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Incentive Policy for Research and Development in Science and Technology in Thailand

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Abstract

Research and development(R&D), a main core of technological development, and progress in technology are one of the most important factorsfor a country's long-run economic development.In Thailand, however, the development in technology is struggling due tothe low level of R&D investment generated by private firms compared tothe firms in thehighly-developedindustrialized countries (e.g., South Korea, Japan, and the United States). Besides, Thailand's overall value of R&D expenditure per GNP in the past decade is more or less stagnant and staying below the world's median figure. This paper attempts to investigate the phenomenon and explain the causes of firms' lack of incentive in R&D investment in which a comprehensive policy arrangement is suggested by focusing on the government's role in promotingR&D investment incentive schemes. Findings cover multidimensional problems and solutions. First, The lack of researcher either public or private sector pose a serious issue on the human capital management in this country. The problem can be explained through the mismatch of demand and supply for researcher in the job market. The low rate of employed researchers to total workforce and the low rate of enrollment in the field of science and technologyin the university create insufficient science and technology human resource. This obstructs the technological progress as well as deterring the sustainability of the country's economic growth. In order to tackle the problems, the Thai government issued two national schemes namely "R&D tax incentive" and "university research fund" aiming to promote the level of R&D investment of the private firms and demand for researchers of the domestic university. Though the main weaknesses of the schemes stems from their inefficient regulation and budget management, due to thesetwo policies, during 2007 – 2009, the number of researchers in both public and private sectors increased by 37 percent, approximately.To go beyond the conventional policy framework, the next issuediscusses a topic of "inspiration in R&D investment and growth in R&D sector" which is an idea that can lead to alternative framework for the policymaker for creating R&D incentive.

Keywords : Incentive Policy, Research and Development, Science and Technology

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1. Introduction

Technology is a fundamental issue of economics theories, from the basic Solow growth model to the modern international economics concept; therefore, it is (and it should be) defined as an important factor. Technology is healthy for the economy, as its improvement leads to higher productivity and welfare. Therefore, technological development is never out of the academic picture, so to speak. The great debate between Justin Lin and Ha-Joon Chang is a good example.

According to Lin's argument, countries that produce products with comparativeadvantage can profit from its low cost competitiveness, and profits should be cumulated and transformed to technology and capital in the long run. By contrast, Changviews the above development path as economic fiction, unlike the real-life scenarioin developing countries. He argues that the success story of Japan and SouthKoreaillustrates an alternative path. He convinces policymakers to offer subsidyto potential companies to learntechnology through various schemes (Lin and Chang, 2009).

Although Lin and Changbelieve in different optimal paths of industrialization and economic development, they confirm that the economic growth rate should positively correlate with technological progress. However, in Thailand, the topic is ignored in both public and private enterprises in practice. Although Thailand's real growth rate annually increased at round 15% from 1988 to 1996, the country achieved only a slight growth rate in technological investment, and the significance of research and development(R&D) in the economy, which is measured by gross expenditure of R&D (GERD) per GDP, was relatively low with respect to the world average (NSTIPO, 2013).[2]

Dissentient argument indicates that large Thai companies are continuously investing in R&D, which is upstream of technology. However, empirical data show a different conclusion. First, only three sectors, machinery and equipment, chemical and chemical products, and refined petroleum products, have nominal GERD higher than USD 40 million per year[3] (NSTIPO, 2013). This sectoral GERD is lower than that of only one multinational company in a developed country.Second,the companies are exceptional casesso they cannot be

[2] Thai GERD/GDP is 0.24 and the world average is 1.7 (NSTIPO, 2013).

[3] Presumed nominal exchange rate of 30 baht per US dollar

representative of a universal policy. Third, almost all their spending is focused on market research and specific final products so they have no chance to obtain breakthrough technology.

The contradictionof the Thai economic development, which is not correlated with technological improvement, is interesting. The aims of this paper are to identify the cause of the contradiction and to suggest solutions, especially, in the form of incentives. This working paperattempts topropose rough comprehensive ideas.

2. Comprehensive Picture

In this part, the contradiction of technology in Thailand will be discussed step by step through the following issues:

2.1 Egg and the chicken: Which one comes first?

Thailand has two significant problems. The first problem is the low supply of qualifiedtertiary labor in the market, as confirmed by evidence. For example,less than a half of the school-age population can pass the compulsory to the tertiary level (Ngamarunchot, 2013). Approximately 70% of them choose non-science and technology (S&T) disciplines as their major so S&T graduates are the minority. Moreover, 30% to 40% of the minority usually work in non-S&T fields,with 40,000 persons/yearare unqualified and unemployed (NSTIPO, 2013).

Table 1: Bachelor's degree students who choose S&T and social science disciplines as their major

Year	Number (Persons)			Growth (%)		% Proportion	
	S&T	Social Science	Total	S&T	Social Science	S&T	Social Science
2007	148,114	377,488	525,602	N.A.	N.A.	28.2%	71.8%
2008	148,644	382,497	531,141	0.4%	1.3%	28.0%	72.0%
2009	127,119	266,637	393,756	-14.5%	-30.3%	32.3%	67.7%
2010	162,616	326,032	488,648	27.9%	22.3%	33.3%	66.7%
2011	169,538	353,999	523,537	4.3%	8.6%	32.4%	67.6%

Source: Collected and analyzed by NSTIPO (2013)

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The second problemis the low demand for qualifiedtertiary labor, which is opposite of the first problem. That is, Thai producers still use low-technology production functionsso they do not need to use humancapital-intensive inputs.The Office of Industrial Economics reveals that majority of the labor shortage in 2013 is atthe under-tertiary level (Manager, accessed 1 September 2013). Although both problems have different foundations, they cannot be solved separately.

For example, policymakersmay intervene to increase the supply of either qualifiedtertiary labor or researchers, but it will not work if the demand side remains limited. Moreover, highhumancapital labor will be driven out to work aboard (i.e., brain drain). However, if the demand side is extended and is signaled to increase future labor supply, which lags at least four years through an educational process, then the first group of companies that invest for higher technological production will be have a high fixed cost (i.e., short-tenure opportunity cost) and a risk of incompatible adoption without sufficient labor supply (i.e., the so-called the first mover disadvantage).

These instances are viewed as a coordination failure in the market. From the freemarket perspective, market failure can be fixed by the market itself if companies have high cumulative profit, and if the expected return on technological investment offsets the actual cost. However, no one knows when the freemarket conditions will be satisfied. Conversely, Khan (2000) suggests that market failure can be solved by the government by providing incentive schemes (the interventionist’s solution). This working paper supports the second one.

2.2 The government as the first sacrificed hen: Fiscal incentives

Khan (2000) explains that,in developing countries, private companies benefitfrom purchasinginstant technology and learning by using it, although the risk of incompatible adoption is a strong barrier, especially for risk-averse firms. Consequently, the government plays an important part in promoting learning by purchasing[4]. Therefore, Khan proposes the government to provide conditional subsidy to the production firms for learning.The subsidy acquires an opportunity cost,

[4] Furthermore, in developed countries, where learning is saturated at the frontier level, the nature of market failure is completely different from the first one. In the latter situation, humancapital is accumulated enough to developnew technology, but there is no incentive to do so because of the free-ridingproblem.Therefore, the government should institutionalize intellectual property rights and its concrete principles. Intellectual property rights right will commit profitability (i.e., *Schumpeterian rent)* from monopolized knowledge produced by the researchers and invested by the company (see Khan (2000)).

such as economic loss from the tax-paying sector. Therefore, policymakers should seriously determine the key competency of technological improvement, which depends on a“condition,” such as a specified time frame or export growth.

To illustrate this“condition” in practice, the scope of time forces the subsidized firms or sectors to accelerate their learning to maximize their gain before the expiration date. By contrast, ifpolicymakers do not limit the lifetime of the scheme or continuously extends it to infinity, the firms will enjoy the subsidy like a windfall gain, with no accountability to technological learning. Thai policymakers have applied this principle[5] to thesolar energysector since 2008.However, it is only a pilotproject limited to 25,000 m^2 of a solarcell-installed area in 2013 (GSTEC, accessed 1 September 2013).[6]

Through the same logic but a different instrument, many countries use *conditional tax exemption*on R&D as the incentive for private businesses to buildup their technological capacity. According to the annual report of the KPMG (2013) and Ernst &Young (2013), Thailand has one of the highest tax deduction ratesamong Asia-Pacific countries (Table 2), but its utilization rate is low. In a seminar conducted for automobile producers and the Thailand Research Fund, I asked the following question to the participants: “Why are you not using the tax incentive?” The answer I received was “It’s inconvenient. The last deduction proposal was delayed two years ago.” If this explanation holds, the inside-lag of the tax deduction process limits the scheme.

[5] In reality, this subsidy policy is not perfectly relevant to Khan’s *Rent for Learning* because of three reasons. First, it has no scope of time for each policy gainer.The short lifetime of solarcells is a limited benefit of the investors by itself. Second, the subsidy is a lump sum, not a quantitative varied approach. Third, policymakers do not clearly separate the investor from the final consumer.Therefore, the subsidy benefit is not fully concentrated on the learning of the investor or producer (i.e., so-called solar farmer). However, this subsidization is geared toward the same logic to promote the imported technology of solar energy and, as a medium-term objective, to decrease the marginal cost of solar power production.

[6] For more information, refer totheWebsite of Global Solar Thermal Energy Council (GSTEC) at http://solarthermalworld.org/content/government-subsidy-programme-2013

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Figure 2: Summary of R&D benefits[7]

Country/Region	Typical SME benefits	Typical large company benefits
Australia	45% refundable offset at 30% tax rate	40% non-refundable offset at 30% tax rate
Bangladesh	100% deduction at 27.5% tax rate	
China	150% deduction at 25% tax rate	
Hong Kong	100% deduction at 16.5% tax rate	
India	200% deduction at 33% tax rate	125% deduction at 33% tax rate
Indonesia	100% deduction at 25% tax rate	
Japan	12% credit up to 30% to tax due, tax rate 28%	8% credit up to 30% to tax due, tax rate 38%
Malaysia	200% deduction at 25% tax rate	
Pakistan	100% deduction at 35% tax rate	
Papua New Guinea	150% deduction at 30% tax rate	
Philippines	100% deduction at 30% tax rate	100% deduction at 10% tax rate
Singapore	400% on first SGD 400,000 then 150% on remainder at 17% tax rate	400% on first SGD 400,000 then 150% on remainder (if on-shore) at 17% tax rate
South Korea	25% credit at 11%/22% tax rate	25% credit at 22%/24% tax rate
Sri Lanka	200% deduction at 15% tax rate	
Taiwan	15% credit up to 30% of tax due, tax rate 17%	
Thailand	200% deduction at 30% tax rate	
Vietnam	100% deduction at 25% tax rate	

Source: Modified from KPMG (2013)

These fiscal incentives are expected to fix the egg–hen problem on the demand side of the labor market. Tax and subsidy should improve the technology and productivity of the targeted firm or sector. Consequently,the skilledbias expansion of the labor demand will increase wages. Wage signaling will then pull the qualifiedtertiary labor supply, including the researchers. However, as I mentioned above, unlike Japan or SouthKorea, direct conditional subsidy is an immature operation in Thailand, and tax deduction is ineffective because of the frictional force within the bureaucratic X-inefficiency. Therefore, their positive effectsare still bounded.

[7] These benefits also depend on other factors, such as the specified sectors or the time period.

2.3 Public university-led model and its weakness

If Khan's argument is the direct (conditional) subsidy to the private sector, the public university-led model is the indirect subsidy to the private sector through the knowledge production unit[8]. That is, the government shouldsubsidize either the budget or the research funds to theresearch universityfor technological learning. Then, the university should reach two long-term objectives.First, results of the research must be linked to the application of technology to the private sector (i.e., to commercialize knowledge). Second,capacity must be transformed for the technological learning oflocal private firms.

This model is similar to that of Thailand, where universities are classified into four categories; includingResearch University, Thailand has many national research funds such as the National Research Council of Thailand, the National Science and Technology Development Agency, and the Thailand Research Fund[9]. The university has a good environment for research; for example, it is free from myopic, profit-seeking pressure. Therefore, this model was chosen by the Thai policymaker during the time that the private sector did not invest in R&D and technology.

However, the university-led model has a disadvantage. Researchers will be gathered into the university to reproduce knowledge for the next generation of researchers, who will also be internally selected by the university again. Moreover, the funding is a closed system that prioritizes public universities in practice. Therefore, this closed feedback loop process will distort and disillusion rather than enhance new researchers to explore opportunities in the private sector. In short, the university-led model may crowd out the supply of researchers and undermine the transforming capacity of local private firms.

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[8] Under the same presumption of the latter model, such as high risk and cost of technological adoption, which are disincentive to the investment of a private firm.

[9] Institutions' profiles are presented in **Appendix A.**

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Table 3: R&D Personnel: FTE (person-year) classified into private and non-private sector

Year	R&D Personel: FTE (person-year)		
	Private Sector	Other Sectors; Government, Academic, Non-profit Organization and State Enterprise	Total
1999	5,291	14,756	20,047
2001	9,710	22,301	32,011
2003	7,010	35,369	42,379
2005	7,750	29,217	36,967
2007	8,645	33,979	42,624
2009	11,846	48,496	60,342

Source: Collected and analyzed by NSTIPO (2013)

The empirical evidence in **Table 3** illustrates the signal of the above problem in Thailand. The government is major investor in the R&D sector, with a 60% total investment share. Moreover, the government-employed rate increased from 70% to 87% in the researcher population from 1999 to 2009 (NSTIPO, 2013). Without a linked-fence system between the university and private companies, R&D cannot be used to manufacture (military or civil) products. Therefore, on its own,the research university model is not sufficient to promote research and technology in the private sector.

2.4 Sufficient condition for the university-led model: science park and incubator unit

The previous section discusses the centralized role of the government in R&D promotion and its limitation. The linked-fence model should be applied to connect and transform knowledge from the university to the firms. Moreover, in the medium term, the model should ease up the problem about imbalanced roles. Currently, science policymakers are considering two linked-fence models: science park and incubator unit.

The first model is thescience park, which is an arena where universities and firms cooperate to create commercial technologically intensive products. Firms should challenge a good proposition, and theuniversities, which possess R&D knowledge, should provide the answers. In the medium term, whenuniversities finally learn about business skills and business units fully accept the benefits of research, the relationship can be transposed. Firms will be expected to invest more on in-house research while universities' members or institutions will be expected to spinoff to establish their own business units.In economics typology, a science park is an instrument for leaning the transaction cost of technological transformation.

For example, a science park was created in the United Kingdom in the 1980s. At that time,famous universities, such as Cambridge, Glasgow, Nottingham, St. Andrew, Warwick, and Sussex, established their own science parks. Funds from tenant enterprises accounted for 24% and other private contributions accounted for 16% of the total cost in land and building. Other sources of funds were the universities, local governments, and regional agencies (Quintas et.al., 1992). Therefore, we can conclude that no free-riders exist in ascience park in practice. Private gainers and public agencies jointly contribute.

In Thailand, the government initiated one national and four regional science parks beginning 2002. My colleagues and I studied Thailand'sscience parks in 2011, and we concluded that the regional science parks were lacking of resources. Their delegated aims were not anchored by a clear accountability system and the managerial structures had a fragmented design by default[10](KMUTT, 2010).

The second model is the incubator unit, which is expected to enhance the spin-off rate of technological business from universities. This idea can be implemented either as a piece-meal policy withinuniversities or a complement to the science park, similar to the study of McAdam and McAdam (2008), who integrated an incubator unit witha science park and called it theuniversity science park incubator. To understand the difference, a science park is area-based but incubator is 'functional-based'. The incubator unit will gear researcher and an academic institution that teaches business skills, matching funds, networking partners, and venture capitalization, among others.

In Thailand, an incubator is integrated with ascience park and is commonly founded in universities. However, its utilization rate is low, similar to other schemes we discussed before. Optimistically, Thailand bought the right track of the developmental tram. The country now has a widerange of policies that cover direct fiscal incentives for the targeted private sector as well as indirect support through upstream activities, R&D, and universities. However, all schemes are ineffective.

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[10] Twoscience institutions were assigned to manage five science parksusing different models and resources.

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2.5 Ambitious objective as an incentive: The big science

If the metaphor about the technological–developmental tram is valid, then all the incentives that we discussed previously are push-factors, like the motors that are attached to bogies. However, we still have not discussed the "locomotive," which is a simile of thebig scienceconcept. Big science means that technological development can be pulled by theambitious goal of research. Why is this argument valid? Common sense and my personal experience confirm that money is not all that motivates aperson's happiness.

According to Kanter (2013), a columnist of Harvard Business Review, the "three primary sources of motivation in high-innovation companies are mastery, membership, and meaning. Another M, money, turned out to be a distant fourth." She presents an impressive casestudy of SouthAfrica: Daimler Benz set up a car production with nearly zero defects. This goalseems impossible, butthe company eventually reached the third "M"(i.e., creation). At that time, the company announced that it would produce a perfect car for the beloved South African leader Nelson Mandela, who had just been released from prison. Thus, theworkers did their best because the goal of having zero defectswas not only for productivity but also for giving respect to Mandela.

In theUS S&T context, the Manhattan and Moon project is a prime example ofbig science. Researchers are exclusively selected by a high-profile institution, and they are assigned an unimaginable mission. Their performance denotes not only individual success but also the country's pride and power. The European context has The European Organization for Nuclear Research (CERN), whose objectives are to find the answers to the following: "What is the universe made of? How did it start? Physicists at CERN are seeking answers, using some of the world's most powerful particle accelerators." (CERN, accessed 2 September 2013).CERN should be defined as big science as it pulls the progression of technological development in a space-related field. Accordingly, CERN upholds the motto of "accelerating science."

In short, having an ambitious objective is an incentive in itself.However, Thailand has no explicit big science that is widely recognized by the research community. The country alsohas no pullforce or national locomotive engine of S&T. I remember when AbhisitVejjajiva, thenprime minister of Thailand, announced the cabinet's policy in 2009[11]. He announced a space-related investment as part of the S&T policies. A colleague of mine, who was sitting beside me, laughed at the announcement. "Does that mean we will go to the moon?" At that moment, I realized that Thai science policymakerscould not justdisregard this problem. We have no big science. Worse, it is interpreted as a negative idearather than a positive one.[12]

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[11] See full paper on http://www.mict.go.th/ewt_news.php?nid=1779.No English version is available.

[12] A high-speed train project can be defined as big science if the policy signaling is clear and the cost of corruption will be lowered. Moreover, the expected local content requirement in the transition period and the technological transfer plan are necessary conditions.

2.6 Another missing piece: Inequality and marginalized people

The policymakers can completely handle all fiveissues, but we have to address social equity as well. Although the advancement in technology benefits science development and technological users, many people become marginalized from the utilization because there is no perfect universality.I will prove this argument as follows.

At the beginning, any newmasstechnology would be rejected and incompatible with users. In Thailand, this problem can be traced back to the agricultural technology adoption during the period of King RamaV. Thailand imported many tractors to promote higher yield in rice farming. However, clay soil made it difficult for the heavy-weighttractors to work, as the tractors were designed for another specification of soil. After trying out other tractors, the project was deemed a failure (Teerasartsawat, 2005).

Problems like this are widely perceived by technologists. In the aspect of massproduction, especially in the industrialization period, technological producers ambitiously tried to fix the problems by making the technology universal. However, the cost of redesignis high so technology is usually seen as a narrow activity of large firms and educated researchers.

Figure 1: Technological development and marginalization by default

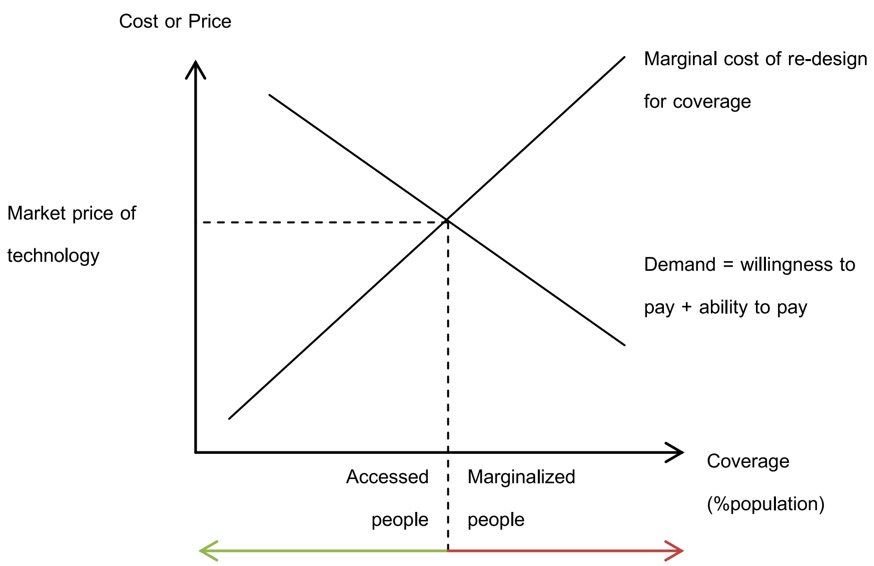

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Figure 2: Effects of technological literacy and financial support (+policy) on marginalized people

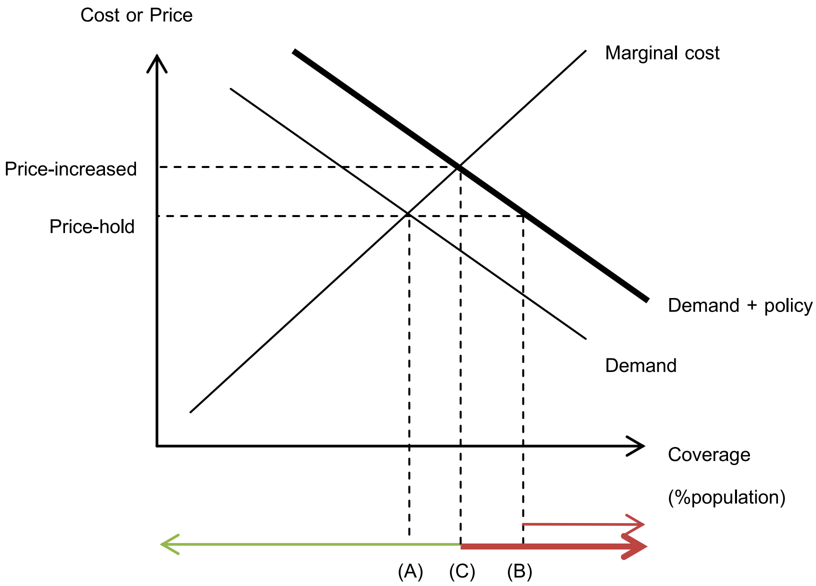

Figure 1 shows that the marginal cost of technological redesignfor higher coverage linearly increases. In some way, the costwill be pushed into the price of technology and then crowd out demand. Therefore, technological producers cannot redesign the coverage of their products higher than the vertical dot-line because the profit of technologists will fall short if they try to reach a coverage rate above that point. In brief, the negative relationship between marginal cost and technological coverage is a naturalstructural barrier for the people to access technology.

In the conventional solution, under the concept of masstechnology, technologists argue that marginalized people need technological literacy and efficient financial support, which increases the demand curve to the thick line. This change should expand accessibility from (A) to (B). However, in reality, technologists may take advantage of the higher demand by increasing the price of the technology so the utilization rate may dropto (C). This action causes the decrease in coverage rate. Comparingthe *ex ante* situation (A) with the technical called *Pareto improvement* (Figure 2) would be suitable.

In the long term, when technology quantumjumps, the cost of old technology will decrease and will become accessible like the basic mobile phone. Therefore, poor or uneducated people can use technology only when it is outdated. In brief, the mainstream policy to expand accessibility to technology is reversed back to fiscal incentives, which referto both subsidy (deceasing the private marginal cost) for technological production and direct cash injection to users (increasing the demand for technology).

In practice, the Thaigovernment attempts to accelerate learning and to expose the coverage of technology. Therefore, the policymakers implemented the One Tablet per Child (OTPC)[13] policy in 2012. As shown in Figure1-2, the government subsidizes the marginal cost and lowers the market price of tablets to zero for the targeted level of education. However, the policy was doubted by empirical evidence on its insignificantperformance in strengthening students' abilities, which were measured by the Science and Mathematics PISA score (Lathapipat, 2013). Moreover, in the process of procurement, the policymakers did not clearly set a targeting of the localcontent requirement or any condition that can help technological diffusion (i.e., tablets).

2.7 The alternatives: Social obligation and technological intensive social enterprise (TISE)

The government's failureswings the policy's momentum toward alternative concepts.The first concept indicates that the R&Dshould not beconcentrated only on massadvancedproduction but also on a specific one: the so-called micro-local R&D. Under this micro-local concept, government agencies should support non-technicians to conductresearch and develop technology by themselves. The result is expected to partially benefit the marginalized people, such as those above the (C) region in Figure 1.

Many research funds are attempting to pilot this idea in many communities. For example, some institutions endorse ricefarmers to collect data, such as their rice yield and quality; they also conceptualize techniques and share them to other members. At the beginning, the experts as well as the farmers themselves doubted this method. However, when they surpassed the learning curve,the experts and participating farmers acceptedthefeasibility of the method (but did not completely guarantee) to conductresearch at the micro-local scale and to develop their own basic technology.[14, 15]

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[13] See more debates on the World Bank's blog: http://blogs.worldbank.org/impactevaluations/one-laptop-per-child-is-not-improving-reading-or-math-but-are-we-learning-enough-from-these-evaluati

[14] These ideas are inspired by Professor VicharnPanich, who is the former executive director of the Thailand Research Fund. He gave an honorable lecture entitled "Political Economy in Community's Culture," without distributing a paper, on 31 August 2013 at Chulalongkorn University.

[15] This movement matches with the global concept of the *Bottom of the Pyramid* (BoP) version2.0, which believes that the poor have the potential to develop their own business model.

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Although the results above were not completely favorable, especially in the largescale, we need to mention their principles: the principle of equity-oriented and belief in the power of change within ourselves.That is, even if people are uneducated in the formal education system, they can learn by doing. Conversely, it should be de-romanticized by the fact that non-technician's technologies are usually rigid and bounded in the agriculture sector only. Therefore, the second alternative concept, social obligation, should beimprinted upon graduating students, especially the "science majors."

I have three reasons to support this argument.First, the students are randomly lucky. TiraphapFakthong and I studied educational inequality, and our result shows that the level of parents' education is significantly correlated with the schooling year of their children[16] (Ngamarunchot and Fakthong, 2012). If people cannot choose their families, well-educated people are partially determined by (structural) windfall gain so they should share their benefits with others.Second, they receive subsidy from the government through public universities.

However, economic return from tertiary education is weighted to private than social. Therefore,the government in most countries triesto relocate resources to the pre-primary and primary levels. In Thailand, the government still highly investsat the tertiarylevel as the priority. Thus,graduating students implicitly gain from social resources (tax), and they should share their gain (windfall)with others.Third, doing so would simply be good for their morality.

In my opinion, there is no instant solution for social obligation. Nevertheless, solutions may come from what I call "cultural incentive." I created this term to explain that incentive is not just monetary. As I discussed in the three non-pecuniary motivations of Kanter (2003), a person's motives are complicated, and part of its complexity is "culture."Culture (i.e., myth and social discourse) will continually shape an individual's behaviors and anchor it to the norm. If you reach that norm, you will obtain the incentives.

The critical question is "Whatsciencestudents can do even if social obligation is provoked in their mind?"From the global practice, graduating students, who are socially obligated technologists, can be supported bywhat is calledTISE. The meaning of social enterprise depends on the context and legal definition of each country. However, in this context, the enterprise denotes to a private firm that produces product that directly focuses on

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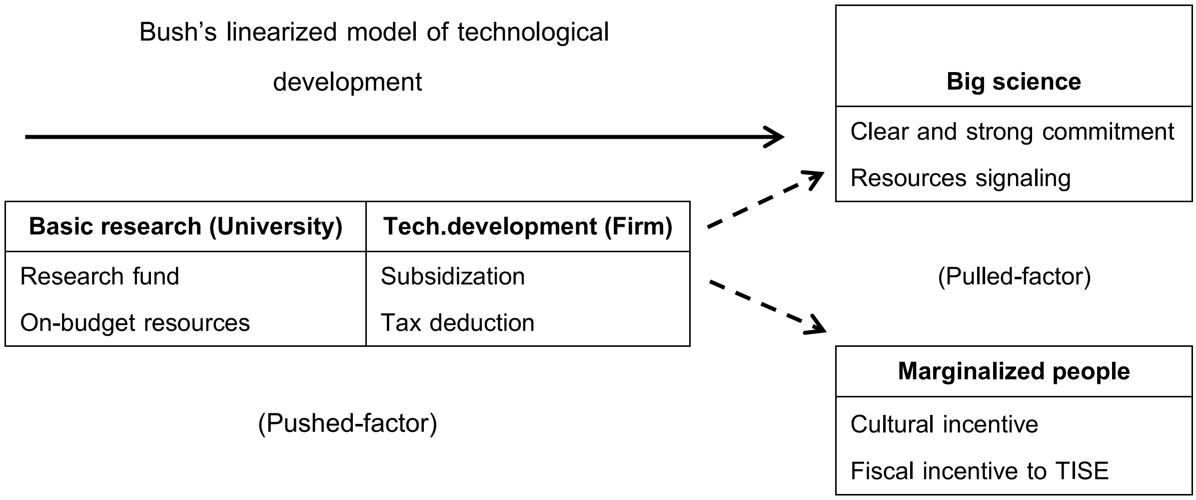
[16] Moreover, students whose family background is an agricultural one will probably obtain schooling year lower than that from a white-collar family, about 3.5 years on average.

increasing marginalized people's welfare given acceptable profit (not the maximized profit produced by a general firm). The term“technological intensive”indicates that the product should have value added useby technology, or,from the cost-side perspective, technology should be accounted as the highest proportion of production cost.

Examples of TISE are evident around the world. For instance,Doukas (2013) presents an overview of social enterprises that aim to help the poor who have no access to clean energy. Recently, BBC (2006)[17] has reported that *LifeStraw*, the straw used for screening dangerous diseases from drinking water, was invented for the African people. The one laptop per child project of the MIT media lab[18], which is the prototype of theOTPC project in Thailand, is also within the scope of TISE. These are examplesof products that were made to fulfill an obligation to the marginalized people excluded from mainstream technology (i.e. purified water or electricity). In Thailand, theprevious government established the Thailand Social Enterprise Organization (TESO) from 2009 to 2010to assist social enterprises. However, the organization wastrivialized during that time.

Figure 3: Conceptualization of the discussion in Chapter 2



17 See full report in http://news.bbc.co.uk/2/hi/africa/4967452.stm.

18 See more details on the official Web site of MIT media lab from, http://www.media.mit.edu/people/nicholas

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3. Conclusion

This study clarifies the theoretical suggestion about incentives for technological enhancement (Figure 3). However, in Thailand, each policy has specific problems.Therefore, technology growth does not automatically lead to economic expansion. I confidently state that the quantitative goal, such as the“number of GERD per GDP,” is not sufficient in itself. It can mislead policymakers to the wrong indicator. Policymakers should focus on solving the problems discussed in Chapter 2. Moreover, the government should expand the resources for incentive functions, as shown in Sections I to VII.The result will be systematically shown by the increase in GERD per GDP.

This preliminary paper needs to be improved by quantitative analysis and deep interviewing. Further that, each issue which is mentioned in chapter 2 can be profoundly extracted into details by following research questions. For example, what is quantitative impact of Science Park in Thailand? (in term of growth and inequalities reduction). What is political-economic barrier to implement incentive scheme in Thailand?

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Appendix A:

Basic structure of Thailand's science and technology, innovation and R&D sphere

Table A.1: Institutions' profile

Institutions	Roles
Ministries/Government Departments	
NESDB	The National Economic and Social Development Plan co-ordination, supervision and assessment a five-year plan for guidance of all government departments/ agencies, current under the eleventh national economic and social development plan (2012-2016)
NRCT	National research policy co-ordination, formulate, monitor and evaluate research plan, R&D projects
National STI Committee	The development of science, technology and innovation shall be in accordance with national policy and plan on science, technology and innovation
BB	Government budget co-ordination, allocation, supervision, monitoring and evaluation
NSTDA	Plan and execution of R&D, R&D funds granting, technology transfer, promotion of human resources development, STI infrastructure development, according to the NESDB plan
NIA	Coordinating, networking and partnering different organizations from various fields such as education, technology, finance or investment. Mainly focuses on utilizing knowledge management to achieve innovation, particularly to induce "innovation on Cluster Platform" which uses innovation as the principal tool in improving the quality of life and as a driving tool for competitive economics
ONEC	Formulating educational policies and plans with a view to providing equal access to education for all; establishing an education system of quality and effectiveness; and enhancing quality of learning. Conducting research for further development of educational provision, and strengthening capacity for competitiveness
OHEC	Higher education policy and plan co-ordination, monitor and evaluate HEI plan, which include mainly public universities and private universities and other higher education colleges

Institutions	Roles
BOI	Promotion of investment in Thailand by offering an attractive and competitive package of tax incentives to manufacturing and services activities. Provide assistance to facilitate entry and subsequent operation for a foreign-owned business. Waives restrictions on land ownership by foreign entities.
TRF	Comprehensive granting of research fund for researchers.Assistance in the development of researchers and research-based knowledge through making research grants and assisting with research management. TRF does not itself conduct and research
IPST	Promotions of STI teaching activities: Curriculum design, Teaching material design and production, Design of evaluation method, Teacher training
HSRI	Sponsoring national processes to support evidence-informed policy decision-making, including the synthesis of issue-focused policy briefs and deliberations to improve national health systems
ARDA	Promotion of agricultural research, especially for commercialization purpose. Promotion of human resource development for agricultural research
DSS	Science testing service for industry such as material properties testing. Certification of laboratory system. Laboratory service scientist training
TISTR	Conduct R&D in food, health products, medical equipment, renewable energy, and environmental management.Provision of science and technology services in analysis testing, calibration, accreditation and consultation compliant to international standards
THAIST	Promotion and provision of support to the production and development of research personnel to increasing researchers towards a sufficient number and elevating the quality of research. Promotion and supporting the establishment of centres of excellence in areas of specialization.

Source: KMUTT and NSTIPO (2013)