

Effect of Human Capital Investment on Economic Growth in India: A Path Analysis

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This paper investigates the relationship between human capital development/investment (HCD), research and development (RD)/innovation, social security and welfare (SSW) spending and economic growth (EG). We conduct a path analysis using 30 years of annual time series data from India. Secondary data is used to construct an estimated hypothesized model. Then, the maximum likelihood statistical technique in Stata 13 is utilized to identify factors affecting growth. The findings suggest that HCD and SSW affect EG directly and positively, whereas RD has a direct as well as an indirect impact on growth via HCD. A negative and relatively large direct effect of RD outweighs the positive and small indirect effect. Therefore, the overall effect of RD on EG is negative. All path coefficients (or time-varying coefficients) are statistically significant except for RD. The negative sign of the path coefficient of RD clearly shows that in addition to quantity, the quality of RD and presence of “social filter conditions” matter. Therefore, a comprehensive policy focusing on a series of factors like socio-economic conditions is needed to support the overall innovation system to reap the benefits of higher RD expenditure. The positive and significant influence of HCD and SSW on economic growth highlights the much-needed impetus for human development and welfare policies. Although several researchers have written on the relationship between HCD, R&D, and SSW and economic growth separately, as per our knowledge there has been no study that tries to capture the direct and indirect impact of these variables on economic growth, or that has used a path analysis technique to do so.

Keywords: Human Capital Development/Investment (HCD), Research, and Development (RD) and Social Security and Welfare (SSW) and Economic Growth (EG)

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INTRODUCTION

Amid the COVID-19 crisis, there has been renewed interest in spurring economic growth (EG). Undeniably, economic growth is a necessary (if not a sufficient) condition for the prosperity of a country and for improving quality of life through alleviating unemployment, poverty, and inequalities. There is no unified theory explaining the underlying factors of economic growth (Petrakos et al., 2007). However, there are well-known models which highlight the role of capital accumulation, human capital formation, innovation, and technology in the process of economic growth (Harrod, 1939; Domar, 1946; Solow, 1956; Swan, 1956; Romer, 1986; Lucas, 1988).

In India as elsewhere, the role of Human capital development/investment (HCD) has been attracting wider attention due to COVID-19. HCD implies expenditure incurred on education and health, and the already fragile health and education system has been stretched beyond limits. There is an ongoing “learning crisis” due to

disruptions caused by closures of schools and educational institutes. Together with a possible “nutritional crisis”, the pandemic is aggravating the already existing human capital deficit and hampering economic revival (Joshi, 2021).

In addition, with the large number of confirmed cases and deaths in India [World Health Organization (WHO), 2021 and Institute for Health Metrics and Evaluation (IHME), 2021] synergizing science and technology efforts through a “pro-active, pre-emptive, and a ‘whole government’ approach”,¹ has been the Indian Government’s focus in its efforts to deal with the crisis and to place the economy back on the growth track.² The importance of research and development (RD) in high performing areas like epidemiological studies, vaccines, and affordable diagnostics has highlighted the growth-enhancing effect of RD more generally. Moreover, RD on provision of both high- and low-tech solutions to learning disruptions caused by the pandemic have helped to mitigate the human capital deficit.

The pandemic has also drawn attention to issues of social security and welfare (SSW). Informal sector workers are estimated to account for around 81% of the workforce in India (ILO, 2018) and often work without any safety net.³ Informal workers have been hit the hardest by lockdown-induced unemployment and underemployment, especially in construction, tourism, the hospitality industry, and a large variety of services. The social security of informal sector workers, a hitherto neglected area of research but with a presumably positive relationship with economic growth, demands adequate and immediate attention.

The present paper makes a significant contribution by estimating an empirical model using time series data and a path analysis technique, an extension of multiple regressions. A unique feature of path analysis is that it helps to recognize, discern and assess the effects (direct as well as indirect) of a set of exogenous/independent variables on the dependent/endogenous variable via casual pathways. This unique feature motivated us to capture the direct and indirect causal connections among a set of variables (HCD, RD, and SSW) acting on a specified outcome (i.e. EG) taken up in this study. This is a clear departure from previous studies which make use of cointegration frameworks⁴ or multiple linear regressions, etc. Such previous studies therefore fail to capture the indirect effect of the independent variables on the dependent variable (i.e. Gross National Income per capita (GNIPC)). Where multiple regressions are concerned, there is only one dependent variable and a variable can be either a predictor or outcome variable. But it is more realistic to assume that an outcome variable may become a predictor of other variables. Using multiple regression techniques will become cumbersome and synthesizing results will be somewhat difficult. Therefore, path analysis constitutes a more direct approach to resolving this issue (Norman and Streiner, 2003; Shipley, 2000).

In addition, this study captures the overall impact of selected variables in a comprehensive way. It examines mediated pathways to capture the influence of an independent variable on the dependent variable via mediating or intermediate variables.⁵ Moreover, while the relationship between the variables HCD, RD, and SSW and EG have been studied separately (Grossman and Helpman, 1994a, 1994b; Dreze and Sen, 1996, 2002; Stiglitz, 1998;

¹ See <https://pib.gov.in/newsite/PrintRelease.aspx?relid=201036>

² One of the five pillars of the Atmanirbhar Bharat Abhiyan (Self-Reliant India Campaign) of Government of India (comprising of an economic stimulus package and a number of reform proposals) has been introducing 21st-century technology-driven arrangements and system in India (see: <https://www.investindia.gov.in/atmanirbhar-bharat-abhiyaan>).

³ The government’s Economic Survey of 2018-19 states that “almost 93%” of the total workforce is informal. NITI Aayog (2018) Strategy for New India @ 75 says that “by some estimates, India’s informal sector employs approximately 85% of all workers” (see: https://www.niti.gov.in/sites/default/files/2019-01/Strategy_for_New_India_2.pdf). An ILO (2018) report puts the figure at nearly 81%.

⁴ The cases in point are the empirical studies on India which use different approaches like cointegration framework (Haldrar, 2008; Haldrar and Mallick, 2010), multiple linear regression and neo-classical Solow production functions (Shukla, 2017a, 2017b) or Johansen Cointegration and Fully Modified Ordinary Least Squares (Parika and Singh, 2020) on time series data covering different periods to show a strong positive relationship between human capital and economic growth.

⁵ For example, in the pathways shown in figure 1, ‘RD_HCD_EG’ and ‘SSW_RD_EG’ (where RD stands for research and development/innovation, HCD for human capital development, EG for economic growth/GNIPC and SSW for social security and welfare), HCD and RD are two mediating or intermediate variables. It implies that RD and SSW impact EG indirectly too through these two mediating variables viz. HCD and RD.

Nagarajan, 2003; Ozcan and Ari, 2014; Scholz, 2017; Athina et al., 2018; Behrendt and Nguyen, 2018; Seeta Prabhu and Iyer, 2019; Zhang et al., 2019; Cammeraat, 2020), there has been no attempt to capture the overall (direct and indirect) impact of these selected variables on economic growth by including them in a single model. Similarly, there is some research on path analysis of factors affecting health (Meyer et al., 2014; Ye et al., 2014; Nurmawati and Kismiantini, 2019) and human development (Oladapo and Rahman, 2018). And, research has been done on the impact of human development and the creative class on regional development (Florida et al., 2008) and the impact of digital adoption and human capital on economic growth taking country -mix data and using path analysis technique (Park and Choi, 2019; Lee et al., 2018). However, there is not even scant literature on path analysis of factors like HCD, RD, and SSW affecting economic growth of a single developing country (like India), not to mention through the use of time series data. Therefore, the present study is timely and relevant.

This study, then, explores the overall effect (direct as well as indirect) of HCD, RD, and SSW on EG. We also provide answers to many questions asked by researchers relating to the ways and manner in which HCD directly influences growth and RD impacts growth indirectly through HCD. The effect of two variables namely RD and SSW, which co-vary and impact growth, has also been captured. The findings provide insights into how policymakers and practitioners can strengthen human capital development, innovation, and social security and welfare strategies and policies.

The remainder of this paper is organized as follows. Next is the review of the literature and hypotheses building. The sources of data and methodology used in the paper are then discussed. This is followed by a presentation of the results of the path analysis and a discussion. Conclusions and policy recommendations are presented in the final section.

LITERATURE REVIEW AND HYPOTHESES BUILDING

Human Capital Development (HCD)

In the context of this paper, human capital is taken to imply “knowledge, skills, competencies, and attributes embodied in individuals and facilitate the creation of personal, social, and economic well-being” (OECD, 2001). This conceptualization is rooted in an extensive literature. The origin of the concept of human capital goes back to Adam Smith, but the credit for popularization of this term lies with Mincer (see Goldin, 2016). Schultz (1961) considers knowledge and skill a cornerstone of economic growth to the extent that it enhances productivity, innovation, and output. Becker (1993), a Nobel laureate in economics highlighted the role of investment in an individual’s education and training in fostering human capital development. He viewed human capital as the most valuable of all forms of capital. Another Nobel laureate Heckman (2004) says that “learning starts in infancy, long before formal education begins, and continues throughout life. Early learning begets later learning and early success breeds later success, just as early failure breeds later failure.”

In particular, paying attention to both child education and health and nutrition among the population can subsequently lead to productivity gains and stimulate overall growth. Education is one of the important components of human capital and impacts economic growth positively (Dreze and Sen, 1996, 2002; Stiglitz, 1998; Bergheim, 2005; Pelinescu, 2015; Popoola et al., 2019). It is looked upon as one of the most powerful instruments for reducing poverty and inequality and setting the foundation for sustained economic growth.⁶ Health has a strong association with educational achievement and economic growth (Behrman, 1996; Mushkin, 1962). Therefore, HCD in terms of both education and health is expected to have a positive impact on growth.

It is important to point out here that there are empirical studies on India which use different approaches like a cointegration framework (Halдар, 2008; Halдар and Mallick, 2010), multiple linear regression and neo-classical

⁶ See: blogs.worldbank.org/education/why-education-matters-economic-development

Solow production functions (Shukla, 2017a, 2017b) or Johansen Cointegration and Fully Modified Ordinary Lease Squares (Parika and Singh, 2020) on time series data covering different periods to show a strong positive relationship between human capital and economic growth. However, no studies have used a path analysis technique. Path analysis has been carried out in the present study by using the maximum likelihood method. This method yields estimates which are best linear and unbiased.

Research and Development (RD)

There has been growing interest in exploring the relationship between the RD and economic growth for the past two decades. RD plays a catalytic role in creating innovation (Begg et al., 1994) and this seems to be the best option to overcome the limits of growth as per Grossman and Helpman (1994a, 1994b). The OECD (2002) defines RD as “creative work done on a systematic basis to increase the knowledge pool, including the knowledge in people, culture and society, and the use of this knowledge pool to devise new applications.”

The crucial role of innovations and investment in human capital on productivity gains and economic growth has been recognized by endogenous growth economists like Romer (1986, 1990a, 1990b) and Lucas (1988, 1993). Some empirical studies find a clear causal and positive link between the RD expenditure and economic growth (Athina et al., 2018; Ozcan and Ari, 2014; Grossman and Helpman, 1994), while others find no relationship (Tuna et al., 2015; Santosa and Catalão-Lopes, 2014). Jones (1995) also found that despite the fact OECD countries invested in RD input over 40 years, GDP growth rates remained constant in many regions. Some scholars (Carlino et al., 2007) point out that only a marginal effect on local development may be visible even when RD investment is very high. The explanation for these divergent results lies in the fact that different regions do not have the same ability to transform RD investment into real economic output (Rodríguez-Pose, 1999; Shearmur and Bonnet, 2011). Regional variation impacts RD efficiency (Xiong et al., 2020) via the presence of different social filters (Rodríguez-Pose, 1999). Social filters are defined as a set of socio-economic elements which promote or deter the development of a regional innovation system (Rodríguez-Pose, 1999; Co, 2002; Crescenzi and Rodríguez-Pose, 2013). The stronger the social filter conditions in the form of rigid labor market conditions, low participation of women, population aging, or shortage of skills, the more innovation averse the region would be. However, weak social filter conditions like the higher level of human capital will make a region innovation prone. Some regions may not reap the economic returns of education due to inadequate social conditions. Scholars believe that RD efficiency is determined by factors such as social capital, human capital, institutional quality, and cultural characteristics. Therefore, “...innovation is no longer explained by the sole combinations of tangible forms of capital (physical, financial...), but also by combinations of intangible forms of capital” (Landry et al., 2002; Xiong et al., 2020).

Therefore, the relationship between RD investment and economic growth may vary depending upon the presence and nature of different social filters in different regions. The underlying message is that policy must look beyond merely increasing RD expenditure to reap the benefits of innovation. Therefore, the government should focus on a series of factors that support the overall innovation system rather than just on quantitative expenditure on RD.

Indirect Effect of RD on EG via the “Mediating Variable” HCD

We are hypothesizing here that RD is a direct driver of growth and also affects growth indirectly through HCD, which is a “mediating variable.” Recent research (Lee et al., 2010; Wang et al., 2018; Reenen, 2021) shows that human capital development and innovation, i.e. people, their knowledge, creativity, and the ability to convert these resources into innovation” are becoming increasingly critical for shaping the competitive advantage of countries and fuelling growth. *Inter alia*, a variety of potential contributions to social sector development can be experienced via integrating science and technology into development policies. For example, the adoption of new technologies in the education sector like the use of information and communication technologies (ICT) can help in addressing

the problem of accessibility of education in rural and backward regions of India and promote inclusive growth. The same holds for FINTECH (financial technology) as a solution for financial inclusion. Therefore, innovation not only plays a pivotal role in the economic growth of a country directly but indirectly, too, by building its innovative and learning capacities which can allow catch up to happen (OECD, 2012).

Direct effect of Social security and Welfare (SSW) on growth

The effect of SSW⁷ spending on economic growth is a highly debated and complex issue. There are scholars (Ding, 2014) who believe that welfare expenditure may be detrimental to economic growth, but other sets of researchers (Lindert, 2004) consider welfare expenditure to be a growth booster. The mutual relationship between SSW and growth has been recognized in several studies (Nagarajan, 2003; Scholz, 2017; Behrendt and Nguyen, 2018; Seeta Prabhu and Iyer, 2019; Zhang et al., 2019; Cammeraat, 2020). Some (e.g. Sakellaridis, 2009; Periera and Andrzej, 2014) demonstrate a negative relationship between public expenditure on social security and economic growth.⁸ Other studies, such as that by Carter et al. (2013), found no statistically significant relationship between the two variables in the case of Barbados. A study done by Koenig and Myles (2013) found a strong positive impact of SSE on EG in the US. It showed that one dollar spent on social security generates approximately two dollars increase in economic output. Lee and Chang (2006a, 2006b) also show strong evidence in favor of the existence of a long-run equilibrium cointegrating relationship between GDP and social security expenditure. Given these diverse results, the hypothesized sign of the coefficient of SSW is uncertain.

Innovation, SSW, and economic growth

We have also hypothesized in our study that RD (innovation) and SSW covary over time and influence economic growth. Onaran and Stockhammer (2016) advance the demand-side argument, suggesting that welfare spending may push up consumption expenditure by placing more purchasing power in the hands of the people. Less explored is the supply-side argument (Esteveveze-Abe et al., 1999; Hall, 2015), which highlights the latent role, played by welfare spending in facilitating innovation and boosting growth. Koo et al. (2020) in their recent study argue that “welfare is an important support system for innovation activities”. Koo and others develop a linkage between the seemingly two unrelated variables, innovation and welfare, by drawing from recent developments in the field of psychology and economics. They suggest that welfare support by enhancing the capabilities of individuals and engendering a positive state of mind (i.e. happiness, optimism) has the potential to contribute to innovative capacity and long-term economic growth. They argue that “the availability of welfare support may harness the innovative potential of individuals by enabling them to take happiness-enhancing as well as risk hedging paths.” While welfare may not be a direct input toward innovation, they argue it may serve as a moderator by facilitating creativity and risk-taking. Given this, we hypothesize a positive relationship between SSW and EG.

It is important to point out that social protection is critical for sustainable development. Social protection policies constitute a key element of the implicit social contract and decent work as recognized and promoted in the Sustainable Development Goals⁹ (Behrendt and Nguyen, 2018). Many developing countries like India have been encountering the twin challenges of enhancing and extending social security. Undeniably, the use of technology (like smartphones,

⁷ The Western model of social security is based on providing relief in cases of specific contingencies that have interrupted regular income. However, in developing countries, social security is intertwined with economic security. In the context of a country like India, social security should focus on basic minimum needs like food security, nutrition, employment, primary health, primary education, and housing. It should also emphasize poverty alleviation measures of land and asset redistribution (Dev et al., 2001).

⁸ In the case of 12 EU countries.

⁹ Sustainable Development Goals (SDG) targets 1.3, 3.8, 5.4, 8.5 and 10.4.

AI, machine learning, blockchain) in delivering social security and welfare services¹⁰ can help in checking diversions, reducing administrative costs, improving efficiency, and fostering economic growth. This can help in achieving various targets laid down under SDGs of UN agenda 2030. As such, we hypothesize that these two co-varying variables, RD and SSW, impact growth positively. Several researchers have written on the relationship between HCD, RD, SSW, and economic growth separately in the Indian context. However, as per our knowledge, there has been no prior study that tries to capture the direct and indirect impact of these variables on economic growth.

DESCRIPTION OF VARIABLES AND SOURCES OF DATA

The data for the path analysis carried out in this study was collected from various reports of Indian Public Finance Statistics over the period 1987-88 through 2016-17. This period has been chosen because the time series data is available following the same classification for the period under consideration.

As discussed above, we use three endogenous/explanatory variables: HCD, RD, and SSW. Human capital development is defined as the developmental expenditure¹¹ in absolute terms incurred by the Government of India (GOI) in two categories: “education, art, culture” and “medical, public health, water supply, and sanitation services”. The developmental expenditure incurred on scientific services and research (in absolute terms) by GOI has been used as a proxy variable for innovation or RD. SSW is defined as the combined development expenditure of both the central government and the states on “social and community services”.

For our outcome variable, Gross National Income per capita (GNIPC) has been used as a proxy for economic growth. The data on Gross National Income per capita (GNIPC) has been collected from the GOI Economic Survey.

METHODOLOGY

A path diagram was constructed first, followed by the estimation of time-varying path coefficients and test of the overall goodness of fit.

Path Analysis

Path analysis is an extension of a multiple regression statistical technique that enables one to examine and understand the relationships between a dependent variable and two or more independent variables (Du Toit and Browne, 2007; Eichler, 2007; Zhang, 2010; Zhang and Zhang, 2014). It is through this method, the magnitude and the significance of causal connections between variables can be captured. This technique recognizes that an exogenous/independent variable can have a direct as well as an indirect effect on the dependent variable. It is this method that allows a variable to be dependent in one relationship and independent in another (e.g. HCD in the current study). These variables are termed mediating or intermediate variables in the path analysis. In addition, unlike regression analysis, the simultaneous modeling of several related regression relationships can be carried out under this method. We have carried out path analysis using the maximum likelihood statistical technique to compute the path coefficients (which are time-varying in nature) present in the model. The use of the maximum likelihood statistical technique gives us the best, linear, and unbiased estimates. It will be important to mention here that the time series is found to be normally distributed and hence it follows the Gaussian time series. In such a case Structural Equation Modeling (SEM) is comparable to time series modeling like autoregressive time series with moving average residuals

¹⁰ See <https://news.itu.int/social-security-technology/>

¹¹ Developmental expenditure is that which adds to the production and the productive capacity of the economy.

i.e. ARMA (Zhang and Zhang, 2014). Zhang and Zhang (2014) write: “structural equation model is based on the equations, and ARMA model is also based on the equations. So the two models seem to have in common. Can methods of study on structural equation models be used to study the ARMA models? The answer is yes.”

The first step in this path analysis is to construct/develop a path diagram to provide a visual representation of the relationship between variables. The causal direction between the variables is specifically laid out using arrows (single-headed arrows) and wires (double-headed arrows) and these clearly illustrate our hypothesized relationship. The squares, arrows, and wires have been used to show causation. The arrows show the cause for the independent, intermediate, and dependent variables. Figure 1 given below shows a path diagram with two exogenous variables (RD and SSW) and two endogenous/outcome variables (EG/GNIPC and HCD), based on the hypotheses emerging from the literature.

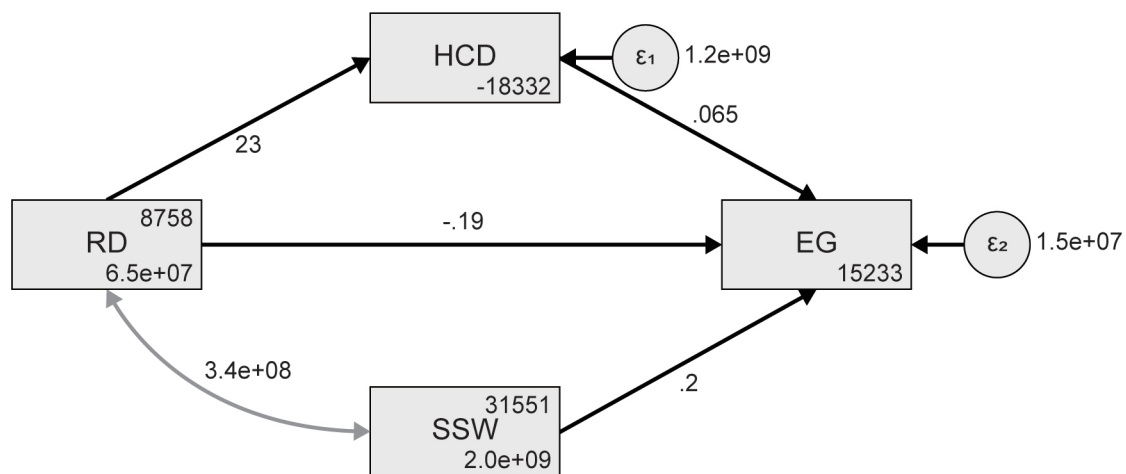


Fig. 1. Path diagram

The diagram shows the relationship among the independent, intermediate, and dependent variables. It shows two effects: direct and indirect. When an arrow is directed from an exogenous variable to the dependent/outcome/response variable then this is called the direct effect. But an exogenous variable may impact the dependent variable through another exogenous variable then that is termed as an indirect effect.

- The direct arrow from RD to EG is depicting the direct influence of RD on EG.
- An arrow pointing from variable RD to variable HCD is showing that Variable RD is hypothesized to influence Variable HCD. And, HCD, in turn, influences EG as indicated by an arrow from HCD to EG. Or we can say that the variable HCD is the “mediating/intermediate variable” between RD and EG.
- A direct arrow from SSW to EG shows the direct effect of SSW on EG. But the wire or double-headed arrow between RD and SSW indicates our hypothesis that these variables co-vary (covariance between RD and SSW is shown) and indirectly influence EG, too.

The total effect of the exogenous variable on the dependent variable will be the total of direct and indirect effects. Here, the overall effect of RD on EG is the total of the direct effect of RD on EG (-1.9) and the indirect effect of RD on EG via HCD as indicated in the path diagram. The indirect effects are calculated by multiplying the coefficient for each path e.g.

$$\text{RD_HCD_EG is } (23 \times .065) = 1.495$$

$$\text{Total indirect effect} = 1.495$$

The indirect effect of RD on EG via HCD is positive. However, the direct effect, which happens to be negative and

larger (-1.9), outweighs the positive but smaller indirect effect of RD on EG. The total effect of RD on EG will be negative [$\{-1.9+1.495\}=-.405$].

The next step is to estimate the proposed model using the maximum likelihood technique after which the evaluation of results of the model and their interpretation will follow.

RESULTS AND DISCUSSION

A path analysis using maximum likelihood estimation in Stata 13 was performed to identify factors affecting the economic growth in India. The intercepts and their standard errors for each variable which were not shown in the path diagram are as follows: for the outcome variable EG the intercept stands at 15233.41 with the standard error of 9239.448 and it is significant at a 5% level of significance.

The interpretations of multivariate regression results for GNIPC are:

- (1) The intercept (b_0^{EG}) for EG=15233.41, the value of EG when all the predictors are zero (HCD=0, SSW=0, RD=0).
- (2) The estimated slope coefficient for HCD (b_1^{EG})=.0654 for predicting economic growth indicates that for every unit increase in HCD holding RD and SSW constant, growth increases by 0.654. This is in keeping with Schultz (1961), Becker (1993), Dreze and Sen (1996), Stiglitz (1998), and Heckman (2004). It is important to emphasize here once again that the path coefficients reported in the study are time-varying coefficients.
- (3) The estimated slope coefficient for RD (b_2^{EG})=-.189 for predicting GNIPC/growth indicates that for every one-unit increase in RD (holding HCD and SSW constant), growth decreases by .189. This result is not in keeping with the majority of the literature which argues that RD efforts are positively associated with economic growth. Contrarily, our result has the support of scholars such as Rodríguez-Pose (1999) and Shearmur and Bonnet (2011) who say that all regions may not be able to uniformly transform RD investment into economic outcomes. Our study lends support to the social filters theory which says that the presence of unfavorable social filters conditions may prove to be detrimental to RD effort and hamper growth.

In contrast to the knowledge-driven literature, our findings are supporting Pessoa (2010) and Shukla (2017a, 2017b) who show the unequivocal negative relation between growth and aggregate vertical innovation rate and RD intensity. The negative sign of the RD coefficient implies that an innovation policy solely relying on increasing RD outlays for improving aggregate productivity may prove to be ineffective in increasing the rate of growth. Therefore, the quality of RD does matter along with quantity. Besides, this negative relationship between RD and growth is lending support to the social filters theory.

- (4) The estimated slope coefficient of SSW (b_3^{EG})=.197 predicting growth shows that for every one-unit increase in SSW (holding HCD and RD constant), growth increases by .197. Like Lee and Chang (2006) among others, the present study demonstrates a positive relationship between social security and welfare spending by the government and economic growth. This is in line with our hypothesis.

We come now to the interpretation of multivariate regression results for HCD:

- (1) The intercept of HCD (b_0^{HCD})=-18332.21, the value of HCD when all predictors are zero (RD=0, SSW=0).
- (2) The estimated slope coefficient for RD (b_1^{HCD})=23.24, predicting HCD indicates that for every unit increase in RD (holding other variables constant), HCD increases by 23.24. This is in line with the studies done by Athina et al. (2018) and Ozcan and Ari (2014).

Table 1. Path coefficients based on estimation of model on the basis of maximum likelihood method

Outcome variables	Predictors	Coefficient estimates
EG/GNIPC	HCD	0.0654 (0.028)*
	RD	-0.189 (0.491)
	SSW	0.197 (0.071)*
HCD	RD	23.241 (0.777)*

Note: The values in parentheses are OIM standard errors
 *indicates a 0.05 level of significance

After the estimation of the model, we proceed to find out whether the model is saturated or the best fit model. This can be done based on a variety of fit indices. Hooper et al. (2007) suggest *inter alia* chi-square (X), root means square error of approximation (RMSEA), and the comparative fit index (CFI), and standardized root mean square residual (SRMR).

The chi-square statistic does not turn out to be significant in our analysis. This might be because of the small sample size and therefore, constitutes one of the limitations of the study. Hair et al. (2019) very clearly say that the chi-square statistics is influenced by the sample size. Considering this argument, the probability of chi-square statistics becoming significant with the increase in the sample size irrespective of the relationship amongst the variables is quite high. Since a variety of other fit indices (RMSEA, CFI, and SRMR) are available with us, therefore, we tried to check the goodness of fit utilizing them.

The RMSEA turns out to be 0.067, which is within the acceptable range (from 0.05 to 0.08) for a good model fit (Steiger, 2007). The value of CFI must be interpreted very cautiously as the closer the value to one, the better the fit. Values of SRMR can range from zero to 1.0 with values less than 0.05 indicative of the ‘well-fitting’ model (Hooper et al., 2007). As shown in Table 2, our estimated model is a best fit model as per RMSEA index, CFI index, and SRMR index.

Table 2. Overall fitness of model based on fit indices

Fit index	Acceptable threshold*	Values as observed from path analysis	Level of significance (p-value)
Root Mean Square Error of Approximation (RMSEA)	Values less than 0.07	0.067	p < 0.05
Comparative Fit Index (CFI)	Cut off value ≥ 0.90	0.934	“Good fit model”
SRMR	< 0.05	0.012	p < 0.05

Note: Acceptable thresholds are derived from Steiger (2007) (RMSEA), Hu and Bentler (1999) (CFI & SRMR). RMSEA confidence interval is 90%, with lower bound=0.062, upper bound=0.073.

CONCLUSIONS AND POLICY IMPLICATIONS

The hypothesized positive relationship between HCD and EG turned out as per expectations. Our finding emphasizes that a focus of decision-makers must be on HCD as economic growth will not be sustained unless accompanied by improvements in HCD.

Since RD indirectly impacts economic growth via HCD, the negative sign of RD suggests that an innovation policy based merely on RD intensity may not be effective in improving productivity and growth. Therefore, while creating an appropriate RD strategy, the government must consider quality and efficiency along with quantity. In addition, the national innovation system needs to be supported and strengthened by focusing on a series of factors. These include ensuring a well-functioning higher education system, provisioning of skilled labor, promoting entrepreneurial activities, encouraging scientific culture, improving labor market conditions, and ensuring institutional connectivity through the engagement of actors such as universities in RD). RD efficiency which is determined by factors such as social capital, human capital, institutional quality, and cultural characteristics also matters. It is high time to realize that RD investment is not sufficient to improve economic performance. What is more important at the present juncture is to recognize the role of social, economic, and institutional factors (Crescenzi and Rodríguez-Pose, 2013). This can break down the thick wall between RD inputs and outputs, generating higher economic returns for RD efforts. Therefore, a comprehensive and coordinated policy intervention is a must to ensure that the new technologies translate into better outcomes for all.

The positive relationship between SSW and EG highlights the underlying role that social policies can play in a country's growth. It also shows the need for evolving better SSW schemes to minimize the harm of job losses and retrenchment during contingencies like COVID-19. The finding that SSW and EG are positively related in the study adds strong impetus to the case for making the social assistance and anti-poverty programs more efficient. This can be done through tech interventions for reducing administration costs and checking leakages. Our study reveals that social security and welfare services have a positive effect on economic growth directly and indirectly via its relationship with RD. Given the fact that 90% of workers in the informal sector do not have adequate social security, the technological interventions via the use of mobile telephony, AI, and machine learning can prove to be very cost-effective and efficient ways of delivering social security and welfare services. The enhancement and extension of these services to remote areas via technology will make them more accessible and inclusive, helping to optimize the opportunities of new technology in the social security field. This can also assist in achieving various targets laid down under the Sustainable Development Goals (SDGs). Therefore, social security and welfare policies should be carefully designed to stimulate innovative activity and to harness the innovative potential of the country, and contribute to its long-term growth.

It is important to mention that investment in human capital and RD impacts economic growth with some time lag. Besides the causal impact, identification of such a time lag is crucial for policy design. This vital issue is beyond the scope of this paper, but warrants future study.

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REFERENCES

- Athina, L., Athanasios, A., Panagiotis, L., Zacharias, D., and Dimitrios, K. (2018). Factors affecting the relationship between research and development (r&d) and economic development in EU. *Advances in Economics and Business*, 6(5), 322-331. <http://dx.doi.org/10.13189/aeb.2018.060506>

- Becker, G. S. (1993). *Human capital – a theoretical and empirical analysis, with special reference to education* (3rd ed.). Chicago: University of Chicago Press.
- Begg, D., Fischer, S. D., and Dornbusch, R. (1994). *Economics* (4th ed.). London: McGraw-Hill.
- Behrendt, C., and Nguyen, Q. A. (2018). Innovative approaches for ensuring universal social protection for the future of work. *International Labour Organisation*. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_629864.pdf
- Behrman, J. (1996). The impact of health and nutrition on education. *The World Bank Research Observer*, 11(1), 23-37.
- Bergheim, S. (2005). *Human capital is the key to growth - success stories and policies for 2020*. Deutsche Bank Research Current Issues Working Paper. <https://dx.doi.org/10.2139/ssrn.774825>
- Cammeraat, E. (2020). The relationship between different social expenditure schemes and poverty, inequality and economic growth. *International Social Security Review*, 73(2), 101-123. <https://doi.org/10.1111/issr.12236>
- Carlino, G., Chatterjee, S., and Hunt, R. (2007). Urban density and the rate of invention. *Journal of Urban Economics*, 61(3), 389-419.
- Carter, J., Craigwell, R., and Lowe, S. (2013). Government expenditure and economic growth in a small open economy: a disaggregated approach. *Central Bank of Barbados*, 1-28.
- Co, C. (2002). Evolution of the geography of innovation: evidence from patent data. *Growth and Change*, 33(4), 393-423. <https://doi.org/10.1111/1468-2257.00204>
- Crescenzi, R., and Rodríguez-Pose, A. (2013). R&D, social-economic conditions, and regional innovation in the U.S. *Growth and Change*, 44(2), 287-320. <https://doi.org/10.1111/grow.12011>
- Dev, S. M., Antony, P., Gayathri, V., and Mamgain, R. P. (2001). *Social and economic security in India*. New Delhi: Institute for Human Development.
- Ding, H. (2012). Economic growth and welfare state: a debate of econometrics. *Journal of Social Science for Policy Implications*, 2(2), 165-196. <https://mpira.ub.uni-muenchen.de/40288/>
- Domar, E. (1946). Capital expansion, rate of growth, and employment. *Econometrica*, 14(2), 137-147. doi: 10.2307/1905364
- Dreze, J., and Sen, A. (1996). *India: economic development and social opportunity*. Delhi: Oxford University Press.
- Dreze, J., and Sen, A. (2002). *India: development and participation*. New Delhi: Oxford University Press.
- Du Toit, S. H. C., and Browne, M. W. (2007). Structural equation modeling of multivariate time series. *Multivariate Behavioral Research*, 42(1), 67-101. doi: 10.1080/00273170701340953
- Eichler, M. (2007). Granger causality and path diagrams for multivariate time series. *Journal of Econometrics*, 137(2), 334-353. doi: 10.1016/j.jeconom.2005.06.032
- Estevez-Abe, M., Iversen, T., and Soskice, D. (1999). *Social protection and the formation of skills: a reinterpretation of the welfare state*. Paper presented at the 95th American Political Science Association Meeting, Atlanta.
- Florida, R., Mellander, C., and Stolarick, K. (2008). Inside the black box of regional development— human capital, the creative class and tolerance. *Journal of Economic Geography*, 8(5), 615-649. doi: 10.1093/jeg/lbn023
- Goldin, C. (2016). Human Capital. In C. Diebolt & M. Hauptert (Eds.), *Handbook of cliometrics*. Berlin: Springer. <https://www.scribd.com/document/371655351/Human-Capital-Theory-at-Harvard-University-handbook-of-cliometrics-pdf>
- Grossman, G. M., and Helpman, E. (1994a). *Technology and trade*. Working Paper No. 4926. National Bureau of Economic Research. <https://www.nber.org/papers/w4926>
- Grossman, G. M., and Helpman, E. (1994b). Endogenous innovation in the theory of growth. *Journal of Economic Perspectives*, 8(1), 23-44. doi: 10.1257/jep.8.1.23
- Hair Jr., J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2019). *Multivariate Data Analysis* (8th ed.). Hampshire, UK: Cengage Learning, EMEA.
- Halder, S. K. (2008). Effect of health-human capital expenditure on economic growth in India: a state-level analysis. *Asia-Pacific Social Science Review*, 8(2), 79-97.
- Halder, S. K., and Mallik, G. (2010). Does human capital cause economic growth? A case study of India. *International Journal of Economic Sciences and Applied Research*, 3(1), 7-25.

- Hall, P. (2015). Varieties of capitalism. In R. Scott, S. Kosslyn & M. Buchmann (Eds.), *Emerging trends in the social and behavioral sciences* (pp. 1-15). Hoboken, NJ : John Wiley & Sons.
- Harrod, R. F. (1939). An essay in dynamic theory. *The Economic Journal*, 49(193), 14-33. doi: 10.2307/2225181.
- Heckman, J. J. (2004). Invest in the very young. In R. E. Tremblay, R. G. Barr & R. DeV. Peters (Eds.), *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood. <https://www.child-encyclopedia.com/pdf/complet/importance-early-childhood-development>
- Hooper, D., Coughlan, J., and Mullen, M. (2007). Structural equation modeling: guidelines for determining model fit. *The Electronic Journal of Business Research Methods*, 6(1). https://www.researchgate.net/publication/254742561_Structural_Equation_Modeling_Guidelines_for_Determining_Model_Fit
- Hu, L. T., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1-55. <https://doi.org/10.1080/10705519909540118>
- Institute for Health Metrics and Evaluation (2021). *COVID-19 projections*. Retrieved December 26, 2021 from <https://covid19.healthdata.org/india?view=cumulative-deaths&tab=trend>
- International Labour Organisation (2018). *Women and Men in the Informal Economy – A Statistical Picture* (Third edition), International Labour Office, Geneva. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_626831.pdf
- Jones, C. I. (1995). Time series tests of endogenous growth models. *The Quarterly Journal of Economics*, 110(2), 495-525. <https://doi.org/10.2307/2118448>
- Joshi, S. (2021). Rising importance of remote learning in India in the wake of COVID-19: issues, challenges and way forward. *World Journal of Science, Technology and Sustainable Development*, 18(1), 44-63. <https://doi.org/10.1108/WJSTSD-10-2020-0079>
- Koenig, G., and Myles, A. (2013). *Social security's impact on the national economy*. AARP Public Policy Institute. <https://www.aarp.org/work/social-security/info-09-2013/social-security-impact-on-the-national-economy-AARP-ppi-econ-sec.html>
- Koo, J., Choi, Y. J., and Park, I. (2020). Innovation and welfare: the marriage of an unlikely couple. *Policy and Society*, 39(2), 189–207. <https://doi.org/10.1080/14494035.2019.1641380>
- Landry, R., Amara, N., and Lamari, M. (2002). Does social capital determine innovation? To what extent. *Technological Forecasting and Social Change*, 69(7), 681-701. [https://doi.org/10.1016/S0040-1625\(01\)00170-6](https://doi.org/10.1016/S0040-1625(01)00170-6)
- Lee, C. C., and Chang, C. P. (2006a). Social security expenditure and GDP in OECD countries: a cointegrated panel analysis. *International Economic Journal*, 20(3), 303-320. <http://dx.doi.org/10.1080/10168730600879372>
- Lee, C. C., and Chang, C. P. (2006b). Social security expenditures and economic growth: a heterogeneous panel application. *Journal of Economic Studies*, 33(5), 386-404. <https://doi.org/10.1108/01443580610706609>
- Lee, K. W., Choi, S. C., Kim, J. H., and Jung, M. J. (2018). A study on the factors affecting decrease in the government corruption and mediating effects of the development of ICT and e-government—a cross-country analysis. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(3), 41. <https://doi.org/10.3390/joitmc4030041>
- Lee, S. Y., Florida, R., and Gates, G. (2010). Innovation, human capital, and creativity. *International Review of Public Administration*, 14(3), 13-24. <https://doi.org/10.1080/12294659.2010.10805158>
- Lindert, P. (2004). *Growing public: social spending and economic growth since the eighteenth century*. Cambridge, UK: Cambridge University Press.
- Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22, 3-42. [https://doi.org/10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7)
- Lucas, R. E. (1993). Making a miracle. *Econometrica*, 61(2), 251-272. <https://doi.org/10.2307/2951551>
- Meyer, O. L., Castro-Schilo, L., and Aguilar-Gaxiola, S. (2014). Determinants of mental health and self-rated health: a model of socioeconomic status, neighborhood safety, and physical activity. *American Journal of Public Health*, 104(9), 1734-1741. <https://doi.org/10.2105/AJPH.2014.302003>
- Mushkin, S. J. (1962). Health as an investment. *Journal of Political Economy*, 70(5), 129-157. <https://www.jstor.org/stable/1829109>
- Nagarajan, N. (2003). Review: economic and social security. *Economic and Political Weekly*, 38(34), 3555-3559. <https://www.jstor.org/stable/4413936>

- Norman, G. R., and Streiner, D. L. (2003). *PDQ Statistics*. Hamilton, Ont.: B.C. Decker.
- Nurmawati, W. P., and Kismiantini (2019). Path analysis for determining health factors in Indonesia. *Journal of Physics: Conference Series*, 1320, 012018. doi:10.1088/1742-6596/1320/1/012018
- OECD (2001). *The well-being of nations: the role of human and social capital*. <https://doi.org/10.1787/9789264189515-en>
- OECD (2002). *Proposed standard practice for surveys of research and experimental development: frascati manual 2002*. <https://doi.org/10.1787/9789264199040-en>
- OECD (2012). *Innovation for development*. <http://www.oecd.org/innovation/inno/50586251.pdf>
- Oladapo, I. A., and Rahman, A. A. (2018). A path analysis approach on the factors of human development among muslims in Nigeria. *Journal of Islamic Accounting and Business Research*, 9(1), 59-76. <https://doi.org/10.1108/JIABR-01-2016-0014>
- Onaran, O., and Stockhammer, E. (2016). *Policies for wage-led growth in Europe*. Brussels: Policy report-FEPS (Foundation for European progressive studies). <https://core.ac.uk/reader/42392460>
- Ozcan, B., and Ari, A. (2014). The relationship between research & development expenditures and economic growth: Panel data analysis. *Maliye Dergisi*, 166, 39-55.
- Parika, A., and Singh, B. P. (2020). *How does human capital affect economic growth in India? An empirical analysis*. MPRA, 102428. https://mpra.ub.uni-muenchen.de/102428/1/MPRA_paper_102428.pdf
- Park, H., and Choi, S. O. (2019). Digital innovation adoption and its economic impact focused on path analysis at national level. *Journal of Open Innovation: Technology, Market, and Complexity*, 5(3), 56-77. <https://doi.org/10.3390/joitmc5030056>
- Pelinescu, E. (2015). The impact of human capital on economic growth. *Procedia Economics and Finance*, 22, 184-190. [http://dx.doi.org/10.1016/S2212-5671\(15\)00258-0](http://dx.doi.org/10.1016/S2212-5671(15)00258-0)
- Pereira, A., and Andraz, J. (2014). *On the long-term macroeconomic effects of social security spending: evidence for 12 EU countries*. Working Paper 150, 1-28, Portugal: The College of William and Mary. https://economics.wm.edu/wp/cwm_wp150.pdf
- Pessoa, A. (2010). R&D and economic growth: How strong is the link? *Economics Letters*, 107(2), 152-154. <https://doi.org/10.1016/j.econlet.2010.01.010>
- Petrakos, G., Arvanitidis, P., and Pavleas, S. (2007). *Determinants of Economic Growth: the Experts' View*. Working Paper 20/2007, DYNREG Research Project–Dynamic Regions in a Knowledge-Driven Global Economy Lessons and Policy Implications for the European Union. <https://core.ac.uk/reader/6461770>
- Popoola, O., Alege, P. O., Gershon, O., and Asaleye, J. A. (2019). Human capital channels and productivity growth: evidence from Nigeria. *Economics and Sociology*, 12(4), 59-73. doi:10.14254/2071-789X.2019/12-4/3
- Press Information Bureau. (2020). *India's S&T institutions raise their game against COVID-19*. Ministry of Science & Technology, Government of India. <https://pib.gov.in/newsite/PrintRelease.aspx?relid=201036>
- Reenen, J. V. (2021). *Innovation and human capital*. Working Paper 28713, Cambridge: National Bureau of Economic Research. <http://www.nber.org/papers/w28713>. doi: 10.3386/w28713.
- Rodríguez-Pose, A. (1999). Innovation prone and innovation averse societies-economic performance in Europe. *Growth and Change*, 30(1), 75-105. <https://doi.org/10.1111/0017-4815.00105>
- Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 1002-1037. <http://links.jstor.org/sici?sici=0022-3808%28198610%2994%3A5%3C1002%3AIRALG%3E2.0.CO%3B2-C>
- Romer, P. M. (1990a). Endogenous technological change. *The Journal of Political Economy*, 98(5), S71-S102. <http://links.jstor.org/sici?sici=00223808%28198610%2994%3A5%3C1002%3AIRALG%3E2.0.CO%3B2-C>
- Romer, P. M. (1990b). Human capital and growth: theory and evidence. *Carnegie-Rochester Conference Series on Public Policy*, 32, 251-286. [https://doi.org/10.1016/0167-2231\(90\)90028-J](https://doi.org/10.1016/0167-2231(90)90028-J)
- Sakellariadis, G. (2009). *An empirical investigation of social protection expenditures on economic growth in Greece*. In Paper for the 4th Hellenic Observatory PhD Symposium on Contemporary Greece, Hellenic Observatory. European Institute, LSE Hellenic Observatory, European Institute, UK, 2526.
- Santosa, J., and Catalão-Lopes, M. (2014). Does R&D matter for economic growth or vice-versa? An application to Portugal and other European

- countries. *Archives of Business Research*, 2(3), 1-17.
- Scholz, T. (2017). *Overworked and underpaid: how workers are disrupting the digital economy*, Cambridge: Malden; MA: Polity Press.
- Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, 51(1), 1-17. <https://www.jstor.org/stable/1818907>
- Seeta Prabhu, K., and Iyer, S. S. (2019). *Human development in an unequal world*, New Delhi: Oxford University Press.
- Shearmur, R., and Bonnet, N. (2011). Does local technological innovation lead to local development? A policy perspective. *Regional Science Policy and Practice*, 3(2), 249-270.
- Shipley, B. (2000). *Cause and correlation in biology*. Cambridge: Cambridge University Press.
- Shukla, S. (2017a). Innovation and economic growth: a case of India. *Humanities & Social Science Reviews*, 5(2), 64-70. https://www.researchgate.net/publication/317397360_INNOVATION_AND_ECONOMIC_GROWTH_A_CASE_OF_INDIA
- Shukla, S. (2017b). Human capital and economic growth in India. *International Journal of Current Research*, 9(11), 61628-61631. https://www.researchgate.net/publication/338084619_HUMAN_CAPITAL_AND_ECONOMIC_GROWTH_IN_INDIA
- Siddharthan, N. S., and Lal, K. (2003). Liberalization and growth of firms in India. *Economic and Political Weekly*, 38(20), 1983-1988. <https://www.jstor.org/stable/4413575>
- Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), 65-94. <http://links.jstor.org/sici?sici=0033-5533%28195602%2970%3A1%3C65%3AACTTTO%3E2.0.CO%3B2-M>
- Steiger, J. (2007). Understanding the limitations of global fit assessment in structural equation modeling. *Personality and Individual Differences*, 42(5), 893-898. <https://doi.org/10.1016/j.paid.2006.09.017>
- Stiglitz, J. (1998). *More instruments and broader goals: moving toward the post-Washington consensus*, The 1998 WIDER annual lecture, WIDER, Helsinki. <https://archive.globalpolicy.org/soecon/bwi-wto/stig.htm>
- Swan, T. W. (1956). Economic growth and capital accumulation. *Economic Record*, 32(2), 334-361. <https://doi.org/10.1111/j.1475-4932.1956.tb00434.x>
- Tuna, K., Kayacan, E., and Bektas, H. (2015). The relationship between research and development expenditures and economic growth: the case of Turkey. *Procedia-Social and Behavioural Sciences*, 195, 501-507. <https://doi.org/10.1016/j.sbspro.2015.06.255>
- Wang, Z., Cai, S., Liang, H., Wang, N., and Xiang, E. (2018). Intellectual capital and firm performance: the mediating role of innovation speed and quality. *The International Journal of Human Resource Management*, 32, 1222-1250. <https://doi.org/10.1080/09585192.2018.1511611>
- World Health Organization (2021). *COVID-19 weekly epidemiological update*. Retrieved December 26, 2021 from https://reliefweb.int/sites/reliefweb.int/files/resources/20210511_Weekly_Epi_Update_39.pdf
- Xiong, A., Xia, S., Ye, Z. P., Cao, D., Jing, Y., and Li, H. (2020). Can innovation really bring growth? The role of social filter in China. *Structural Change and Economics Dynamics*, 53, 50-61. <https://doi.org/10.1016/j.strueco.2020.01.003>
- Ye, X., Yao, Z., Liu, W., Fan, Y., Xu, Y., and Chen, S. (2014). Path analysis to identify factors influencing health skills and behaviors in adolescents: a cross-sectional survey. *PLOS ONE*, 9, 1-5. <https://doi.org/10.1371/journal.pone.0104406>
- Zhang, M., Zou, X., and Sha, L. (2019). Social security and sustainable economic growth: based on the perspective of human capital. *Sustainability*, 11(3), 662-676. <https://doi.org/10.3390/su11030662>
- Zhang, T. (2010). *Structural equation modeling with time series data. doctoral dissertation*, Stony Brook University. https://dspace.sunyconnect.suny.edu/bitstream/handle/1951/55695/Zhang_grad.sunysb_0771E_10062.pdf?sequence=1&isAllowed=y
- Zhang, Y., and Zhang, H. (2014, August). *Study on time series data based on structural equation modeling*, Paper presented at 2014 sixth international conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC), Hangzhou, China. <https://doi.org/10.1109/IHMSC.2014.37>