In this concluding chapter I present the major findings of my study, and attempt to put them in perspective given the received literature.

5.1 Main findings related to TFP measurement

Chapter 2 estimated growth in agricultural total factor productivity for fifteen states of India for the years 1983-84 to 2005-06 using non-parametric Sequential Malmquist TFP Index, that is a conceptually superior technique and also has less stringent data requirements. Four sets of TFP indices are reported - one, using Index of Agricultural Production data for thirteen states (excluding Bihar and Kerala) computed on the basis of contemporaneous technology; two, using Index of Agricultural Production data for thirteen states (excluding Bihar and Kerala) computed on the basis of sequential technology; three, using Index of Agricultural Production data for thirteen states and Net state domestic product from agriculture as a proxy for output for Bihar and Kerala computed on the basis of contemporaneous technology (for fifteen states) and four, using Index of Agricultural Production data for thirteen states and Net state domestic product from agriculture proxied for Bihar and Kerala computed on the basis of sequential technology.

The productivity performance of fifteen states - using the index of agricultural production as the output measure for thirteen states, and net state domestic product from agriculture as the output measure for Bihar and Kerala – is discussed at length. TFP growth rates are estimated to be 3.74% during the first sub-period 1983-84 to 1996-97 and a lower 2.99% during 1997-98 to 2005-06; the average TFP growth being 3.4% per annum for the entire time period.

For the overall time period 1983-84 to 2005-06, all states except Odisha are found to exhibit improvement in productivity. There are ‘large’ productivity gains occurring in
Haryana, Kerela, Punjab, and Tamil Nadu. While the states of Assam and West Bengal exhibit “medium” improvements in TFP, the states of Andhra Pradesh, Bihar, Karnataka, Maharashtra, Rajasthan and Uttar Pradesh exhibit ‘small’ productivity improvements. Gujarat and Madhya Pradesh experience “marginal” productivity gains. As far as sources of TFP change are concerned, efficiency decline is observed in eight out of fifteen states - Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Odisha, Uttar Pradesh and Maharashtra. “Large” technical change occurs in three states - Punjab, Haryana and Kerala - with the growth rate of technical change more than 5% for the entire time period.

During the sub-period of 1983-84 to 1996-97, the state of Odisha exhibits a decline in productivity, with rest of the states showing productivity improvements. ‘Small’ TFP gains are observed in Andhra Pradesh, Assam and Rajasthan, “medium” TFP gains in Bihar, Gujarat, Karnataka, Maharashtra, Uttar Pradesh and West Bengal. The states of Haryana, Kerala, Punjab and Tamil Nadu show ‘large’ productivity improvements. During this period, the technical efficiency is observed to decline in five out of fifteen states and is found to be improving in seven states (with Assam, Haryana and Kerala reporting no change in efficiency, being the frontier states). Madhya Pradesh and Odisha report ‘marginal’ technical progress; and large technical progress is exhibited by Bihar, Haryana, Punjab and Kerala. The remaining states experience small and medium technical progress.

During the second sub-period 1997-98 to 2005-6, a decline in productivity is observed in five states - Bihar, Gujarat, Karnataka, Maharashtra and Uttar Pradesh. The TFP is observed to improve marginally in Madhya Pradesh. Assam, Haryana, Kerala, and Punjab show large TFP improvements; while the remaining states - Andhra Pradesh, Odisha, Rajasthan, Tamil Nadu, West Bengal show medium TFP improvements. This sub-period witnesses a decline in efficiency in five states - Bihar, Gujarat, Karnataka, Maharashtra, and Uttar Pradesh. All these states also report TFP regress since technical progress made did not outweigh the rate of efficiency decline. The non-frontier states of Andhra Pradesh, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu and West Bengal show improvements in efficiency. The state of West Bengal exhibits
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When we compare the relative contribution of sources of productivity change, we find that during the overall time-period, technical change component assumes greater significance for all the states. Although efficiency is observed to decline in eight states, TFP regress occurs only in Odisha. This is due to positive counteracting effect of technical progress in the seven states while in Odisha the declining efficiency coupled with marginal technical progress pulls down overall productivity levels. During sub-period 1983-94 to 1996-97 also, the contribution of technical change is found to be greater than that of efficiency change to overall productivity changes in all states. Although efficiency decline is observed in five states, only Odisha reports overall productivity regress (that is attributable to low technical progress together with declining efficiency). In the remaining states, technical progress far outweighs the impact of declining efficiency and hence they report an overall productivity improvement. However during sub-period 1997-98 to 2005-6, the contribution of technical change is greater than that of efficiency change in ten out of fifteen states. The average technical progress seems to slow down from nearly 4% in sub-period 1 to 3% in sub-period 2.

The changes in TFP and its decomposition as obtained for fifteen states from the two alternate ways of frontier construction - contemporaneous and sequential - are compared. The mean TFP growth is found to be 1.6% and 3.4% per annum under contemporaneous and sequential technology respectively. As expected, in comparison to sequential approach, the technical efficiency change computed under contemporaneous approach is observed to be over-reported for all states (except Tamil Nadu) as well as on the average - mean technical efficiency growth rate being 0.41% p.a. under contemporaneous technology while it is estimated as -0.11% p.a. under sequential technology. Several frontier states reported technical regress on year-to-year basis due to declines in the usage of some inputs, thereby necessitating construction of the frontier using sequential technology.
The observed efficiency decline in almost fifty percent of the states is a matter of serious concern. This implies huge potential increase in production even with existing technology. The technical stagnation and near-stagnation is observed in most of the states.

Our study confirms the slowdown in TFP growth since the mid-1990s, reported by the earlier literature (Fan, Hazell and Thorat 1998; Mukherjee and Kuroda 2001). The existing evidence on all-India all-crop TFP change lies in the range of 1.4-1.73% for the 1970s, 1.99-2.51% for the 1980s, and 0.59-1.34% for the early-1990s. By comparison, our figures for TFP growth rate are 3.74% and 2.99% during the two sub-periods 1983-84 to 1996-97 and 1997-98 to 2005-06 respectively; the average TFP growth rate being 3.4% per annum for the entire time period. Further, we find the states with the highest TFP growth to be Punjab, Haryana, Kerala and Tamil Nadu, which accords partially with the earlier evidence (Chand et al 2011; Fan, Hazell and Thorat 1998); the difference being the good performance of Kerala and Tamil Nadu in our study. At the other extreme, we observe negative growth rate for Odisha and the lowest (but positive) growth rates for Gujarat and Madhya Pradesh, which again is partially consistent with the earlier studies noted above; the difference being the poor performance of Gujarat found in our study. The differences in the TFP performance so obtained in comparison to other studies can be attributed to differences in the methodology adopted for computation as well as differences in type and sources of data used.

5.2 Main findings related to construction of Health Index

Chapter 3 presented the results for the three sub-indices, namely Material Access Index, Health Infrastructure Index and Health Care Utilization Index, and the Health Index for selected years 1983-84, 1994-95 and 2005-6.

A steady improvement is observed in Material Access Index (MAI) for all the states over time, the mean index rising from 1.89 in 1983-84 to 5.14 in 2005-6. The ranking of the states across the years remains almost unaltered. The states with better access to
food, clean cooking fuel, having principal source of drinking water within premises, sanitation facilities at home and higher literacy levels are Kerala and Punjab. The states with lowest MAI include Madhya Pradesh, Odisha, Bihar and Rajasthan. The rise in material access over the years, however, needs to be taken with caution since the levels of access to basic facilities in 2005-6 still remains low.

The mean Health infrastructure index (HINFI) exhibits an improvement from 2.14 in 1983-84 to 4.59 in 1994-95, thereafter declines to 4.37 in 2005-6. In 1983-4, Maharashtra had highest HINFI, the rank later taken over by Kerala. Although Kerala retains the rank through 2005-6, its performance on this front has declined in comparison to its own past performance that peaked in 1992-3. The lowest value for HINFI is reported in Bihar, Madhya Pradesh, Odisha and Tamil Nadu in 1983-84 and states of Bihar, Uttar Pradesh and West Bengal in 2005-6. The states of Odisha and Rajasthan have considerably improved their health infrastructure in the post-2000 years. Deterioration in HINFI is observed in eight out of fifteen states - Bihar, Gujarat, Haryana, Kerala, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal - since mid-1990s.

The Health Care Utilization Index (HCUI) is discussed next. The mean HCUI improves from 4.65 in 1983-4 to 6.46 in 1994-5 and then declines marginally to 6.35 in 2005-6. In 2005-6, highest health services utilization takes place in Punjab followed by Kerala. The lowest utilization is reported in Assam, Bihar, Madhya Pradesh, Rajasthan and West Bengal in 1983-4 while in Assam and Bihar in 2005-6. The HCUI exhibits stagnation in eight out of fifteen states - Andhra Pradesh, Assam, Gujarat, Haryana, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal - since mid-1990s. The state of Kerala reports highest HCUI in 1988, thereafter showing a declining trend. The worst performance is observed in Bihar and Maharashtra where HCUI has declined over the entire time period.

The mean Health Index (HI) is found to increase substantially from 2.39 in 1983-4 to 4.95 in 1994-5 and then rises marginally to 5.36 in 2005-6. All the states except Maharashtra exhibit an improvement in HI in 1993-4 in comparison to 1983-4.
Comparing performance across 1994-5 and 2005-6, HI shows stagnation in six states - Bihar, Gujarat, Maharashtra, Punjab, Tamil Nadu and West Bengal and a decline in Kerala and West Bengal. While the performance on health seems to have significantly improved in 1980s till mid 1990s, it has not shown major improvements in post-1995 years. The states of Bihar, Madhya Pradesh, Assam, Uttar Pradesh, West Bengal, Odisha and Rajasthan score lowest mean HI and face a serious challenge to health status of their populations. There is an urgent need to reduce health risks and provide better medical care facilities to people at large.

The Health Index so constructed is compared with three alternate composite health outcome indicators - using a time series of IMR and life expectancy at age one; taking the additional parameter of percentage of women having body mass index less than 18.5 kg/m² and then augmenting it with percentage of women having height less than 145 cm – the last two being constructed for selected time periods. Although IMR and life expectancy are highly correlated, the correlation between mortality/longevity statistics and anthropometric measures is not found to be high. On the other hand, the constructed Health Index is found to be reasonably correlated with each of the health outcome indices, either taken singularly or composite.

The observed improvement in the health index for the state of Rajasthan (although its mean health index is one of the lowest) is consistent with Joshi (2007) who also reports an improvement in the health status of Rajasthan over 1991-2001, using eight parameters with equal weights assigned to all, namely percentage of rural population served by medical amenity, that having access to drinking water, education amenity, power amenity, connected by pucca road, percentage of villages having medical amenity, sex-ratio and female literacy rate. While Joshi (2007) reports nearly 20% improvement in Health Status Index, we find a much higher rate of improvement in health index by 36%, 32% improvement in Material Access Index, 28% rise in Health Infrastructure Index and 24% rise in Health Care Utilization Index between the two time periods.
The health index results for Maharashtra and Odisha compare well with those obtained by Annigeri (CMDR Monograph Series No. - 41) that finds the health performance indicator (comprising of crude birth rate, crude death rate, net growth rate, infant mortality rate, total fertility rate, couple protection ratio) to be fluctuating for the period 1983-1990, shows a declining trend since 1990, thereafter fluctuating till 1996. On the other hand, while Annigeri (CMDR Monograph Series No. - 41) gets a similar result for the state of Karnataka, we get an improvement in the Health Index in 1990s, although slower than the previous years. Other than these studies, there is precious little multi-measure empirical evidence to compare our results to.

5.3 Health and agricultural TFP growth

The estimation results from the dynamic panel GMM-SYS are now discussed. Apart from health as treatment variable, few control variables are also considered, namely education, adoption of modern varieties of seeds and extension expenditures. Three sets of results are presented. The first set is derived from the TFP equation taking the health variable as exogenous. A robustness check is provided by the second set of results that redefines the education variable as primary education instead of secondary education. The third set of results corrects for endogeneity bias, since health may well be a function of TFP. Taking health as endogenous, the coefficients of health, education and adoption of HYV seeds turn out positive and significant. A 1% increase in the health index growth rate increases TFP growth rate by 0.22%. A 1% increase in the percentage of literate population raises TFP growth rate by about 0.38%. As growth rate of area under modern varieties of seeds increases by one percent, the TFP growth rate goes up by about 0.09%. The extension variable turns out insignificant across alternate specifications.

In order to provide a measure of relative strength of various regressors, the standardized beta coefficients are computed that suggest the maximum impact of health growth rate on TFP growth, followed by education and then adoption of modern varieties of seeds. When health variable increases by one standard deviation, it is likely to increase TFP growth rate by 0.11-0.14 standard deviations. The impact
of one standard deviation increase in control variables, namely education and modern seed varieties on TFP growth is 0.09-0.11 and 0.08 respectively.

The Pooled Mean Group estimation results comprise of long run relationship as depicted by normalized cointegrating vector and short-run dynamic coefficients. The modified-TFP index is found to improve by 0.28% with a 1% increase in the health index, 0.2% with a 1% increase in percentage of population with at least secondary level and 0.07% with a 1% increase in area under HYV seeds. The extension variable turns out to be insignificant as before. The standardized beta coefficients suggest that a one standard deviation increase in the health index results in a 0.8 standard deviation change in the modified-TFP variable.

The present study empirically establishes health to be an important determinant of TFP growth. The above set of results suggests that the positive association between improvements in health and improvements in TFP is robust to model specification, endogeneity bias, and choice of estimator/estimation technique.

Most of the existing studies that have estimated agricultural productivity function for India have ignored health. There are few studies that take health as one of the determinants of TFP growth, namely Fan (2002) - that takes government expenditure on health as a proxy for health indicator and does not find it to be significant; and Kumar et al (2004) that does not seek to capture the impact of health explicitly since it takes health indicator (number of primary health centres) to be a part of the composite infrastructure index. A significant impact of health (measured by IMR) is found by Venkataramani et al (2010) on one of the components of TFP, that is, technical efficiency. These studies have used the notion of health in terms of a single indicator such as infant mortality rate, government expenditure on health or primary health centres; and not a multi-metric broad-based health indicator.

Demand for food would continue to rise and food supply has to keep pace in order to avoid shortages. This requires production to increase manifold. It is necessary to reverse the efficiency decline that is exhibited by many states and achieve a faster and
larger scale of diffusion of technical innovations across states. Since net area under cultivation has been almost exhausted, productivity levels have to increase substantially. In order to increase agricultural productivity, it is necessary to improve health and education of agriculturists and also promote adoption of high yielding varieties of seeds.

There is a need to step up the health status of rural population, reduce health risks and provide better medical care facilities to people at large. This would require an active role of the state in making available good quality health infrastructure services in rural areas. Also the task of improvement in population health cannot be achieved by efforts of health department alone - it needs to be complemented by the efforts from several departments in order to ensure adequate nutrition, transport to ensure connectivity, water supply, sanitation facility, clean cooking fuel, education and information.