REPORT

The thesis entitled “Effects of Health on Human Capital Formation, Income, and Economic Growth in India” is a good piece of work and I enjoyed reading it. I congratulate the candidate for doing hard work in putting the things in perspective.

The thesis examines the effect of health on income, and economic growth in India by first estimating the effect of health on capital formation, and then effect of calorie intake on wages of the workers. The thesis estimates the effect of average health of the working age population on income, and economic growth in India. It also examines whether distribution of health or socio-economic inequalities in health affects the income, and economic growth.

The thesis has been divided into six chapters. The first chapter is devoted to introduction and review of literature; need of the study, conceptual framework, research questions, and objectives. Under the need of the study part, the thesis mentions the rising share of both agriculture and services in GDP in India needs to be corrected as share of agriculture in GDP is declining while services is rising. Further, it mentions that the study will establish the rationale for several poor oriented public health programmes and increased health allocations by the NITI Ayog and budgetary allocations. Unlike Planning Commission, NITI Ayog is not the fund allocating body but a think tank and advisory body (page 17-18).

The second chapter analyses the effects of linear growth and relative weight gain between mid-childhood and adolescent on human capital formation. The chapter analyses the effect of linear growth and relative weight gain on human capital accumulation (through different levels of the distribution of health and education) by using Young Lives Survey for India. The chapter explains everything well but mentions that India suffers from low school enrolment and rampant malnutrition (page 54). It explains everything about the malnutrition but completely silent on education. Further, now India does not suffer from low school enrolment.

The third chapter analyses the nutrition – productivity linkages by employing Two-Stage Least Square (2SLS) and Instrumental Variable or Two Stage Least Square Quantile Regression (IVQR) which captures the casual and heterogeneous impacts of calorie on wages in India. The results support the efficiency wage hypothesis – workers with adequate calorie
consumption receive higher wages. Regarding policy implications, the thesis argues in support of Food Security Bill (now it is Act not Bill) to solve the problem of declining per capita caloric intake. If we look at the Food Security Act 2013, it provides only supply of cheaper food grains to approximately 2/3rd population. With this provision only, will it be possible to check declining per capita caloric intake?

The fourth chapter estimates the effect of health (measured in terms of adult survival probability) on income (measured in terms of Per capita NSDP), and economic growth in India for the time period of 1983-2011. Using statistical models, the thesis finds that a 10 percent increase in probability of adult survival increases the level of national income by 11.8 percent. Also, a 10 percent increase in growth in probability of adult survival results in an increase in economic growth rate by about 7.4 percent. Further, it finds that a 10 percent increase in probability of adult survival increases the level of PCNSDP by about 8 percent; whereas a 10 percent increase in the growth of adult survival probability has the potential to increase the economic growth rate by about 26.23 percent. The results looks quite encouraging but needs to be explained in detail explaining how these linkages can take place. What is the force behind them? Further, suggesting rising budget allocation is not working in India. Implementation and utilisation of public health care is a serious issue.

The fifth chapter examines the effects of socio-economic inequality in health on income, and economic growth in India. The chapter focuses on how distribution of health affects income, economic growth, and development of a society. The thesis finds that a 10 percent decrease in health inequality when measured in terms inequality in under-five child mortality results in a 0.8-1.6 percent increase in economic output or income. The results also indicate that a 10 percent decline in the growth of inequality in under-five child mortality increases the economic growth by about 0.7 percent. Like the previous chapter, there is need for explaining how these linkages will take place and factors responsible for the effect.

Last chapter concludes the study and suggests policy implications. However, the policy implications are of general in nature.

Overall, it is a good piece of work and approved for the award of PhD degree.
Annexure: Report and Comments of Examiners on PhD Thesis

Acknowledgement: I would like to thank the two anonymous examiners for their thoughtful and constructive comments. I am grateful to both the examiners for the appreciation and recommendation of the award of Ph.D. degree.

Report on PhD Thesis and reply to EXAMINER I:

1) The Thesis has been divided into six chapters. The first chapter is devoted to introduction and review of literature, need of the study, conceptual framework, research questions, and objectives. Under the need of the study part, the thesis mentions the rising share of both agriculture and services in GDP in India needs to be corrected as share of agriculture in GDP is declining while service is rising. Further, it mentions that the study will establish the rationale for several poor oriented public health programmes and increased health allocations by the NITI Ayog and budgetary allocations. Unlike Planning Commission, NITI Ayog is not the fund allocating body but a think tank and advisory body (page 17-18).

Reply: - Agreed, Sentence “the thesis mentions the rising share of both agriculture and services in GDP in India” modified as suggestion and context of the study. And, the word “Planning Commission” is replaced by the “Ministry of Finance”.

2) The second chapter analyses the effect of linear growth and relative weight gain between mid-childhood and adolescent on human capital formation. The chapter analyses the effect of linear growth and relative weight gain on human capital accumulation (through different levels of distribution of health and education) by using Young Lives Survey for India. The chapter explains everything well but mentions that India Suffers from low School enrolment and rampant malnutrition
(page 54). It explains everything about the malnutrition but completely silent on education. Further, now India does not suffer from low school enrolment.

Reply: - Present study is primarily aimed to study, for given quality and level of education, the effect of health on human capital formation there by higher labour productivity and personal income hence economic growth. Therefore, the thesis does not extensively investigate on the effect of the quality and level of education on income and economic growth. The statement “low School enrolment” has been removed from the text.

3) The third chapter analyses the nutrition - productivity linkages by employing Two-Stage Least Square (2SLS) and Instrumental Variable or Two Stage Least Square Quantile Regression (IVQR) which captures the causal and heterogeneous impacts of calorie on wages in India. The results support the efficiency wage hypothesis – workers with adequate calorie consumption receive higher wage. Regarding policy implications, the thesis argues in support of Food Security Bill (now it is Act not Bill) to solve the problem of declining per capita calorie intake. If we look at the Food Security Act 2013, it provides only supply of cheaper food grains to approximately 2/3rd population. With this provision only, will it be possible to check declining per capita calorie intake?

4) Reply: - The word “bill” has been replaced by the “program”. My study clearly shows that at the low level of economic equilibrium, higher calorie intake increases labour productivity and wage. Food security act is meant to improve the calorie intake for the two-thirds of the India population and preferably those in the lower spectrum of the MPCE percentile. Hence, there is every chance that food security act will improve the calorie intake of the labour force belonging to the lower strata of the MPCE, thus
increasing the productivity and wage. It is also important to note that 65% of the employed labour force, as per NSSO 2011-12, engaged in occupations like agriculture, fisheries, mining, crafting, machine operator and elementary work. These occupations involve more physical labour than the other occupations. Notably, food security act is more likely to help this group labour force. The fourth chapter estimates the effect of health (measured in terms of adult survival probability) on income (measured in terms of per capita NSDP), and economic growth in India for the time period of 1983-2011. Using statistical models, the thesis finds that a 10 percent increase in probability of adult survival increases the level on national income by 11.8 percent. Also, a 10% increase in growth in probability of adult survival results in an increase in economic growth by about 7.4 percent. Further, it finds that a 10 percent increase in probability of adult survival probability has the potential to increase the economic growth rate by about 26.23 percent. The results looks quite encouraging but needs to be explained how these linkages can take place. What is the force behind them? Further, suggesting rising budget allocation is not working in India. Implementation and utilisation of public health care is a serious issue.

**Reply:** - In the section adult mortality has been taken as one of the measures of adult health, which also highly correlated with under-5 child mortality(Wilmoth, Zureick, Canudas-Romo, Inoue, & Sawyer, 2012). As mentioned in the introduction and previous literature section of the study, literature suggests that four mechanisms through which adult survival increases economic growth. First, in the economy with higher child mortality, preferring higher quantity of children at the cost of quality of children the parents tend to invest less in the children’s nutrition and education. Less investment in children’s nutrition and education leads to poor cognitive and physical development at the adult age. Poor cognitive and physical growth hampers the labour
productivity. Second, healthy workers are more likely to be physically and mentally energetic and robust to do hard work for longer period, hence are more productive and earn higher wage. They are also less likely to be absent from work because of illness (or illness in their family). Third, higher adult mortality reduces the expected future earnings of the household. In the scenario of higher adult mortality, the labour force is less likely to invest in its education and skill development. Likewise, the employer are also likely invest less in the skill development of their employees. Which leads to sub-optimal employment of the labour force and low productivity. Fourth, low mortality escalates the post retirement life expectancy. Hence, better adult health promotes savings thereby physical capital formation and investment. Agreed, that budgetary allocation is not working in India. Implementation and utilisation of public health care is a serious issue. These, issues are matter of governance and ruling party ideology, which is very difficult to incorporate in an empirical model. Although, we have tried to controlled these state specific attributes by including ruling party dummies in state fixed effect model.

5) The fifth chapter examines the effect of socio-economic inequality in health on income, and economic growth in India. The chapter focuses on how distribution of health affect income, economic growth, and development of a society. The thesis finds that a 10 percent decrease in health inequality when measured in terms inequality in under-five child mortality results in 0.8-1.6 percent increase in economic output or income. The results also indicate that a 10 per cent decline in the growth of inequality in under-five child mortality increases the economic growth by about 0.7 percent. Like the previous chapter, there is need for explaining how these linkages will take place and factors responsible for the effect.
**Reply:** - As mentioned in the theory and empirical framework of the chapter-5, at a low level of income and nutrition distribution, increased calorie intake leads to higher labour productivity and wage but at a decreasing rate (Dasgupta, 1997; Deolalikar, 1988; Strauss & Thomas, 1998). Hence, two populations with equal average health, population with lower variation in health, will have a higher average human capital or labour productivity.

6) The last chapter concludes the study and suggests policy implications. However, the policy implications are general in nature.

**Reply:** - In the present work we tried to establish that for a given quality and grade of education, the level and distribution of health in India has significant effect on income and economic growth. In this context, specific recommendations are 1) improvement in childhood nutritional will lead to higher physical growth, cognition development and educational attainment, and hence higher labour productivity in adulthood thereby contributing to higher personal income and economic growth; 2) reduction in health inequality would pay high dividend not only in terms of increasing the income at individual level but also contribute to national income and economic growth by improving labour productivity.
COMMENTS ON THE THESIS

EFFECTS OF HEALTH ON HUMAN CAPITAL FORMATION, INCOME AND ECONOMIC GROWTH IN INDIA

By Mr Kaushalendra Kumar

The impact of health on development has been well established although the pathways through which health operates on different development indicators are still unclear. This thesis brings out the effect of health on human capital, income and economic growth in India and thus provides an in-depth understanding of its relationship. The thesis is original in its empirical analysis, and is well structured and well written. It has established the various linkages through appropriate statistical techniques. The theoretical issues relating to relationship between each of these indicators have also been discussed in detail. Overall, the work provides an excellent understanding of the impact of health on various aspects in the context of India with considerable policy relevance. I have no hesitation in recommending the thesis for the award of the Ph.D Degree.

My comments which may help to improve the work further for publications are as follows:

1. The chapter 2 deals with the effect of child nutrition on human capital formation. Both the theoretical as well as the empirical analysis is interesting and has come out with very interesting findings. However, any analysis on human capital formation in the context of India needs to bring out some indicators on the quality of education as the quality significantly varies across schools and areas. Therefore, the result on the performance of students can be simply the result of the school effect than the individual effect which are considered for the analysis.

2. In chapter 3, on the estimation of wage equation, important variables like experience, public/private sector, type of occupation and type of industry are left out which are very important in the Indian context.

3. The chapter 3 being a cross section data analysis, the variance of random disturbance will generally be not constant and may lead to inefficient estimate.

4. Again in Chapter 3, it is better not to use per capita expenditure and per capita calorie consumed together since the calorie consumption is, in a way, derived from the per capita expenditure and it can result in spurious results?

5. The panel data analysis in chapter 4 with time series data need to undergo time series tests like panel stationarity and panel co-integration, etc. The ideal model in such circumstances will be either a panel error correction model or panel VAR/VEC framework.

6. The variable on experience used in chapter 4 as explanatory in the model is individual specific and aggregation on the state level may not be appropriate.
7. It is difficult to estimate the model in chapter 4 through a fixed effect model since the individual specific dummies are included like ruling party dummy. Table 4.5.4 indicates that it is a random effect model, not a fixed effect model.

8. Chapter 5 on health inequity/inequality across states has been interesting and the different models estimated provide variable insights on the relationship between health inequity and income.

The thesis, in general, provides an excellent analysis of various issues relating to health, human capital formation, income and economic growth in India. I congratulate the student and supervisor for undertaking such an exciting work for the Ph.D. Beside being recommending the thesis for the award of Ph.D, I would recommend publication of the thesis. I wish him all the best.
Comments on PhD Thesis and reply to EXAMINER II:

1) The chapter 2 deals with the effect of child nutrition on human capital formation. Both the theoretical as well as the empirical analysis is interesting and has come out with very interesting findings. However, any analysis on human capital formation in the context of India needs to bring out some indicators on the quality of education as the quality significantly varies across schools and areas. Therefore, the result on the performance of students can be simply the result of the school effect than the individual effect which are considered for the analysis.

Reply: - In this chapter quality of education has been controlled through household education expenditure in last one year and type of school attended (not enrolled, public school, private school). Hence, the effect of linear growth and relative weight gain on educational human capital measures is adjusted for the quality of education and also parental investment on children’s education.

2) In chapter 3, on the estimation of wage equation, important variables like experience, public/private sector, type of occupation and type of industry are left out which are very important in the Indian context.

Reply: - Experience is nothing but current age excluding years of schooling and six years of childhood (Barro & Lee, 2000; Bloom, Canning, & Sevilla, 2004). Since, I have already included current age and years of schooling, I did not include experience in the models. All multivariate models include nature of occupation: 1) legislators, senior officials and managers; 2) professionals; 3) associate professionals; 4) clerks; 5) service workers and shop & market sales workers; 6) skilled agricultural and fishery workers; 7) craft and related trades workers; 8) plant and machine operators and assemblers; and 9) elementary occupations. I have already included nature of
occupation therefore I have not included type of Industry in the model. In the NSSO employment and unemployment round 2011-12 there is no specific question on public/private sector of employment, hence I have not included public/private in the models.

3) The chapter 3 being a cross section data analysis, the variance of random disturbance term will generally be not constant and may lead to inefficient estimate.

Reply: - All regression models in the Chapter-3 are adjusted for the NSSO district region fixed effects and standard errors are robust and adjusted for clustering by the NSSO district regions. Clustered standard error takes into account the conditional heteroskedasticity and conditional autocorrelation (Bertrand, Duflo, & Mullainathan, 2004; Cameron & Trivedi, 2005)

4) Again in Chapter 3, it is better not to use per capita expenditure and per capita calorie consumed together since the calorie consumption is, in a way, derived from the per capita expenditure and it can result in spurious results?

Reply: - The rationale of using per capita consumer expenditure as an instrument comes from the fact that at the low level of economic equilibrium, monthly per capita consumption expenditure is highly correlated with food expenditure. However, as per Engel’s law share of food expenditure to the total expenditure either remains constant or declines with increase in MPCE. Hence, per capita consumption expenditure will be highly correlated with calorie intake but not with wage or productivity of the workers.

5) The panel data analysis in chapter 4 with time series data need to undergo time series tests like panel stationarity and panel co-integration, etc. The ideal model in such
circumstances will be either a panel error correction model or panel VAR/VEC framework.

**Reply:** - Unit root test shows that the outcome variable, per capita net state domestic product (PCNSDP), is non-stationary but its determinants are stationary. In such situation, fixed effects panel dynamic model is appropriate than the VAR/VEC framework. Over this, panel co-integration test shows that the error term is stationary, hence the linear combination of PCNSDP and its determinants cancels out the non-stationary trends in the PCNSDP series. And there is long term equilibrium between PCNSDP and its determinants.

6) The variable on experience used in chapter 4 as explanatory in the model is individual specific and aggregation on the state level may not be appropriate.

**Reply:** - Assuming an individual starts schooling at age six then after completion of formal education enters into the labour market, we have computed the average experience by state and year using NSSO data. Like, mean age of population, years of experience could be aggregated at the state level.

7) It is difficult to estimate model in chapter 4 through fixed effect model since the individual specific dummies are included like ruling party dummy. Table 4.5.4 indicates that it is a random effect model, not a fixed effect model.

**Reply:** - State Government of any political party changes at each five years, hence ruling party is not individual specific dummies variables. Here, all models in chapter-4 has been estimated using fixed effect model. As Hausman test for fixed effect against the random effect also allows for the fixed effect model.
8) Chapter 5 on health inequity/inequity across states has been interesting and the different models estimated provide variable insights on the relationship between health inequity and income.

Reply: - Thanks for appreciation and encouragement.

References in reply to Report and Comments of Examiners


Dasgupta, P. (1997). Nutritional status, the capacity for work, and poverty traps. *Journal of Econometrics, 77*(1), 5-37. doi: [http://dx.doi.org/10.1016/S0304-4076(96)01804-0](http://dx.doi.org/10.1016/S0304-4076(96)01804-0)

