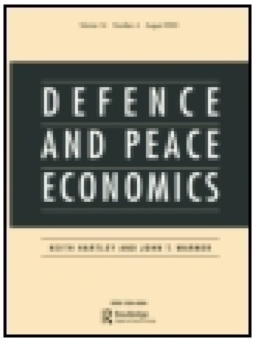

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Investment in Research and Development Compared to Military Expenditure: Is Research Worthwhile?

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ABSTRACT

Both research and development (R&D) and military expenditure are pivotal areas for any country's economy. However, most countries tend to spend more on military because of global insecurity and power politics. Nevertheless, this study shows the merit of R&D investment and how it contributes to the national human capital. An analysis was undertaken on the gap between R&D and military expenditure considering the Human Development Index (HDI) and Gross Domestic Product (GDP) of 76 countries for a period of 15 years (2000–2014). Mixed effect models were applied to adjust the effect of six different continents. The results showed that HDI has a positive bi-directional significant relationship with higher R&D investment. National spending on R&D builds human capital, which in turn contributes to public development over the years, unlike military expenditure that only marginally contributes towards GDP and makes no contribution to HDI.

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HDI; GDP; human capital; investment gap; research; defense; investment; spending; development; military

Introduction

For any country, investment on research and development (R&D) and its subsequent contribution to both the economy and human capital remains unclear. Existing studies on military expenditure shows the slightly 'positive' effect of such investment on national economy, but not on human development. However, there is a literature gap for a country-wise comparison between these two expenditures (as % of GDP). This study analyzed the difference between R&D and military expenditure for 76 countries from six different continents and their relationship with both the Human Development Index (HDI) and Gross Domestic Product (GDP). The authors assessed data from 2000 to 2015, a period of 15 years. The objective was to assess the contribution of this expenditure gap on the development index or economic portfolio of these nations. Our assessment showed that there exists a bilateral positive relationship between R&D expenditure and HDI. The countries with higher HDI spent significantly more on R&D budgets compared to those countries with a focus on military expenditure over the years. Furthermore, a contrasting interaction effect was found between HDI and GDP, as higher HDI encouraged more R&D and GDP growth aided military investment.

The economic benefit of firm-based R&D has been discussed in several studies; however, its relationship with national economy or HDI is less researched. R&D is increasingly considered as an important strategy to enhance the technological and creative dimension of a company to a greater extent and

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is termed as 'asset seeking' in various studies (Wesson 1999; Penner-Hahn and Shaver 2005; van Beers, Berghällb, and Poot 2008). Expenditures for research and development refers to the public and private spending (current and capital) on innovative plans undertaken systematically to increase knowledge, particularly on humanity, culture, and society, and its use for new applications (Singh 2010). Verner (2011) claimed that the expenditure on education and R&D aggregates to national competitiveness as such investments lead to higher human capital; for example, Nigeria (Oluwatobi and Ogunrinola 2011), China (Dan 2009), and OECD countries (Zachariadis 2004). Similarly, several studies found a positive interaction between R&D, and long-term firm and national level economic growth (Mairesse and Sassenou 1991; Hall and Mairesse 1995; Guellec and Van Pottelsberghe de la Potterie 2004; Coccia 2011). These show the importance of R&D and its direct effect in national and social capital.

Although R&D covers basic research, applied research, and experimental development, the impact and application of these on national economy vary significantly (The World Bank 2016). Tertiary education and the proportion of scientific researchers in a country are important determinants of national R&D investment (Wang 2010). Complicated modeling is required to fit basic research with economic benefits (Salter and Martin 2001). Theoretical studies on the impact on policy implementation is generally slow; however, they are gaining momentum over the years with more economic contributions from both public and private research funds (Pavitt 1991). Furthermore, migration of scientists from basic research to industry facilitates the transfer of the knowledge scientists previously developed and accumulated in the context of their research programs (Zellner 2003). The capitalistic market economy encourages applied research (technology) over theory (science) (Nelson 2004). Mansfield (1988) used a cross-section of 200 industries from Japan and the Unites States, and concluded that productivity increase was positively associated with applied R&D in Japan, but had a negative and statistically insignificant association with basic research. He suggested that efficient increase of industrial R&D capacity should result in greater economic return for the Unites States (Zachariadis 2004). In a review article, Drucker and Goldstein (2007) showed that R&D spending by the universities has considerable impact on regional economic development measured in terms of producing knowledge and innovations mostly technological, creating local employment, and attracting research funds. Statistically, an increase of 1 percent in business R&D generates 0.13 percent in net productivity growth (Guellec and De La Potterie 2002), again showing the importance of investment in R&D.

Military spending and its impact on national economy have shown two outcome streams in literature: the literature on defense economics has found that military expenditure contributes to economic growth, while several studies disagreed with that conclusion (Guellec and Van Pottelsberghe de la Potterie 2004; Lavergne, Doppelhofer, and Miller 2004; Dunne, Smith, and Willenbockel 2005; Yildirim, Sezgin, and Öcal 2005). For example, Abu-Bader and Abu-Qarn (2003) conducted multivariate cointegration and variance decomposition techniques for Egypt, Israel, and Syria and found a bi-directional causality from government spending to economic growth with a negative long-term relationship between these two. Alptekin and Levine (2012) showed the discrepancies in the current literature and confirmed the hypothesis of a nonlinear military expenditure growth relationship through a review of 32 empirical studies with 169 estimates. Alongside several opportunity costs, military expenditure does not necessarily aid the national economy and vice versa. However, this conclusion is limited to the specific countries that have been studied so far.

R&D investment and military expenditure depend on a country's geo-political scenario and economic stability. Compared to poor countries, developed nations spend more on R&D due to their financial depth, protection of intellectual property rights, government capacity to mobilize resources, and improved quality of research institutions (Lederman and Maloney 2003). In contrast, military spending is more complicated and varies geographically, depending in particular on regional and international politics. The African nations are more concerned about internal insurgents and civil wars (le Billon 2001; Smaldone 2006; Ahmed 2012), whereas the U.S.A. is playing the role of a global leader closely followed by China–Russia and their alliances (Paarlberg 2004; Chan 2005; Tammen and Kugler 2006; Haass 2008). Europe, comparatively passive, expands the military for supporting the United Nations (UN) and the North Atlantic Treaty Organization (NATO) (Hartley 2003; Kollias, Manolas, and Paleologou 2004; Lucarelli and Manners 2006), while the Middle East is part of an ever-continuing struggle, where Iran, Israel, and Saudi Arabia continue to increase their military strength (Halliday 2005; Sørli, Gleditsch, and Strand 2005; Laqueur and Schueftan 2016). Moreover, the *mission* and *non-mission* military R&D spending may have a civilian impact (Mowery 2010). Thus, the reasons behind these countries' investments on military have different demands and stakes, and the existing paradigm generally forces most countries to invest more on military than research.

The expenditure gap between R&D and military, along with its association with HDI and GDP, are explored in this study. HDI is measured based on three criteria: Health – measured by life expectancy at birth; Education – calculated by expected years of schooling for school-age children and average years of schooling in the adult population; and Income – quantified by the Gross National Income (GNI) per capita (PPP US$) (Alkire 2010; Harttgen and Klasen 2012). GDP determines the size of the wealth of a nation, which is the accumulation of personal consumption, business investment, government spending, and national exports–imports (Leamer 2009; Yamarone 2012). Thus, GDP and GNI (of HDI) are not the same scale. GNI measures all income of a country's residents and businesses, regardless of where it is produced. Gross Domestic Product (GDP) measures the income of anyone within a country's boundaries, regardless of who produces it (Hatfield-Dodds et al. 2015). However, correlation was checked prior to fitting the models for the independence assumption.

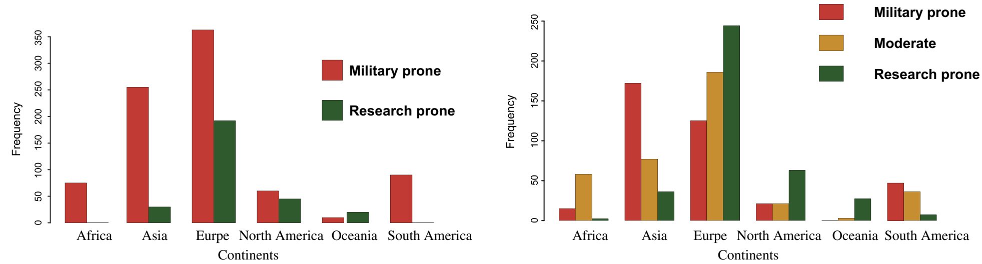
Data Description

The data was collected from the World Development Index (WDI), where data on various national indicators have been stored since 1960 (The World Bank 2016). We collected R&D and military expenditure (as % of GDP) along with GDP (current US$) of 76 countries from 2000 to 2014, as the remaining countries had incomplete data. Less than 5% of missing values of R&D expenditure was estimated through the multiple imputation method (Allison 2002). In the WDI, military expenditure is calculated as a share of GDP (% of GDP), which is an approximate rough indicator of the portion of national resources used for military activities and of the burden on the economy (The World Bank 2016). Similarly, Research and Development expenditure refers to the portion of GDP (% of GDP) spent on basic research, applied research, and experimental development. The HDI data were collected from the United Nations Development Program (UNDP), where the country-wise data over the years are readily accessible (UNDP 2017).

The outcome variable (for the first part of the analyses) is the national expenditure gap between R&D spending and military investment represented as a percentage of the GDP, which is the GDP share of military investment versus R&D spending. We considered three possible options for converting this continuous variable: two in ordinal scales and one as continuous for interpretation convenience. Firstly, if the research expenditure was higher than the military (in *absolute* scale), the country was labeled as research-oriented. It provided a binary outcome variable: (i) military-prone countries; and (ii) research-prone countries. Secondly, the continuous outcome variable was trisected equally to attain a three *relative* scale outcome variable: (i) military-prone; (ii) moderate; and (iii) research-prone (Figure 1). Finally, the expenditure gap between R&D spending and military investment was taken as it is, a continuous variable. Among the 76 countries we considered, 48% are from countries in Europe, followed 25% from Asia (Figure 1). The HDI increased sharply for Europe, Asia, and Oceania (Figure 2). Interestingly, the confidence intervals (95%) for GDP (red line in Figure 2) has increased over the years for all the continents, except for North America, which shows that the inequality in economic growth that has multiplied over the last decade.

Statistical Algorithm

The bi-directional relationship between expenditure gaps and the indices was assessed by fitting Generalized Linear Mixed Model (GLMM) in both directions. It is particularly applicable in this scenario as the variation of continents should be considered as a random effect in the regression model. Both



(a) Absolute difference between R&D and military expenditure among the continents

(b) Relative difference between R&D and military expenditure among the continents

Figure 1. The R&D and Military expenditure gaps in various continents, generated from World Development Index. (a) Absolute difference between R&D and military expenditure among the continents (b) Relative difference between R&D and military expenditure among the continents.

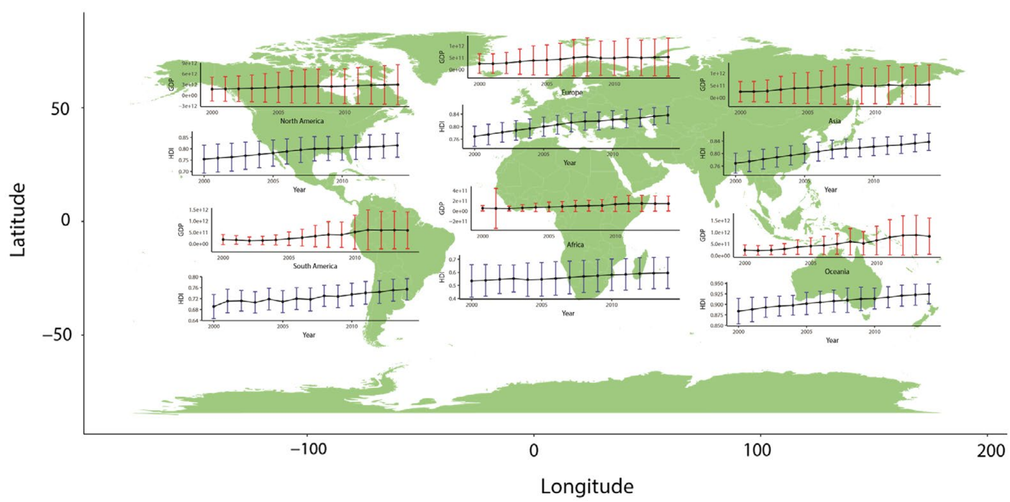


Figure 2. HDI and GDP of different regions of the world from 2000 to 2014.

HDI and GDP (the sum of gross value added by all resident producers quantified in US$) were scaled by adjusting the mean to better fit the regression model (The World Bank 2016). GLMM is an applied model that allows the fitting of multivariate distributions for non-normal data that can accommodate some flexibility along with incorporating random effects into the linear predictors (McCulloch and Neuhaus 2013; Biswas and Kabir 2017). Let Y be the observed data vector and, conditional on the random effects, u, assume that the elements of Y are independent and drawn from a distribution in the exponential family; assuming a distribution for u depending on parameters, D (McCulloch 1997):

$$f_{(yi|u)}(y|u,\beta,\varphi) = \exp\{(y\eta_i - c(\eta_i))/a(\varphi) + d(y,\varphi)\}u \sim f_u(u|D)$$

Here, $\eta_i = x^0_i\beta + z_i^0 u$, with x^0_i represents ith row of the fixed effect X and z_i^0 is the same for random effect Z (McCulloch and Searle 2001). The continents clustering was considered as random effect in this paper. The $R - package\ glmer(lme4)$ and $clmm(ordinal)$ were applied for fitting the binary and ordinal outcome based GLMM respectively. The linear effects of GDP and HDI were fitted with the expenditure gaps (and vice versa) using the package *lme*{*nlme*}. All computations were conducted in *R* (version 3.4.0).

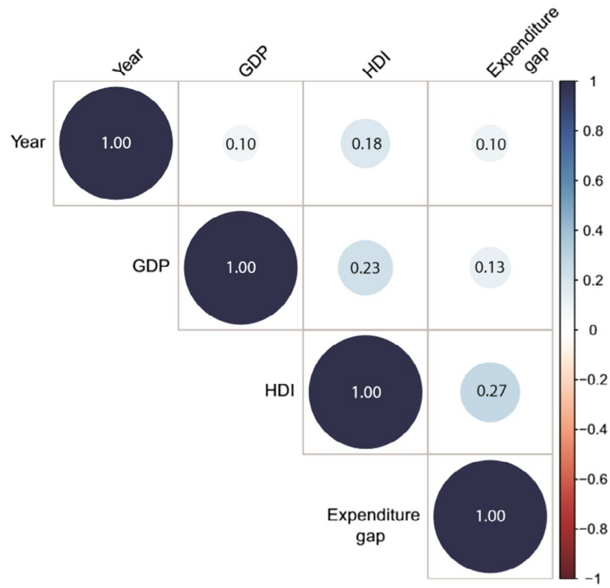


Figure 3. Correlation matrix of the variables of interest. Positive correlations are displayed in blue and negative correlations in red color. Color intensity and the size of the circle are proportional to the correlation coefficients. In the right side of the correlogram, the legend color shows the correlation coefficients and the corresponding colors.

Table 1. The effects of HDI, GDP, and Year on the expenditure gaps in *absolute (binary)* scale.

	Model 1		Model 2		Model 3	
Random effect variance	3.246		3.474		3.38	
	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value
HDI	3.054 (2.29, 4.07)*	<0.001	2.939 (2.20, 3.93)*	<0.001	1.654 (0.96, 2.84)***	0.068
GDP	0.847 (0.73, 0.98)**	0.026	1.597 (1.19, 2.13)*	0.001	1.610 (1.01, 2.56)**	0.044
Year	1.038 (1.00, 1.08)**	0.042	1.034 (0.99, 1.07)***	0.072	0.996 (0.95, 1.04)	0.879
HDI*GDP			0.533 (0.41, 0.69)*	<0.001	0.492 (0.37, 0.65)*	<0.001
HDI*Year					1.077 (1.01, 1.14)**	0.016
GDP*Year					1.007 (0.97, 1.04)	0.675
AIC	1036.4		1017.6		1014.9	
BIC	1061.6		1047.9		1055.2	

*, ** and, *** represents significance at 1, 5, and 10%.

Results

In the absolute scale difference, only 25.2% of the countries had invested more on R&D than military since 2000. African and South American countries lag in this scale (Figure 1(a)). The scenario remains the same in the relative scale (Figure 1(b)), where Europe, North America, and Oceania seem to invest more on research. The bivariate dependence between the continents and the expenditure gaps in both scales were significant ($P-$ value < 0.001 for χ^2 test). The effect of GDP and HDI on the expenditure gaps was evaluated though the GLMMs. However, such models require independent correlation structures for robust fitness. Figure 3 shows that even though HDI and GDP have theoretical overlaps, our data-set has the adequate independence required to fit the models. Here, the expenditure gaps are in continuous scale.

Firstly, the expenditure gaps, in both absolute (binary) and relative (three) scales, were assessed as dependent variables by fitting them with HDI, GDP, and Year (Table 1). All three covariates are on continuous scales as fixed effects and continents (nominal) as random effects. The fixed effects (Model

Table 2. The effects of HDI, GDP, and Year on the expenditure gaps in *relative (three)* scale.

	Model 1		Model 2		Model 3	
Random effect variance	1.140		1.441		1.492	
	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value
HDI	1.866 (1.58, 2.21)*	<0.001	1.636 (1.37, 1.96)*	<0.001	1.159 (0.87, 1.55)	0.318
GDP	1.012 (0.87, 1.17)	0.879	2.299 (1.69, 3.11)*	<0.001	2.396 (1.65, 3.48)*	<0.001
Year	1.037 (1.01, 1.07)*	0.008	1.030 (1.00, 1.06)**	0.031	1.028 (1.00, 1.06)**	0.047
HDI*GDP			0.421 (0.32, 0.55)*	<0.001	0.394 (0.29, 0.52)*	<0.001
HDI*Year					1.045 (1.01, 1.08)*	0.004
GDP*Year					1.002 (0.97, 1.03)	0.887
AIC	2210.14		2155.14		2150.2	
BIC	2240.369		2190.409		2195.552	

*, **, and *** represents significance at 1, 5, and 10%.

Table 3. The effects of HDI, GDP, and Year on the expenditure gaps in *continuous* scale.

	Model 1		Model 2		Model 3	
Random effect variance	0.419		0.518		0.526	
	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value
HDI	1.307 (1.16, 1.47)*	<0.001	1.208 (1.07, 1.36)**	0.002	0.959 (0.78, 1.18)	0.698
GDP	1.196 (1.08, 1.32)*	<0.001	1.880 (1.57, 2.25)*	<0.001	2.421 (1.81, 3.24)*	<0.001
Year	1.027 (1.01, 1.05)**	0.015	1.021 (0.99, 1.043)	0.589	1.019 (0.99, 1.04)	0.073
HDI*GDP			0.618 (0.53, 0.72)*	<0.001	0.595 (0.51, 0.69)*	<0.001
HDI*Year					1.029 (1.01, 1.05)	0.0113
GDP*Year					0.978 (0.96, 1.00)***	0.050
AIC	4311.026		4281.87		4291.727	
BIC	4341.259		4317.142		4337.076	

*, ** and, *** represents significance at 1, 5, and 10%.

1) showed a significant (at 1% level) positive effect of HDI and negative effect of GDP on the absolute (binary) expenditure gaps, when the year was adjusted. As the gap was quantified by subtracting military from R&D expenditure, it meant higher HDI led to greater R&D investment while higher investment in GDP resulted in potential military spending. This was substantiated in model 2 (Table 1), as the interaction effect between the HDI and GDP had a contrasting direction. However, the interaction effect of HDI and year (Model 3) showed that the HDI investment over the years significantly (at 5% level) increased the R&D (decreased the gap) spending. However, such significance was not observed in the GDP–year interaction. The effect of continent (random) showed significant variances, rationalizing the application of mixed effect models. AIC (Akaike information criterion) and BIC (Bayesian information criterion) are model goodness-of-fit statistics that determine the fitness of the models and would be critical during the reconstruction of the results.

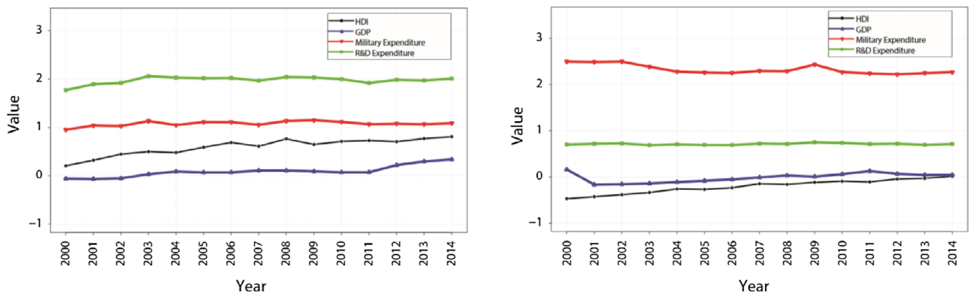
Similar results were attained when expenditure gaps were in relative (three) scale (Table 2). However, GDP did not have a significant effect in the fixed effect model (model 1), when year was adjusted. The interactions were significant and showed the opposite effect of GDP and HDI. The effect of year showed that the impact of HDI on expenditure gaps has increased over the years, as higher HDI lead to more R&D investment. Same results were for found linear mixed effect model fitted to the continuous measure of expenditure gaps with HDI, GDP, and year (Table 3). In the year adjusted Model 1 and Model 2, the significant effect of HDI showed positive association with expenditure gaps. In the final Model 3, the interaction between HDI–Year and GDP–year showed opposite direction just like the models with categorical outcomes.

In the second approach, we fitted HDI and GDP separately to the expenditure gaps (continuous scale) and year, where the continents were the random effect (Table 4). Linear mixed model for both HDI and GDP showed that the expenditure gaps contribute to both indices significantly (at 1% level) with adjusted year effects. However, interaction effect with year and the expenditure gaps did not display any significance. The random effect variances of the continents were comparatively small for all four models (Table 4).

Table 4. The effects of the expenditure gaps on the HDI and GDP over the years.

Outcome variable	HDI				GDP			
	Fixed model		Interaction model		Fixed model		Interaction model	
Random effect variance	0.864		0.864		0.176		0.176	
	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value	Odds (C.I.)	*P*-value
Expenditure gap	1.081 (1.05, 1.11)*	<0.001	1.056 (1.00, 1.115)**	0.048	1.086 (1.05, 1.12)*	<0.001	1.079 (1.01, 1.15)*	0.021
Year	1.040 (1.03, 1.05)*	<0.001	1.043 (1.03, 1.06)*	<0.001	1.019 (1.01, 1.03)*	0.003	1.020 (1.01, 1.04)*	0.006
Expenditure gap*Year			1.003 (0.99, 1.009)	0.320			1.00 (0.99, 1.01)	0.834
AIC	2739.099		2749.898		3138.089		3149.473	
BIC	2764.28		2780.109		3163.269		3179.685	

*, **, and *** represents significance at 1, 5, and 10%.



(a) Research Prone countries: R&D expenditure is higher than military

(b) Military Prone countries: military expenditure is higher than research

Figure 4. Variation between Human Development Index (scaled) and Gross Domestic Product (scaled) due to expenditure difference in R&D and military (a) Research Prone countries: R&D expenditure is higher than military. (b) Military Prone countries: military expenditure is higher than research.

The interpretation of the results requires understanding of the bilateral effects of expenditure gaps with HDI and GDP over the years. The countries where research investment is higher than military tend to have better HDI score than GDP (Figure 4). Alternatively, countries focusing on military have higher GDP compared to the HDI. These lead to a critical interpretation of Figure 4. As HDI and GDP are scaled (with zero mean), both graphs show the contrast between military and R&D expenditures in (a) research prone and (b) military prone countries. In either case, the GDP variation between these two types of nations are lower than the HDI; as HDI of research prone nations are convincingly higher than military prone countries with continuous increments in recent years. The p-value for an independent T-test is 0.02 for GDP (research vs military) and <0.001 for HDI. It infers that the countries investing more in R&D gained more human capital return and slightly higher GDP; similarly, countries with stronger human capital and stable economy spends more on research than military.

Discussion

It is an expected conclusion that countries with higher HDI would invest more in R&D, and R&D in turn will contribute to their human capital. However, while GDP in both research prone and military prone countries remains nearly similar, HDI is exclusively better in research prone countries than in military prone countries. Although the military investment in military prone countries contributes to economic production to some extent, they lag in human and social development. The countries in Europe and Oceania, whose investment is greater in R&D, has exclusively higher HDI and somewhat closer GDP growth in contrast to countries in Africa or South America.

An important part of the current analyses was the two different levels of the expenditure gap, considered as outcome variable during the first approach, which was segregated into two portions: absolute and relative. When the R&D spending is higher than the military (absolute case), the country focuses more on human capital and thus the opportunity cost of military service increases. As Francis (2009) wrote, 'human capital may decrease the benefits of conflict, since human capital, unlike land and other natural resources, cannot be easily appropriated or transferred.' With more investment in R&D, it contributes more to the value of human life, and higher economic return is gained, which also increases the social index scores, thus attaining increased GDP and HDI (Murphy and Topel 2006; Costantini and Monni 2008; Lutz and Samir 2011). However, this hypothesis raises the question that if a country is *relatively* investing more on R&D, does it gain higher HDI or GDP compared to the countries investing less on R&D and more on military? Our result argues that it does, and existing literature agrees (OM Nour 2005; Oketch 2006); as Petrariu, Bumbac, and Ciobanu (2013) showed, R&D investment leading to innovation and technological advancement contributes to national competitiveness and economic growth.

Human Development Index measures health, education, and income of the citizens; these constitute the segments of human capital (Ardichvili, Zavyalova, and Minina 2012). Early investment on human capital (education, skills, non-cognitive development etc.) results in long-term production increase (Heckman 2000). China's heavy investment in education and physical capital has resulted in both social and economic development, particularly the high rate of return from human capital (Heckman 2005). Kuemmerle (1999) showed that Foreign Direct Investment (FDI) on R&D increases the attractiveness of the local market, generates employment opportunities for local researchers and aids policy development. Even building social capital requires research, communication, and collaboration along with economic capital (Woolcock and Narayan 2000). A country with greater investment in human capital will have higher HDI and that requires more investment in R&D sector, thus explaining the results of this study.

The results indicated that GDP is a positive attribute for R&D, which encourages innovation and leads to increased technological advancements. Coccia (2015) claimed that a purposeful system (e.g. a complex society), with high economic potential and purposeful institutions with the target of a global leadership encourages revolutionary technological and technical improvements. R&D is positively associated with labor productivity, particularly if the national private R&D exceeds public R&D (Griliches 1986; Lichtenberg 1987; Coccia 2012). The research in universities that are recipients of both private and public investments concentrates on science and innovation, and contributes to greater human output (Klevorick et al. 1995; Agrawal and Henderson 2002; Cohen, Nelson, and Walsh 2002; Cohen 2010). However, limitless investment on R&D does not guarantee the high end of labor productivity; Coccia (2017) showed from OECD data that when R&D intensity equals to about 2.5% of the GDP, it maximizes the national labor productivity.

The interaction of military spending and R&D investment is a study of interest for understanding their impact in human capital and social gains, because the military 'classified' technology made life easier for the general public years later, particularly during post-war scenarios. Countries like the United States, which substantially invest in defense R&D on 'mission' activities, and France/Germany, which invest in 'non-mission' military R&D, fuel both applied science and innovation during peacetime that is expected to contribute to market economy and civilian applications (Mowery and Rosenberg 1999; Ruttan 2000; Mowery 2010). However, defense-related R&D has not been successful for public endeavors and had negative effect on production growth compared to non-defense public R&D (Guellec and De La Potterie 2002). These effects are hard to measure, particularly the spillovers and indirect effect of R&D investments in defense due to the substantial overlap between defense and non-defense applications (Griliches 1979; Bloom, Schankerman, and Van Reenen 2013).

We found that a negative bi-directional relationship exists between HDI and military expenditure. In the past, it was considered that 'there has been no clear link between reduced military spending and enhanced spending on human development' (UNDP 1994). However, Thomas (2001) claimed that the global security threat shadows the eminent threat of health, environment, and poverty. Furthermore, public spending is likely to be compromised due to military expenditures (Looney and Frederiksen 1996; Gupta, Verhoeven, and Tiongson 2002). Corruption is associated positively with military spending and negatively with human capital investment, particularly with education (Ak¸cay 2006; Delavallade 2006). Our result supports the existing literature and further quantitatively assesses the importance of R&D investment.

This study was limited by the lack of long time series data and number of available countries. Otherwise, we could assess the trend of the factors over time, where the application of a continuous outcome variable would be better suited. Moreover, the budget of health, education, public service etc. would have provided a greater scope for discussion. The interpretation should be carefully considered as the WDI data sets did not specify whether the military R&D overlaps with the national R&D expenditure. However, the current analysis gave a clear indication of the development impact of the expenditure gaps between the R&D and military, and how R&D investment ensures higher human capital return. Future studies with more data points would be able to fit lag-distributed models (e.g. Autoregressive Distributed Lag Model – ARDL) to extrapolate more information from the analysis. Furthermore, the effect of the R&D spending by the developed country on developing nations could be analyzed, if possible, to understand the overarching effect of high R&D investment on military prone poorer countries. If available, the models should be adjusted by control variables like geography, natural resources, ethnolinguistic polarization, and governance.

Conclusions

Data from the WDI was analyzed in this study to explore the differences, if any, among 76 countries from 2000 to 2014 based on their R&D and military expenditure. The results showed that human development index has positive bi-directional significant relationship with higher R&D investment. National spending on the R&D builds human capital, which in turn contributes to the public development over the years, unlike military expenditure that contributes positively towards GDP, not HDI. Investing more on basic, applied, and experimental research would provide better health services, higher educational standards, and sustainable income growth for a country. However, the military spending would only slow down the human capital, which in turn would reduce the R&D investment and long-term development. Wider time series data are required to perform a causality analysis along with a lag-distributed model and to consider the ecological control variables to confirm the direction of R&D investment in national economy and social development, which could provide further policy suggestions.

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