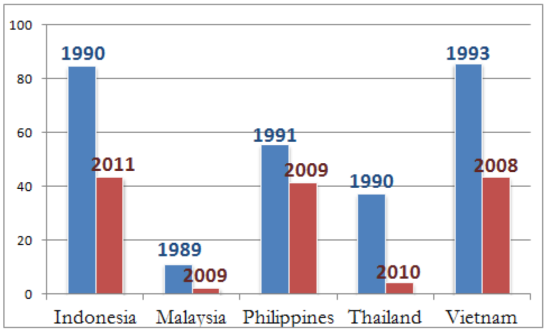


Source: World Bank, ADB

Source: World Bank, ADB

Figure 2b. Poverty headcount ratio at US$2/day (PPP)

Percent of population



Source: World Bank

C. Economic sectors

PH economy is known to have skirted the normal progression of growth, as exemplified by the Asian mature and emerging economies, from agriculture to manufacturing and then to services. Instead, it leapfrogged from an underdeveloped agriculture to services, largely skipping the manufacturing phase (Figure 3 and Table 4).

Figure 3. Sectoral Composition of GDP, 1990 and 2010

Percent share

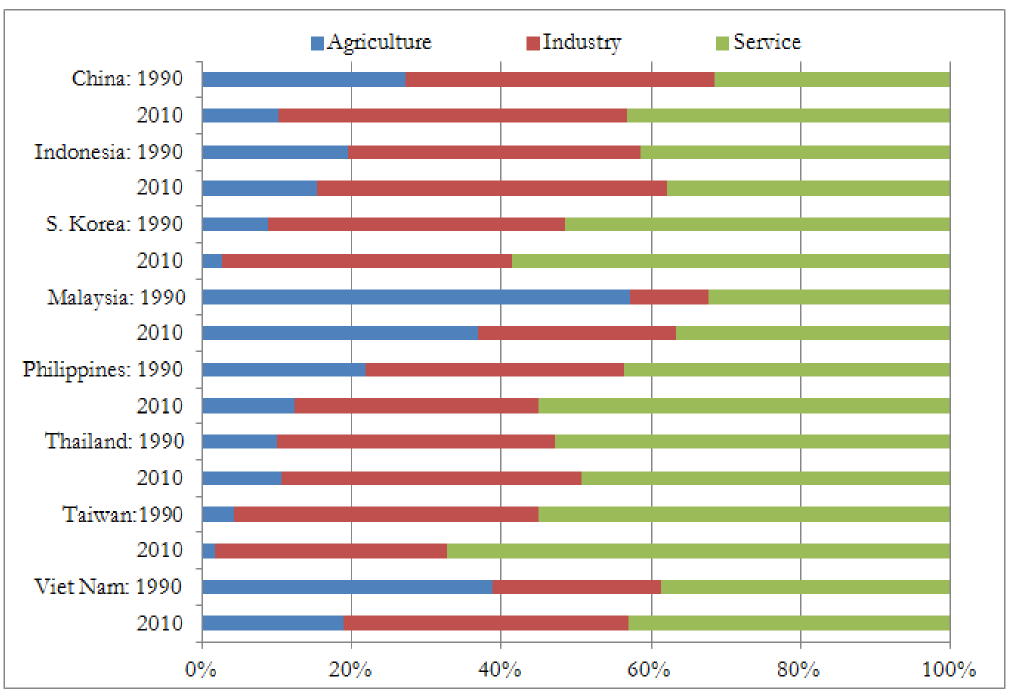


Table 4. GDP Growth Rate by Sector, 2000-2012

At constant prices

Economy	Agriculture		Industry		Manufacturing		Services	
	2000-09	2010-12	2000-09	2010-12	2000-09	2010-12	2000-09	2010-12
ASEAN								
Indonesia	3.4	3.4	4.2	5.1	32.9	5.5	6.7	8.2
Malaysia	3.3	3.0	3.5	5.0	12.9	7.1	6.3	7.0
Philippines	**3.2**	**1.7**	**3.7**	**6.7**	**3.2**	**7.1**	**5.2**	**6.6**
Singapore	0.3	1.0	4.5	9.9	5.7	11.0	3.0	3.1
Thailand	2.9	2.6	4.7	4.5	4.7	4.5	4.2	6.2
Vietnam	3.8	3.3	8.2	6.5	30.6	8.4	7.1	6.6
East Asia								
China	4.0	4.4	11.2	10.2	17.3	32.2	11.2	9.1
Hong Kong	(3.9)	1.1	(2.7)	7.3	(4.4)	1.1	4.2	4.7
S. Korea	2.0	(2.4)	5.5	5.8	6.7	8.1	3.9	3.0
Taiwan	0.3	1.0	4.5	9.9	5.7	11.0	3.0	3.1

Source: World Bank, ADB, and Bank of Thailand.

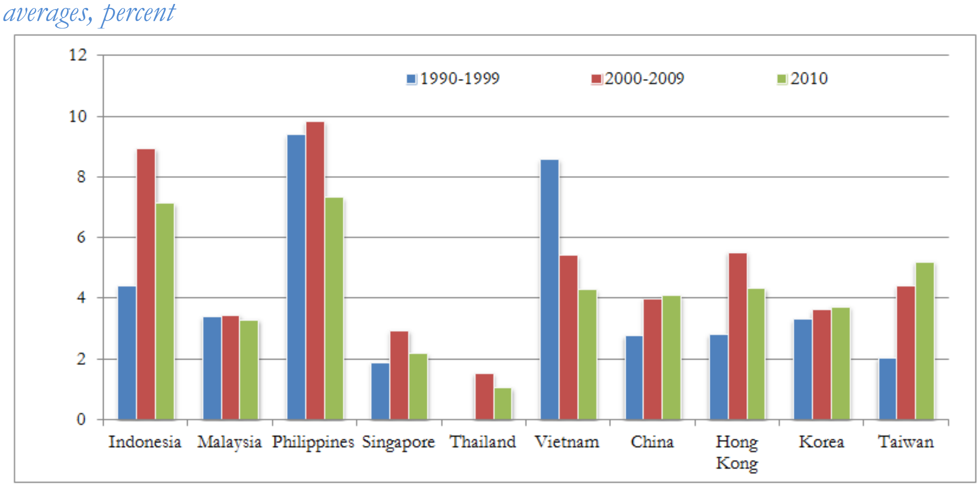
A serious policy-induced mistake as agriculture and manufacturing are the key sectors for generating jobs and domestic goods besides exports. Of course, it did not help that the country's politically turbulent 1980s deterred FDIs – particularly from Japan – while its neighbors were going to town riding on the investment and export waves.

PH economy is characterized to have a relatively small and narrow industrial base that limits growth (ADB 2007). As shown in Figure 2, the industry sector accounted for only about a third of GDP in both 1990 and 2010, lower than those of Indonesia, Thailand, and Viet Nam. In addition, the growth of industry, particularly manufacturing, had been mediocre though signs of a revival have been visible since 2010 (Table 4). Weak manufacturing expansion has not only been growth-constraining, it has also limited employment creation, earning the epithet "jobless growth" (Figure 4).

Studies suggest that market failures (information and learning externalities), besides coordination failures, may explain weak manufacturing and export-led growth in

Figure 4. Unemployment Rate, 1980-2010: ASEAN and East Asia

Period averages, percent



Sources: IMF

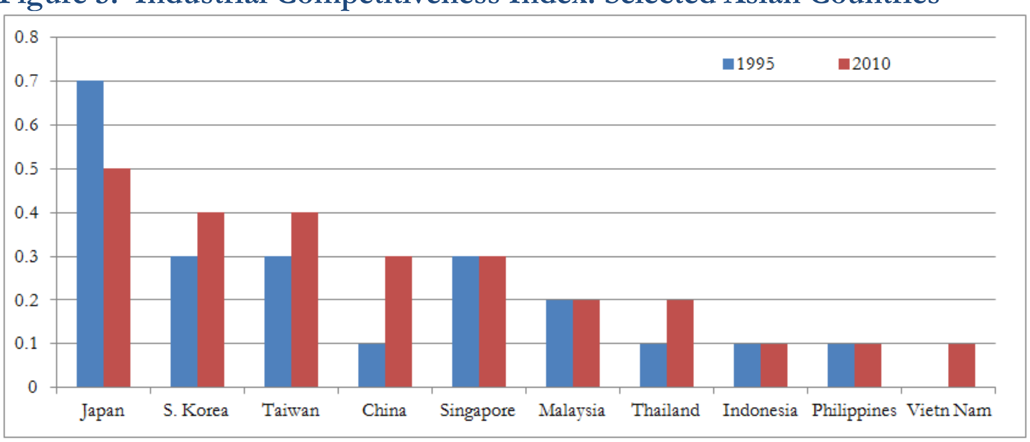
some developing economies [(Hausman and Rodrik (2006) as cited in ADB (2007)]. The presence of information and learning externalities make it difficult for investing firms to exclude other firms from the returns to investment, thereby discouraging investment in new processes and products and, in turn, resulting in low product diversification and innovation. Moreover, critical coordination failures persist due to poor infrastructure, inadequate regulations, and other public goods.

Further, PH manufacturing has low technology and scale quality (ADB 2007). It is concentrated in low-productivity subsectors, such as food, beverage, tobacco, textile, footwear, clothing, and garments. In stark contrast, in Malaysia, Singapore, and South Korea high technology and scale products account for a big chunk of manufacturing. This can be partly explained by the comparatively underdeveloped state of science and technology (S&T) and, in turn, attributable to relatively low general interest in and spending for S&T and R&D.

III. Philippines' Regional and Global Competitiveness

A lethargic and narrow manufacturing subsector brought about by scant technological innovation translates to PH's weak industrial base relative to its regional competitors (Figure 5). According the NSO's 2009 Survey of Innovative Activities (SIA), government support for private innovative activities is limited, and networks for knowledge production are weak (Aldaba et al. 2011). Likewise, the survey also reveals that university-industry links are trivial, and firms have limited access to technical support from the government and research institutions. In general, SIA highlights the importance of networking, linkages and technical partnerships between the government, industries, universities, and research institutions to enable manufacturing to flourish, thereby facilitating inclusive economic growth through job creation.

Figure 5. Industrial Competitiveness Index: Selected Asian Countries



Source: UNIDO

Government-industry-academe partnerships would facilitate skills development needed to support the service sector while moving it up to higher levels, as well as help upgrade the competitiveness of the manufacturing sector. Over time, skills upgrading will boost the long-term capacity of the country to innovate, absorb and implement new technologies (World Bank 2010). This further underscores the importance of upgrading the country's national innovation and learning system.

Institutional and policy reforms initiated by the incumbent government administration since 2010 appear to be getting traction and are paying off in terms improvements in PH's global competitiveness scores. In the World Economic Forum's (WEF) *Global Competitiveness Ranking, 2013-2014*, PH jumped six places to 59th from 65th in the previous year (Table 5).This reflects broad-based improvements particularly in the dimensions of macroeconomic environment, financial market development, business sophistication, and market size (Table 6). Among areas that need upgrading in particular are infrastructure, health and primary education, labour market efficiency, technological readiness, and innovation.

Table 5. Global Competitiveness Index (GCI)

Rank out of 148 economies

Economy	GCI 2013-2014		GCI 2012-2013	Change in Rank
	Score	Rank	Rank	
Singapore	5.61	2	2	0
Hong Kong	5.47	7	9	2
Japan	5.40	9	10	1
Taiwan	5.29	12	13	1
Malaysia	5.03	24	25	1
Korea, Rep.	5.01	25	19	-6
Brunei Darussalam	4.95	26	28	2
China	4.84	29	29	0
Thailand	4.54	37	38	1
Indonesia	4.53	38	50	12
Philippines	**4.29**	**59**	**65**	**6**
Vietnam	4.18	70	75	5
Lao PDR	4.08	81	n/a	n/a
Cambodia	4.01	88	85	-3
Myanmar	3.23	139	n/a	n/a

Source: World Economic Forum

Further, the WEF's "The Global Enabling Trade Report 2014" reveals that PH has advanced eight notches in its rank as a world trade destination to 64th of 138 economies from 72nd of 132 countries in 2012. The enabling trade index comprises market access, border administration, infrastructure, and operating environment. Still, PH trails behind the other four Asean originals, and better only compared with the newer Asean members.

Table 6. Performance of ASEAN in different pillars of the GCI 2013–14

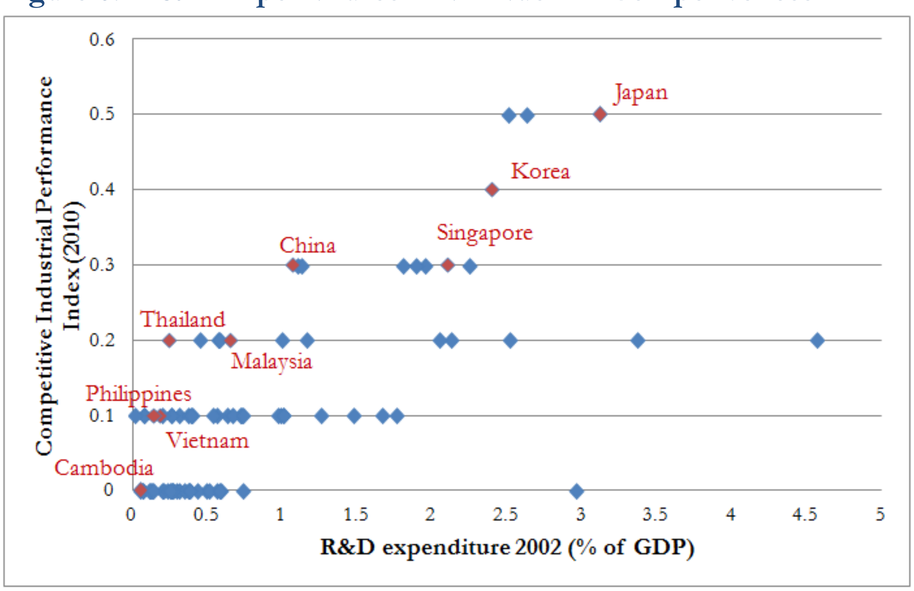
Rank out of 148 economies

Economy		Basic Requirements				Efficiency Requirements						Innovation and Sophistication	
	Global Competitiveness Index	1st pillar: Institutions	2nd pillar: Infrastructure	3rd pillar: Macroeconomic environment	4th pillar: Health and primary education	5th pillar: Higher education and training	6th pillar: Goods market efficiency	7th pillar: Labor market efficiency	8th pillar: Financial market development	9th pillar: Technological readiness	10th pillar: Market size	11th pillar: Business sophistication	12th pillar: Innovation
Singapore	2	3	2	18	2	2	1	1	2	7	34	17	9
Malaysia	24	29	29	38	33	46	10	25	6	51	26	20	25
Brunei Darussalam	26	25	58	1	23	55	42	10	56	71	131	56	59
Thailand	37	78	47	31	81	66	34	62	32	78	22	40	66
Indonesia	38	67	61	26	72	64	50	103	60	75	15	37	33
Philippines	**59**	**79**	**96**	**40**	**96**	**67**	**82**	**100**	**48**	**77**	**33**	**49**	**69**
Vietnam	70	98	82	87	67	95	74	56	93	102	36	98	76
Lao PDR	81	63	84	93	80	111	54	44	91	113	122	78	68
Cambodia	88	91	101	83	99	116	55	27	65	97	92	86	91
Myanmar	139	141	141	125	111	139	135	98	144	148	79	146	143
East Asia													
Hong Kong	7	9	1	12	31	22	2	3	1	6	27	14	23
Japan	9	17	9	127	10	21	16	23	23	19	4	1	5
Taiwan	12	26	14	32	11	11	7	33	17	30	17	15	8
Korea	25	74	11	9	18	19	33	78	81	22	12	24	17
China	29	47	48	10	40	70	61	34	54	85	2	45	32

Source: World Economic Forum

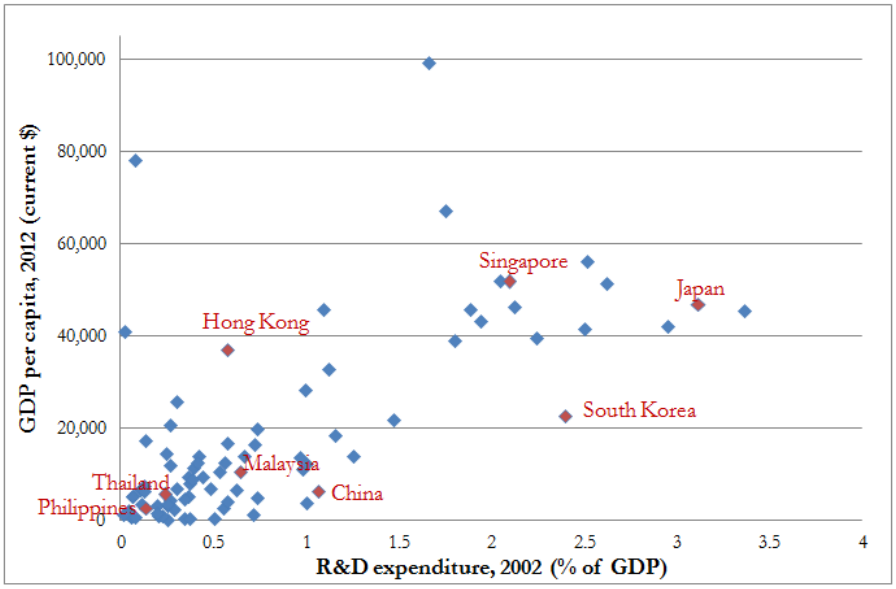
The following cross-country scatter plots relate *ex ante* R&D expenditures to *ex post* industrial competitiveness, GDP per capita, and university competitiveness (Figures 6-8). They appear indicative of (lagged) long-run effects of R&D spending on these areas of concern. Intuitively, the positive relationship between R&D and industrial competitiveness highlights the importance of innovation in manufacturing. Higher R&D spending is also expected to exert a positive effect on income via increased productivity and output. Needless to say, the connection between R&D spending and university competitiveness (ranking) should be quite natural and straightforward (Table 7 on world universities ranking does not include PH, Thailand and Indonesia).

Figure 6. R&D Expenditures and Industrial Competeveness



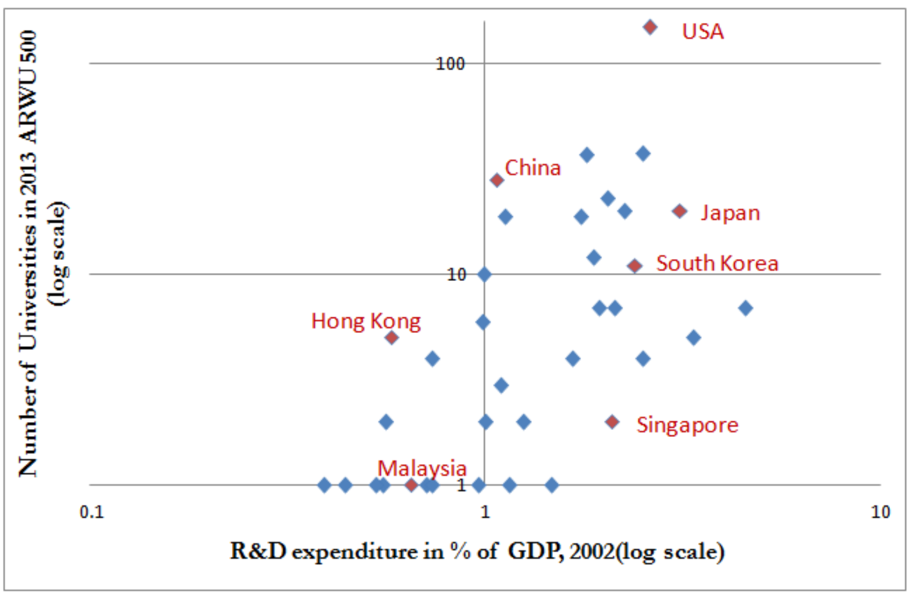
Sources: World Bank and UNIDO

Figure 7. R&D Expenditure and GDP per capita



Sources: World Bank

Figure 8. R&D Expenditure and University Competitiveness



Sources: World Bank, Shanghai Ranking

Note: There is no Philippine university included in the Shanghai Ranking

Table 7. Universities Included in World Rankings
Number per country

Economy	ARWU Top 500 (2013)	THE Top 400 (2013)	QS Top 500 (2012-13)
China	28	10	9
Hong Kong	5	6	6
Indonesia	0	0	1
Japan	20	11	16
Rep. of Korea	11	7	11
Malaysia	1	0	5
Philippines	**0**	**0**	**1**
Singapore	2	2	2
Taiwan	9	8	7
Thailand	0	10	2

Sources: Times Higher Education, Shanghai Ranking, and QS Limited
Note: ARWU – Annual Ranking of World Universities (Shanghai Ranking)
THE – Times Higher Education World University Rankings
QS – Quacquarelli Symonds World University Rankings

IV.Philippine Human Resources and Intellectual Capital

Human capital and knowledge are unquestionably a nation's greatest resource. Accordingly, adequate investments in education, health and nutrition by both households and government are a must for a country to progress so that decent living standards are made accessible to all. Taking a cue from several empirical studies, the Oslo Declaration of 2008 urged governments to spend 4-6 percent of GNP or GDP on education (UN-ESCAP 2013), and WHO has strongly recommended a similar percentage for health services.

A. **Investment in human capital as priority**

PH's level of public spending on education as a fraction of GDP has been very low compared with its Asean and East Asian neighbors. In the 1980, the country spent 1.72 percent of GDP on public education and rising to 2-3 percent in the 2000s, compared with the Asean-5's average of 5 percent and around 6 percent during comparable periods (Figure 9). PH's levels of spending are appreciably lower than those of its closest Asean competitors such as Singapore, Malaysia, Thailand, and Vietnam (Figure 10).

There appears to be a downtrend in public education spending relative to GDP that is common to the Asean-5 countries. However, this is particularly alarming for PH given its subpar education investment level, to begin with, and its large and younger population. Son (2010), using Bosworth and Collins's (2003) data set, estimates that growth in factor productivity (in which human capital investment is crucial) is the third largest source of world output growth after growth in employment and in physical capital per worker. Citing Hanushek and Woessman (2008), Son further stresses that having both an elite pool of "rocket scientists" to generate technological innovation and a workforce with basic literacy skills that can use this technology in production generates the strongest contribution to economic growth.

Figure 9. Public Spending on Education as % of GDP: ASEAN and East Asia

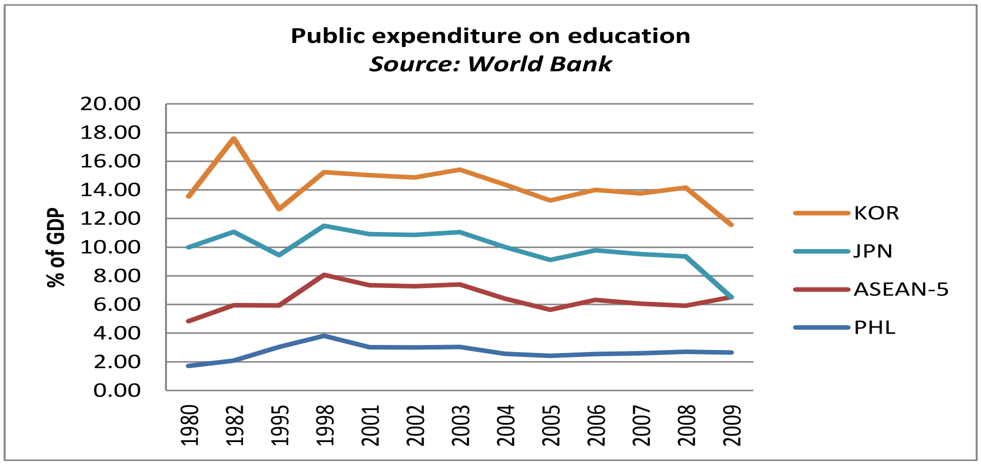
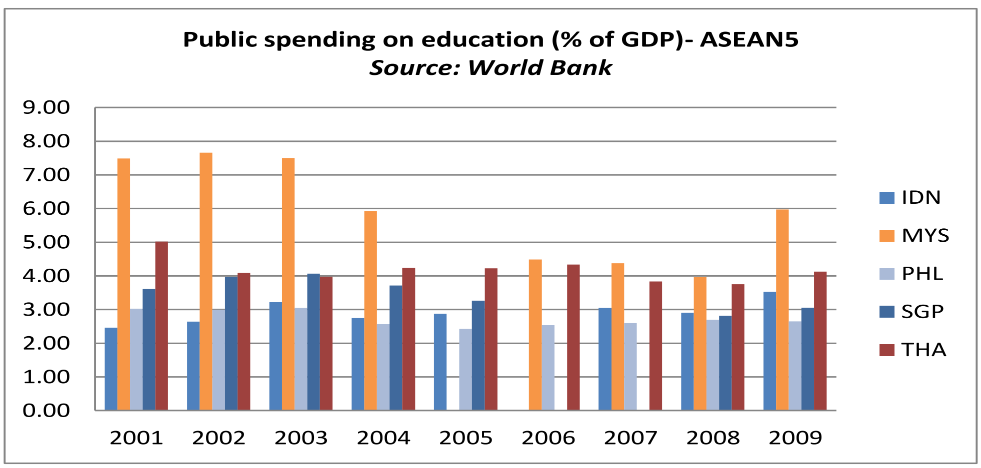


Figure 10. Public Spending on Education as % of GDP: ASEAN-5 Countries

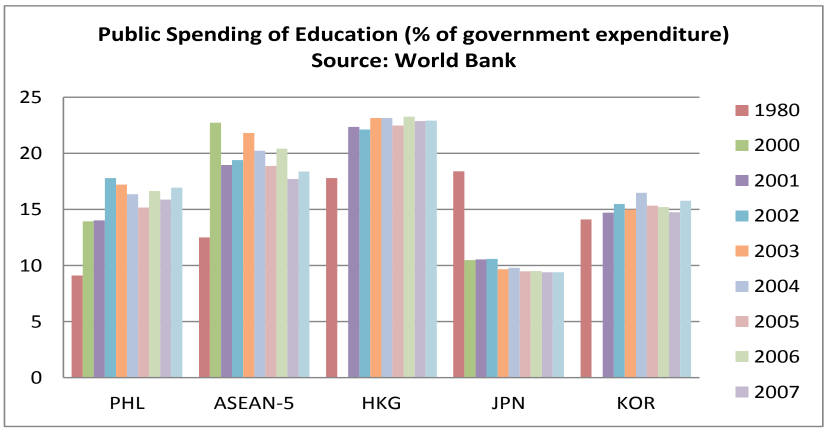


The investment priorities of the government are manifested in its annual budgets that include public expenditure on education as a fraction of total government spending. The Oslo Declaration 2008 also recommends that countries spend 15-20 percent of total government expenditure on education – which reflects a country's political commitment to education vis-à-vis other national priorities (UN-ESCAP 2013). Here again, we find PH lagging behind the Asean pattern (Figure 11).

In 1980 only 9.1 percent of PH's government budget was channeled to public education, compared with 14.4 percent for Malaysia, 7.9 percent for Singapore and 18.5 percent for Thailand. PH's number increased to 14 percent in 2000 while Malaysia's rose sharply to 26.7 percent and Thailand's nearly 40 percent. In 2008, it was 17 percent for PH against Malaysia's 25.2 percent, Singapore's to 21.8 percent and Thailand to 23.7 percent.

Improving quality in addition to merely increasing the resources devoted to education is critical in order to fully capture the relationship between skills and economic growth. Educational expenditure directed to such activities as R&D, faculty development, and facilitation of linkages with global centers of excellence (particularly in the science and engineering fields) will greatly impact the level and quality of the human capital of university graduates. Hanushek and Woessman (2008) conclude that "there is strong evidence that the cognitive skills (a manifestation of the quality of education) of the population—rather than mere school attainment—are powerfully related to individual earnings, the distribution of income, and economic growth."

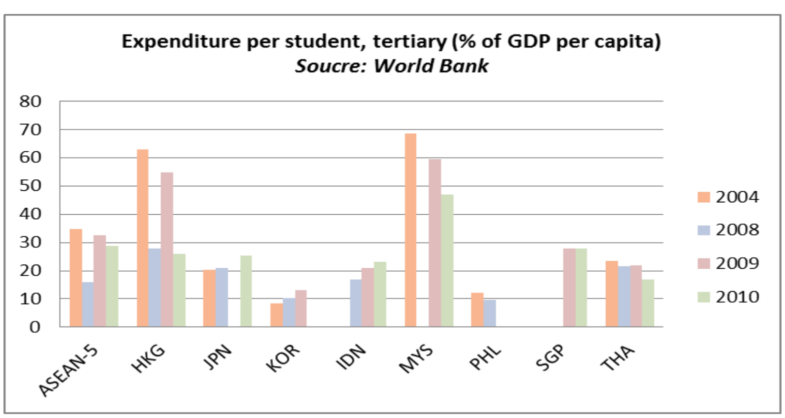
Figure 11. Spending on Education as % of Total Government Budget



B. **Expenditure per student at tertiary level**

It logically follows from the above data that PH has the lowest spending on tertiary education relative to GDP per capita. This refers to public expenditure (current and capital) that includes government spending on educational institutions (both public and private), education administration, and subsidies for private entities (students/households and other privates entities). In 2004, PH's public expenditure per student at the tertiary level, as a fraction of GDP per capita, was 12.1 percent – a stark contrast to the 34.8 percent average for Asean-5, 68.7 percent for Malaysia, 23.5 percent for Thailand, and about 17 percent for Indonesia. In 2008, PH's number decreased to 9.7 percent, while those for Malaysia and Thailand were also down though not for Indonesia (Figure 12). In any case, PH remains at the bottom.

Figure 12. Spending per Tertiary Student as % of GDP per capita



C. **Technical and vocational education and training**

Enrolment in technical and vocational education and training (TVET) increased from 1.68 million in 2004 to 2.14 million in 2007, representing a 27.4 percent increase (Table 8). However, owing to efforts to improve quality assurance, enrolment declined to 2 million in 2008 and further to 1.98 million in 2009. The absorption rate of graduates of TVET was 55.1 percent in 2008, down from the 64.6 percent in 2005, attributable to the recent financial crisis that slowed economic activities, skills mismatch and geographical mismatch between job openings and job seekers (NEDA, 2011).

Table 8. Enrolment in Technical Education and Vocational Training

Year	2005	2006	2007	2008	2009
Male	673,353	694,745	856,965	805,567	893,091
Female	1,010,029	1,042,120	1,315,449	1,208,353	1,091,555
Total Enrolees	1,683,382	1,736,865	2,142,414	2,013,920	1,982,435
Graduates	**1,154,333**	**1,340,620**	**1,702,307**	**1,812,528**	**1,903,793**

Source: NEDA, 2011.

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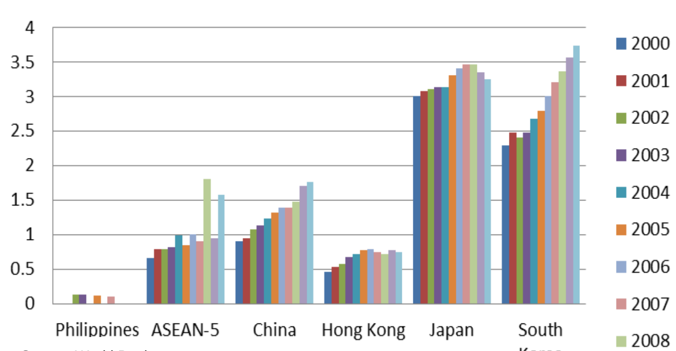
Ciccone and Papaioannou [2009] finds empirical evidence that "value-added and employment growth in schooling-intensive industries is significantly faster in economies with higher initial levels of schooling." And the link comes out even stronger when quality of education is included as an explanatory variable. Further, the authors highlight that labor-augmenting technology facilitates a faster increase in the productivity of workers with higher levels of human capital relative to workers with low human capital. Therefore, technologies augmenting skilled labor result in faster total factor productivity growth in human-capital-intensive industries. Also worth reiterating is Son's (2011) point on the need for the complementation of a skilled workforce with highly-skilled professionals taking the lead on innovation and technological developments for the implementation of technological advances in production.

D. **Expenditure on research and development**

Expenditure on research and development (R&D) is defined as current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development. PH's R&D spending at 0.15 percent or even less of GDP is woefully inadequate for the country's modern day requirements. Sadly, this reflects the relative importance the government and society in general give to the economy's modernization (Figure 13) vis-à-vis PH's Asean

Figure 13. Research and development expenditure (% of GDP)



Source: World Bank

contemporaries' R&D expenditures, as well as the UNESCO norm of 1.0 percent of GDP.

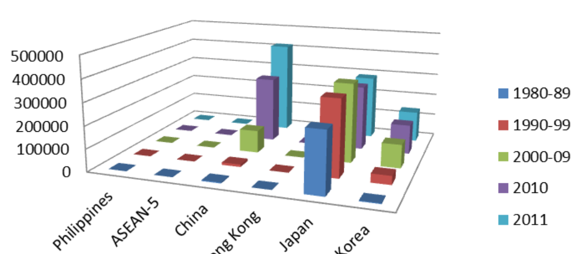
In order for the country to transition to a knowledge-based economy, investments in S&T and R&D are a *sine qua non*. They not only contribute to increased productivity but, more importantly, lead to innovative products and processes. Government should lead in incentivizing and sponsoring basic and applied research in diverse fields. The results of the 2011 UIS Pilot Data Collection of Innovation Statistics state the factors that may hamper innovation activity. In the case of the Philippines, 20.9 percent of firms rated the high cost of innovation as the most important economic impediment. Such factors lack of qualified personnel, information technology, information markets, and difficulty in finding suitable partners also dampen the innovation efforts of the private sector (UNESCO-UIS 2012).

Son [2010] shows that cross-country differences in growth of output per worker are largely attributable to changes in physical capital and total factor productivity over time. PH's low level of R&D expenditure particularly puts it at a disadvantage not only in promoting innovation but also in establishing an industrial base, representing lost growth and employment opportunities. R&D is also critical as human capital investment, and shortage of it not only compromises the quality of the workforce but also constrains the economy from producing highly skilled workers who can participate in high-productivity and high positive-externality production activity.

E. **Patent applications**

The highest levels of R&D spending correspond to countries that are well known for industry, technology and innovation, such as Singapore, Japan and Korea. The number of patents filed (both by country residents only and including non-residents) suggests that it is correlated with the level of R&D expenditure of each country. The number of patent applications in PH is a far cry from those of its closest Asean competitors, and even more so vis-à-vis China, South Korea and Japan (Figures 14 and 15).

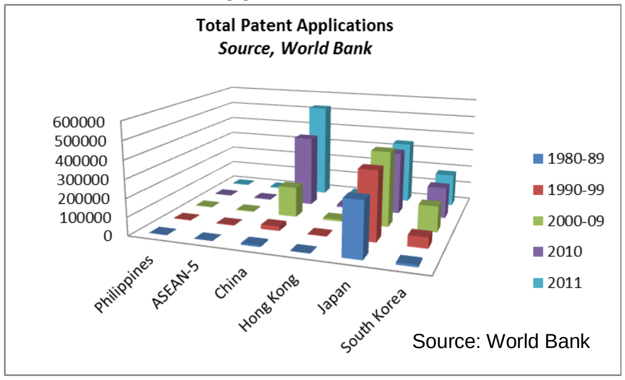
Figure 14. Patent applications resident



Source: World Bank

These patent applications refer to worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention – a product or process that provides a new way of doing something or offers a new technical solution to a problem.

Figure 15. Total Patent Applications: Resident and Non-resident

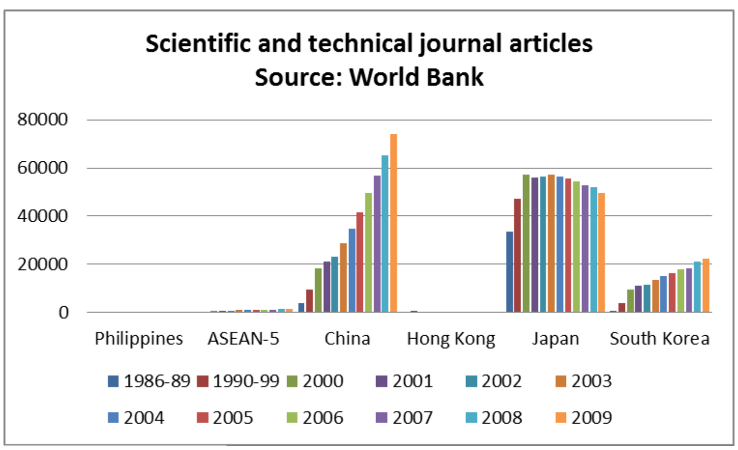


R&D is also an area where partnerships with the private sector should be sought, not only to pursue the type of research that the market needs but also to facilitate the launching of the country's own industrial base and the strengthening of the agricultural sector.

F. **Scientific and technical journal articles**

The level of R&D expenditures as well as the expenditure on public education particularly at the tertiary level are also manifested in the number of published scientific and technical journal articles of a country. The scientific articles recorded here refer to scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences (Figure 16).

Figure 16. Scientific and Journal Articles



Source: World Bank

In the 1980s PH scientists and engineers published an average of 138.8 articles per year. This improved to 156.4 articles per year in the 1990s and further up to 185.5 articles per year in 2000s. These numbers are a far cry from that of Malaysia's yearly average in 2000s of 694.1, Singapore's 3,325, and Thailand's 1,291; even worse vis-à-vis PH's East Asian neighbors.

V. PH's National University and Other Select HEIs

Higher education institutions (HEIs) are regularly ranked regionally and internationally. In the 2014 Quacquarelli-Symonds (QS) rankings of Asian universities, of the 38 Asean universities in the top 250, the Philippines has only four, viz. UP, ADMU, UST, and DLSU. The main criteria in the rankings are academic reputation, employer reputation, faculty-student ratio, papers per faculty, citations per paper, international faculty and students, and inbound and outbound exchanges.

In the QS-Asean ranking, UP is 8th of 10 universities and has next to the lowest total government funding after the University of Indonesia which is ranked 10th (Table 9). Except for three outliers, the data show a fairly close correlation between government funding and the QS ranking.

Table 9. Government Funding for Top Universities in ASEAN

Million US dollars

University	QS-Asia Ranking (2014)	QS-ASEAN Ranking (2014)	Total Funding	Year
National University of Singapore	1	1	868.5[a]	2011-2012
Nanyang Technological University	7	2	610.4[a]	2011-2012
University of Malaya	32	3	247.8	2012
Mahidol University	40	4	325.9	2012
Chulalongkorn University	48	5	*no data available*	
Universiti Kebangsaan Malaysia	56	6	202.7[b]	2012
Universiti Sains Malaysia	57	7	243.9[b]	2011
University of the Philippines	63	8	178.2	2012
Universityi Teknologi Malaysia	66	9	184.4	2011
University of Indonesia	71	10	69.2	2011

Sources of data: Quandl. www.quandl.com, 2014; IMF Exchange Rates Archives; University websites; Malaysia Ministry of Finance; and Singapore Ministry of Finance

Note: Converted to US dollars using annual average exchange rates data from the IMF Exchange Rates Archives

a – April 2011-March 2012

– estimate

Even more telling are the disparities in faculty compensation. For instance, basic monthly salary (in US$) for a full professor at the National University of Singapore (NUS) is $14,051 versus $ 2,821.4 in the University of Malaya (UM) [both as of 2010] and $1,862 in UP as of 2013 (Table 10). The data also show that UP's full professor has a basic salary even lower than that of a lecturer ($3,910) in NUS and an associate professor's (US$2,016.3) in UM.

Table 10. Average Faculty Compensation in Some ASEAN Universities
US dollars per month

Academic Rank	NUS[a]	UM[a]	UKM[a]	USM[c]		UTM[c]		MU[b,d]	UP[c,e]
	basic	*basic*	*basic*	*basic*	*w/allowance*	*basic*	*w/allowance*		
Lecturer	3,909.9	1,213.9	1,123.5	808.3	1,221.1	1,374.72	1,692.21	858.9	582.8
Sr. Lecturer	6,414.6	1,609.2	1,677.8	1,452.0	1,960.0	1,841.90	2,254.64		798.4
Assoc. Professor	9,347.0	2,016.3	1,761.0	1,537.3	2,172.3	1,951.05	2,490.78	1,087.5	1,173.1
Professor	14,051.0	2,821.4	2,465.3	2,465.8	5,164.5	2,552.15	4,129.02		1,861.6

Sources of data: USM, UTM, MU, UP, Association of Commonwealth Universities, IMF
Notes:
Converted to US dollars using annual average exchange rates data from the IMF Exchange Rates Archives
NUS – National University of Singapore; UM – University of Malaya; UKM – Universiti Kebangsaan Malaysia; USM – Universiti Sains Malaysia; UTM – Universiti Teknologi Malaysia; MU – Mahidol Univeristy; UP – University of the Philippines
a – 2010; b – 2011; c – 2013
d – The actual ranks posted are "Instructor" and "Visiting Professor"
e – The lecturer and senior lecturer positions correspond to the "Instructor" and "Assistant Professor" ranks, respectively. Salaries used pertain to the highest possible salary per rank based on SSL3.

The QS World University Ranking and Asian University Ranking (AUR) have consistently put UP at the top among PH universities (with ADMU a far second), as Table 11 shows. When the AUR scores are disaggregated, UP's academic and employer reputations turn out much higher than the overall rank, implying that UP produces very good college graduates and professionals.

Table 11: Philippine Universities: Asian University Rankings, 2014

	Overall	Overall	Academic Reputation		Employer Reputation		Citations Per Paper	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
University of the Philippines	63	60.7	46	80.3	41	87.6	73	82.7
Ateneo de Manila University	115	46.4	66	67.7	48	82.8	201	18.2
University of Santo Tomas	141	42.4	120	45.1	74	66.5	12	98.1
De La Salle University	151-160	n.a						
Ateneo de Davao University	251-300	n.a						

Source: http://www.topuniversities.com/university-rankings/asian-university-rankings/2014, accessed June 24, 2014

Being a public and the premier higher education institution (HEI) in the country, UP has been designated as the "National University". As such, it is the flagship HEI expected to provide leadership in the country's higher education system and should be on the forefront of S&T and R&D.

A World Bank (2012) study on the link of higher education and skills to economic growth in East Asia highlights the need to "finance adequately the aspects of higher education that correct for externalities and market failures, such as research, science, technology, engineering, math, and scholarships and loans for the poor and disadvantaged." The need for greater efficiency of public financing of education entails a "more selective and performance-based approach in the way public funds for teaching and research are allocated across institutions and targeting scholarships and loans better." Apart from the government, private resources could be harnessed to augment public funds. Public-private matching grant schemes have been employed in other countries with good results.

The study also underscores the case for public financing to support research and STEM (science, technology, engineering and mathematics) capacity as two areas with high positive externalities. Although the financial costs can be high, the social benefits are greater, considering the positive link to innovation. There is a need to develop and allocate resources to a few premier research and teaching universities, such as UP, ADMU, UST, DLSU, Ateneo de Davao University [ADDU], and University of San Carlos [USC] – the latter two down South. Such selectivity – directing substantial resources to a small number of institutions – takes into account the substantial resource requirements to undertake high-level research and teaching. To the extent that the few select institutions meet international standards in teaching or research, the trend in low-cost and low-quality education can be reversed.

Moreover, the same study simulates the financing needs for the Philippines, and projects large capital and increasing recurrent expenditures such as salaries, administrative costs, and costs for faculty qualification upgrading to improve the quality of education while maintaining enrolment rates. The results reveal that expenditure (for capital, operating and other recurrent expenditures, etc.) needs to grow from nearly US$6,000 per student per year to about US$10,000 (Table 12).

Table 12. Gaps between current and projected capital and operating expenditures needed per tertiary student in the Philippines
As percentage of GDP per capita

Year	Projected tertiary expenditure needed	Gap between projected levels needed and 2009 levels
2011	303.1	291. 5
2013	359.6	125.2
2015	430.7	174.6
2017	536.4	259.5
2018	633.6	341.1

Source: World Bank (2012). Scenario: Financing requirement to maintain enrolment coverage and improve quality.

Further, linking the higher education system to the private sector is an important aspect of education policy such that the curriculum becomes more responsive to the needs of the industry, thereby avoiding skill gaps and disconnects. For the country it is extremely critical to have both a solid skill base and a stronger capacity for innovation through research and skillful application. In sum, the country must focus on improving the quality of graduates and inclusiveness while building research capacity in a few select universities.

Regarding faculty loading, the tertiary student-teacher ratio for PH is 23.2, which is higher than most of its Asean counterparts, such as Thailand (13.7), Malaysia (14.2), and Singapore (19.9) [Table 13]. Given that student-teacher ratio is indicative of the time spent in classroom instruction and individual consultations, it implies the tradeoff in hours spent between instruction and research. A Malaysian study shows that Malaysian universities (both public and private) spend an average of 18 hours per week on teaching and related responsibilities, nine hours on research and five hours on other services during the semester (Altbach, Phillip et al. 2012). Research time goes up to 14 hours while teaching drops to 10hours per week when universities are not in session.

Table 13. Tertiary enrolment and teaching staff: SE and E Asia
Number and ratios

Economy	Tertiary Level Enrolment	Tertiary Education Teaching Staff	Student/Teacher Ratio
ASEAN			
Indonesia	5,364,301	238,637	22.5[d]
Malaysia	1,061,421	74,613	14.2[c]
Philippines	2,625,385[a]	112,941[b]	23.2
Singapore	2,430,471	122,232	19.9[d]
Thailand	243,546	17,719	13.7[e]
Vietnam	2,261,204	84,109	26.9[e]
East Asia			
China	31,308,378	1,606,554	19.5[d]
Rep. Of Korea	3,356,011	230,048	14.6[d]

Source: Quandl
Note: a-2005; b-2009; c-2010; d-2011; e-2012.

VI. Conclusion and Recommendations

A variety of explanations has been advanced why the Philippines (PH) has fallen well behind the four other Asean originals (Singapore, Malaysia, Thailand, and Indonesia). This ranges from the protectionist policies for so-called infant industries from external competition, political instability particularly in the 1980s that practically shooed away Japanese FDIs to the country's neighbors, weak governance and dysfunctional institutions, to poor infrastructure, rapid population growth, brain and skills drain from massive emigration, and so on. While all these likely mattered one way or another, little is said about the underinvestment in education in general and in science and technology (S&T) in particular. Being a public good, education and S&T create positive externalities and, hence, tend to be privately under-consumed and under-supplied especially in terms of quality.

The development economics literature says that technological innovation and economic growth are interactive and mutually reinforcing. That is to say, economic growth can be effectively sustained by spending for technological innovation that results in new processes, products and markets, and innovation in turn can come about from research and development (R&D) made possible by economic growth. Substantial investments in S&T and R&D are in fact what underlie the sustained rapid growth and poverty reduction achieved by the East Asian miracle economies.

It is time for PH to seriously recognize and resolutely deal with its scientific and technological shortcomings as there is no turning back from globalization. Indeed, the urgency is further underscored with the Asean Economic Community (AEC) integration set to be in full effect by end-2015. Thereafter, all goods, capital and labor (including high-level human resources) can freely flow across national borders within AEC. Simply put, Asean's 10 member countries will become a single market and production base.

This paper has argued that in order for PH face up to competition in AEC, the country needs to sharply ramp up investment spending in science, technology and R&D (aka knowledge capability building [KCB]). If this is achieved along with other ongoing policy and institutional reforms, the economy could in time be on a stronger platform to face up to AEC challenges. Otherwise, an uncompetitive Philippines may have to bear with a double whammy of (a) dumping of products from other countries, and (b) accelerating drain of its already scarce high-level human resources to greener pastures, thereby further hurting manufacturing besides agriculture.

The objective should be to rapidly raise the investment budget for KCB toward the UNESCO norm of 1.0 percent of GDP from around 0.15 percent currently. Such a steep climb in KCB investment may not be too tall an order if the private sector (say, the 20 largest corporations that are among the most likely to benefit from high-level human-capital workforce) cooperates more closely with the government. In short, public-private partnerships in KCB along with universities whose function it is to generate the human capital and research output, as has been the praxis and experience in PH's more advanced Asian neighbors. This should foster synergistic university-industry links.

In the immediate to near-term, given PH's considerable lag in industrial progress (particularly in manufacturing), the paper argues for a massive investment in Master-of-Science (MS) programs, as has been done in the dynamic Asian economies, to speedily produce able MS graduates to address the human capital needs in the various economic sectors, especially for R&D in technology-based manufacturing industries and knowledge-based BPOs. At the same time, the Bachelor-of-Science (BS) programs must be strengthened especially in terms of their technical components, such that graduates could also be readily employed in industries, prior perhaps to pursuing higher degrees. Likewise, institutions like TESDA should be geared to providing solid vocational/technical training of workers in large numbers (as in South Korea, for example) who are especially needed in small and medium-sized enterprises (SMEs) that constitute the predominant majority (>95 per cent) of the industrial sector.

In the longer run, the goal is to develop Filipino scientists and engineers with PhDs (besides MSs and MAs) in quantity and quality adequate to support the economy's *endogenous growth* that will be inclusive and self-sustaining. This, in turn, would enable the KCB system to steadily move to higher levels as will be required by an increasingly sophisticated knowledge-based economy.

Focus on few select HEIs

Considering the large resource requirements for high-level research and teaching, there is a need to first focus on a few premier research and teaching universities – such as UP, ADMU, UST, and DLSU, and ADDU and USC down south – that will have wider spread effects over time. Mobilization of both public and private resources for the purpose can more likely be achieved if society accords a higher value to quality education, R&D and innovation required for jacking up the economy's regional and global competitiveness. Media will be key in rebalancing society's cultural values from the glitz and glamour of showbiz and sports to the critical importance of S&T and R&D for the country's economic modernization and long-run inclusive development.

Being the "National University", UP is expected to play the role of leadership in higher education, S&T and R&D. There is an urgent need and compelling rationale for scaling up the UP budget to upgrade faculty and staff salaries, besides physical facilities and equipment, toward enhancing the university's competitive standing, regionally and globally. Otherwise, there is a real risk that the "National University" will not be able to attract or retain Filipino faculty (with the required academic degrees) and draw international faculty and students. Worse yet, UP might find itself losing existing faculty and students to its AEC competitors.

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