Government Spending vis-à-vis Business Enterprise Investments on Research and Development

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ABSTRACT

This paper investigated the association of government spending and business enterprise investment to research and development. Exploratory data analysis was done on R&D expenditures on gross expenditures on Research and Development (GERD). Ratios of business enterprise investment over government spending revealed that Agriculture, Humanities and Social Sciences are usually governmentally funded; Engineering and Technology, and Medicine and Health Sciences are business-enterprise driven, and Natural Sciences is financed by both. It was also found out that business enterprises tend to support R&D sectors in high and middle-income countries, while government expenditure is more evident in low-income countries. Among the sectors, only E&T, NS and SS have highly significant and positive association on public and private spending. Therefore, public spending on R &D is focused on fields concerning citizen welfare and human development while business enterprises focus on advancements in technology and medical research. Research prioritization as measured through government expenditure spurs investment in the private sector in fields as they are deemed to have high social value, and positive impact on a country's development. Policy decisions on R & D budget allocations should consider the dynamics of current spending in relation to private sector investments to maximize productivity and growth.

Keywords: *government spending, business enterprise investment, research and development*

INTRODUCTION

The United Nations has challenged countries and economies around the world to strengthen pursuits in scientific research, boost industries in all countries through technological advancements, in particular developing countries, including, by 2030, push for innovation and place substantial investments geared towards increasing the number of research and development (R&D) workers per 1 million people and public and private R&D spending. The UNESCO Institute for Statistics (2015) has identified this as specific objective for the achievement of the ninth sustainable development goal, on building resilient infrastructure, stimulating sustainable industrialization and fostering innovation.

For progress in science and development, MacIlwain (2010) highlights that investment in research is important.

In answer to the challenge of the United Nations, it can be noted that R&D across the countries around the world has reached a record high of almost US$ 1.7 trillion (UNESCO Institute for Statistics b, 2015). Increased investments on R&D can be interpreted as research prioritization in the world. The budget allocated for these initiatives are largely sourced out from a country's government support and the investment from the business enterprise.

Studies show that financial investments on R&D from the government's coffers can have positive associations to productivity. For example, a study involving Asian countries revealed that nations with higher expenditures relating to R & D initiatives, have a large number of universities and scientific indexed journals produced more in research outcomes including total number of research publication, citations per documents and H-index in various science and social science subjects (Meo, et al, 2013). Considering that there are various fields of research and every government has numerous fiscal appropriations to cater to, public budget allocation is never enough. Private investments are also deemed of value to research productivity.

The study of King's College London (2016) on public medical research expenditures and private pharmaceutical industry R&D expenditures in the United Nations showed that there is a complementary relationship between the two variables. Looking into the significant findings of the aforementioned study, it was found 44% of augmentation of private sector funding follows within one year of the expenditure increase in public research but it takes decades for full impact to be felt (King's College London, 2016). These findings make mention of the effects of spending on research productivity but there is a gap in literature as to who should be spending more for research and development. Increase in budget and spending for Research and Development necessitates the need to look into where investments from both public and private sector be directed in order to achieve positive impact.

Taking into consideration that research is treated differently in various sectors, this paper investigates the association of public and private investments to research and development in Agriculture (AGR), Engineering & Technology (E&T), Humanities (HUMS), Medicine and Health Sciences (M&HS), Natural Sciences (NS) and Social Sciences (SS). Spending by low-income, middle income and high income countries is also investigated to look into the ratio of business enterprise and government spending. Looking into investments per sector would reveal whether government spending has a

positive correlation to business enterprise investments in R&D.

The dynamics of R & D spending could provide evidence to back policy decisions on R &D budget allocations for various sectors in a country to maximize productivity and growth. This paper operates on the assumption that research prioritization by the business sector is a return of investment (ROI) of research prioritization by the government.

SHORT LITERATURE REVIEW

Research and Development has had increasing investment in the past years from countries around the world as a concrete response to the sustainable development goals on spurring innovation, pushing for sustainable industrial advancements and promoting the construction of resilient infrastructures (UNESCO Institute for Statistics *a*, 2015). One of the sources of funding is from the government wherein investments in R & D are made in order to promote the progress of the nation. However, the increasing number of scientific research in the recent years has translated to the depletion of sufficient public resources available to support it (Bornmann, 2012). There is a need for various sectors to get additional support leading to productivity in R & D.

Other studies done on research productivity and funding show that government funding alone is enough to guarantee research outcomes. One significant result in the study of Meo, et al (2013) revealed that there is no significant association between the per capita GDP and research productivity (measured through bibliometric indicators, including total number of research documents, citations per document and H-index in various science and social sciences subjects) in 40 Asian countries from 1996-2011. Data on GDP per capita, spending on R&D, total number of universities and indexed scientific journals were collected were also looked into. This finding emphasizes the complex dynamics of spending and productivity in research and how evidence-based fiscal decisions are important.

Private sector spending on research and development is not only deemed necessary but is linked to government spending. In a study done by Czarnitzki and Fier (2002) in Germany, service sectors who benefit from public funding of innovation activities have been granted additional private sector support which translates to the fostering of innovation efforts. In the medical research area, a study by King's College London (2016) also highlights complementary relationship government spending on medical research and private sector investments in R&D in the pharmaceutical industries of the United Nations. The aforementioned investigations put forward the notion that there is a need to look into the peculiarities of sectors in R & D and how

funding varies with the prioritization of these fields.

Discussions have been made for instance in the area of Humanities Research wherein scholarly research are not considered to be at par with the natural and social sciences because of their seeming lack of having direct and immediate relevance to public policy as utilization of humanities research outputs tend to be less obvious and less specific (American Academy of Arts and Sciences, 2018). Benneworth (2015) attributes this to the idea that disciplines other than the Humanities use 'investment logic' or the creation of value from knowledge generation efforts to create links between research and economic growth. However, arguments have been made that research need not lead directly to wealth generation as it has other benefits to a nation. (King, 2004).

The need for research investment, returns for the said investments and the dynamics of funding from the private and public sector in relation to research productivity need to continuously investigated to enable countries around the world to make better fiscal decisions. The challenge is to be able to mobilize limited resources for maximum results through building partnerships with stakeholders in the various sectors of research and development.

METHODOLOGY

The study utilizes exploratory data analysis of the data on R&D expenditures of 158 countries obtained from the UNESCO Institute of Statistics data bank. The data of interest is the gross domestic expenditure on R&D (GERD) of countries, expressed in dollars ($), performed by the government and business enterprise in a span of 11 years (from 2004-2014). The ratio of GERD by the business enterprise (y) over that of the government (x) over the stated period of time is plotted to determine whether spending is made mostly by the government or by the business enterprise. The six sectors (AGR, E&T, HUMS, M&HS, NS and SS) are taken into consideration, as well as the income classification (high, middle, low) of the countries as additional variable.

To test the association of public and private investments to research and development in Agriculture (AGR), Engineering & Technology (E&T), Humanities (HUMS), Medicine and Health Sciences (M&HS), Natural Sciences (NS) and Social Sciences (SS), Pearson coefficient of correlation (r) is obtained.

RESULTS AND DISCUSSION

Trend in Government and Business Enterprise Spending in R&D

The trends of government and business enterprise spending in R & D as seen in Figure 1 clearly show how the

Engineering and Technology Sector has a significantly higher ratio than the rest of the sectors. This reveals the biggest private sector spending which could be attribute to it being the most profitable sector as well. Investments in infrastructure, equipment, and machinery lead to efficiency in the delivery of goods and services in other areas and return of investment (ROI) does not solely mean profits for the private sector but for the country where spending is made. Research-based developments largely come from this sector as innovation is integral to it.
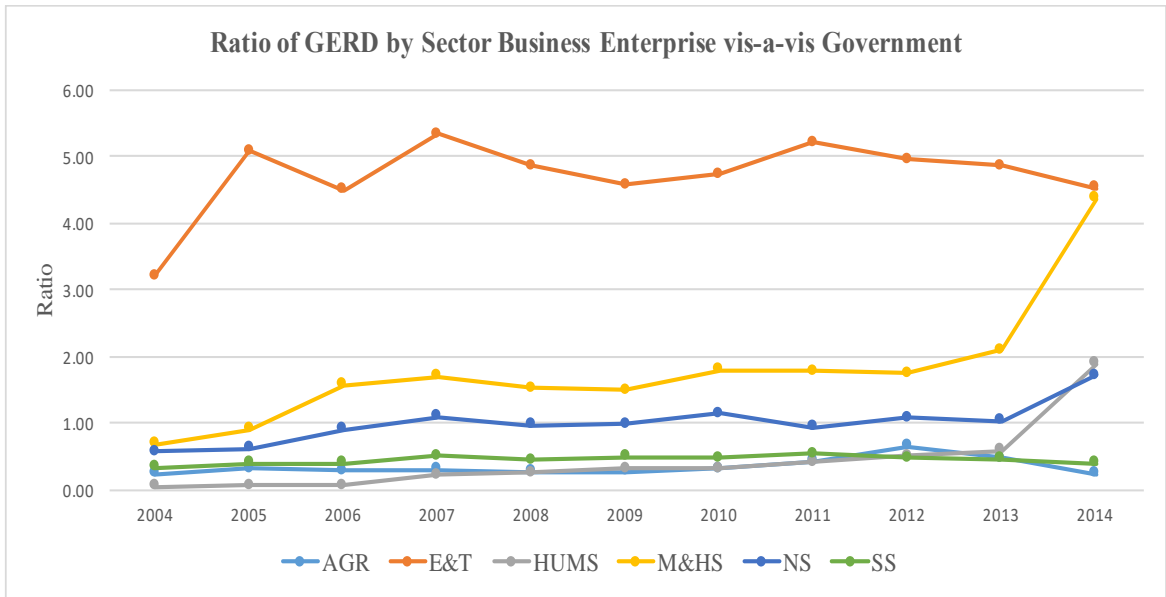
Figure 1. Trend of government and business enterprise spending to R&D (2004-2014)

Research and Development sectors in AGR, SS and HUMS are mostly financed by the government rather than the business enterprise. This could be due to the fact that these sectors cater to the basic provisions that the government must provide its citizens, and as such, research should be done to improve life. In particular, AGR government research projects are initiated to fight and eradicate hunger and poverty, leading to the development of anti-poverty floors and agro-processing methods (Martin, 2013). It is however important to note that the findings do not mean that private investments are not coming in but rather are not as significant in comparison to E&T. This could be because returns in agriculture as an area of research has vulnerabilities. Natural calamities, for instance, is a risk it needs to deal with. It is important to note that there is an increasing support for agriculture research from government coffers and while such support is increasing, private investment from the business sector is catching up with the former, especially

in researches on crop breeding, pesticides, and food technologies (Pardey, Chan-Kang, Dehmer and Beddow, 2016).

Like R&D in AGR, the expenditures of the SS sector come mostly from government funds. Government invests in this sector primarily because R&D findings in SS are usually beneficial to policy-makers and government managers (DFID South Asia Research Hub, 2011). On the other hand, business enterprise has challenges in deriving significance from the findings of SS studies due to the lack of relevant time series data, as well as negative effects of knowledge spillovers due to cultural limitations (Smith, 1998). More recent literature support the notion wherein distinguished scientific articles due to its publication in reputable journals and high citation index may contribute significantly to the academic discipline but not for the community (Nightingale and Scott, 2007). However, according to *Harvard Business Review*, the future of SS R&D will be with the private companies due to integration of online services, such as Google, Facebook and Amazon which conduct social experiments a thousand-folds than actual experimentations (Scharge, 2015).

In addition to agricultural and social sciences R&D sectors, HUMS sector has been seen to be mostly invested by the government, though, the least invested sector. According to *Humanities Indicator*, a project of the

American Academy of Arts and Sciences (2018), HUMS researches are least financed due to the less obvious and less specific applications of the findings. Though, research in HUMS, as exemplified by the government of the United Kingdom, is an investment which could yield wealth, enhance public policy-making, and improve quality of life (Arts and Humanities Research Council, 2009). Both the government and business enterprise do not invest much in HUMS studies, as they only require the minimum support compared to other fields such as engineering and technology researches which require up-to-date tools.

Another field investment in R&D is on NS, which is funded almost equally by the government and the business enterprise. This might be due to the fact that R&D initiatives in NS are usually geared towards basic research on biology, chemistry, physics and other sciences, an important realm of both the public and private stakeholders. Basic NS creates a ground for both stakeholders to play complementary roles. For instance, Chakravarthy, et al. (2015) stated that 54% of basic science milestones were achieved predominantly by the public, while 58% of the discovery milestones were made by the private enterprise. Basic researches lead to the acquisition of new knowledge, social cohesion of the country, and economic returns (dos Remedios, 2006).

E&T and M&HS sectors are highly financed by the private business enterprise. This support suggests that the business sector has their eyes on product development, rather than knowledge generation which is funded by the public. Knowledge spillovers of the publicly funded research boost the private R&D productivity, thereby increasing commercial inventions and creations in areas such as transportation, telecommunications and pharmaceuticals, facilitating future product development (Albert, Yasay and Gaspar, 2015). As market pressures businessmen to put their money on these products, applied research investment increases as much as five-folds in 2007 than the government expenditures.

Country Classification and Government and Business Enterprise Spending on R&D

As shown in Table 1, there is a decreasing ratio of business enterprise over government expenditures from high-income to low-income countries in AGR, E&T, HUMS, M&HS and NS sectors. This means that the business sector usually support R&D initiatives in the five sectors in high and middle-income countries, and that the government in low-income countries mostly funds these R&D projects. Noted also is the increasing interest of the government under the said income classes to back SS research projects, primarily to improve social services as well as legislation matters.

Table 1. Ratios of business enterprise over government spending to R&D and country classification (2004-2014)

R&D Sector	Country Classification		
	High Income	Middle Income	Low Income
AGR	0.387	0.355	0.113
E&T	4.852	4.606	3.758
HUMS	0.625	0.099	0.007
M&HS	2.949	0.738	0.039
NS	1.279	0.745	0.186
SS	0.386	0.758	1.406
Overall	*2.617*	*2.274*	*0.442*

The minimal investments of the business sector in the low-income countries could also provide evidence that private sector funding in research and development comes together with public sector investments leading to development returns for a nation. Low-income nations may translate to limited funding for all its operations including that of R & D. Less investments in the said sector would not merit support from private sector partners except for considerably high ratios on E &T and SS which could be its most profitable sectors or where returns to investments come much faster.

Overall, R&D projects in high and middle-income countries are highly funded by the private business enterprise, whereas the government in low-income countries supports most of the R&D initiatives. Coccia (2010) stated that countries with bigger GDP tend to have higher private business enterprise investment in R&D, and that those with lower GDP who have higher government spending to R&D sectors.

Association between Government and Business Enterprise Spending in R&D

Looking at Table 2, only E&T, NS and SS are highly significant and positively associated in terms of government spending and business enterprise investment. This means that the increase in government spending in these R&D fields boosts the interest of the business enterprise to invest on the fields as well. This could also be an evidence of better partnerships in these sectors as literature reveals that cooperation among public research institutions increases private R&D spending (Enterprise Research Center, 2015). Engineering and Technology, and Natural Sciences are research sectors that have direct applications to innovations in infrastructures, systems, and processes.

Table 2. Association between government and business enterprise spending in R&D

R&D Sector	r-value	P-value
AGR	-0.045^{ns}	0.895
E&T	$+0.901^{**}$	0.000
HUMS	-0.156^{ns}	0.647
M&HS	$+0.228^{ns}$	0.501
NS	$+0.629^{**}$	0.038
SS	$+0.960^{**}$	0.000

** Highly significant ^{ns} Not significant

On the other hand, Social Sciences as an area of research have direct relations to human development and policy-making directions. The impact of research outcomes may be more felt in these sectors in comparison to the other areas. As government spending increases, the private sector investments also come in. This is valuable since private sector funding has been identified to have a positive impact on the productivity, growth and success of countries (Coccia, 2010; ERC, 2015).

Government spending and private sector investments on Agriculture, Medicine and Health Sciences and Humanities Research have no significant relationship. Food is a basic need of every nation and it is possible to interpret this finding as a consideration that it should primarily be taken cared of by the public sector. However, existing literature reveals that this may not be a matter of spending but prioritization. Health is a basic necessity as well but the data reveals that there is more spending from the private sector. In the study of Meo, et al. (2013), research outcome was revealed to not depend on the Gross Domestic Product, but on how much percentage of its totality is being spent on R&D. Furthermore, this lack of correlation may be because of how it may not be as profitable of an investment to the private sector. Research in Humanities is seldom given an equal standing to that of the other fields of study. Benneworth (2015) argues that despite arguments made to push for the contribution of arts and humanities research through the social value it creates, these efforts have had little effect within public policy debates.

Over-all, the variation of the correlation among R&D sectors means that there is a wide divergence in

research funding internationally (Scienceogram, 2013). There may be a need to look into the specific context of every country to give more valid arguments. General trends on the dynamics, however, provide strong evidence that research productivity varies per sector and is affected by government prioritization and private sector support on expenditure.

CONCLUSION AND RECOMMENDATION

Public spending on R &D is focused on fields that focus on citizen welfare and human development while business enterprises focus on advancements in technology and medical research. Research prioritization as measured through government expenditure spurs investment in the private sector in fields that are deemed to have high social value and positive impact on a country's development. Policy decisions on R & D budget allocations should consider the dynamics of current spending in relation to private sector investments to maximize productivity and growth.

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