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Immunization in India 1993-1999: Wealth, Gender, and Regional Inequalities Revisited

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Abstract: *Six years have made a significant difference in childhood immunization in India. The grim picture revealed by the National Family and Health Survey of 1992/3 has significantly improved overall but large differences still exist between states. The paper gives an update of India's successes and failures in childhood immunization along five dimensions: heterogeneity between states, rural-urban differentials, gender differentials, and wealth induced inequalities. Recently developed methodology is used to calculate an extended achievement index that captures immunization performance along dimensions of efficiency (change in overall immunization rates) and equity (wealth-based distribution of outcomes) using increasing degrees of inequality aversion. An analysis of the change in this index between 1993 and 1999 reveals a positive correlation between efficiency and equity improvements.*

JEL classification: I18, O12, O53

Key Words: Immunization, Inequality, Gender, India

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1. Introduction

Because immunization is a preventive health care practice and therefore mostly independent of need, monitoring immunization rates is a convenient way to assess improvement in health care accessibility and outreach. When immunization outcomes are observed at a sufficiently disaggregated level and compared to previous performance, they give important information about where policies have worked or failed, and where improvements are still needed. In 2003, this journal published an article describing the state of childhood immunization in India and prevalent wealth, gender, and regional inequalities (Pande and Yazbeck). The study used data from the Indian National Health and Family Survey conducted in 1992/93 to sort households into wealth quintiles by applying principle component analysis on asset data, and to classify children into 3 categories: not immunized, partially immunized, and fully immunized. [1] While the article was in press, results of a new survey conducted in 1998/99 became available. Although some changes were made to make the Indian data comparable to other countries, the questionnaires and survey methodology remained mostly unchanged, allowing us to take a new snapshot of the situation using the same methodology, and compare it to the earlier data.[2] In addition, a new measure –Wagstaff's extended achievement index– was introduced in the literature, allowing us to assess immunization performance looking both at efficiency (changes in overall mean immunization rates) and equity (wealth-based distribution of outcomes), using variable levels of inequality aversion (Wagstaff, 2002). Comparing changes in the inequality-adjusted measure across time is especially usefully in identifying whether efforts to reach lower-income groups are necessarily made at the expense of improvement in overall performance. Our intent is to present the most striking findings to motivate further research to better understand the link between policy, group-specific characteristics and performance.

The situation in 1992/3, as described in Pande and Yazbeck (2003), was mostly dismal with 70 percent of children aged 12-60 months in rural areas still not fully immunized and close to 40 percent with no immunization at all. Even in urban areas, only about half of the children were fully immunized and close to 20 percent had not received any immunization. Performance was found to be very uneven across locations (rural/urban; north/south), wealth status, and gender. Bihar was found to be the worst performing state in both rural and urban areas with only 10 percent of children fully

[1] A child is considered immunized after receiving one dose of BCG, three doses each of DPT and OPV and one dose of measles vaccine.

[2] The only (although important) constraint relates to the calculation of immunization rates and in particular the time span during which immunization has to take place. The 1998/99 survey asked immunization questions about children from 12 to 36 months instead of 12-60 months as in 1992/93. Although this is an improvement over the previous survey for cross-country comparisons, it does not allow for direct comparisons of the Indian data over time. In the following, it is important to keep in mind that statistics calculated using the new data span a more restricted age group with a higher likelihood of no immunization and a lower likelihood of full immunization.

immunized and two-thirds who had not received any vaccination in rural areas. In comparison, more than 98 percent of children in urban areas of Tamil Nadu had received at least partial immunization. Inequalities based on wealth were found to be less pronounced in areas with higher immunization rates but wealth did not help children in areas where a larger proportion of children had not received any vaccination. Gender inequalities were also found to be large both for no-immunization and full immunization, although no significant correlation was found between gender inequality and overall immunization performance by state. In rural areas, 16 of the 17 Indian States in the study were found to have some degree of gender inequality whereas in urban areas, 12 out of 17 had higher immunization rates for males.

Between 1992/3 and 1998/9, the government of India (central and state) spent each year between 0.77 and 0.90 percent of their GDP in public health, still among the lowest in the world (Peters, Yazbeck, Sharma, Ramana, Pritchett, & Wagstaff, 2002). Low overall expenditures reflect a weak commitment to health services, but mask large variations among states (Mahal 2003; Mahal, Yazbeck, Peters, & Ramana, 2004). Another source of state level variations are state-specific projects externally financed by donors and lenders. Some of these programs cover a subset of states while others only cover certain urban or rural areas within a state. By documenting changes in immunization coverage and inequality by rural and urban regions in the major states, it is possible to assess the extent to which public commitment through expenditures (domestic or borrowed) have impacted the performance of the health sector in India. Of special interest is to see whether the conscious effort made by the Government of India to target groups with lowest immunization levels -- particularly children in the bottom income group, children in rural areas, and girls-- has produced tangible results such as improved immunization coverage for the socially vulnerable groups and whether it did so at the expense of overall immunization performance.

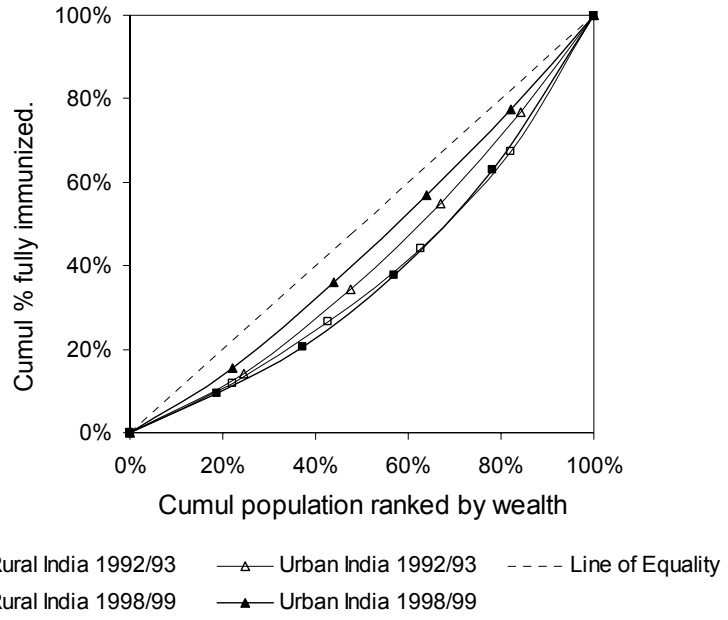
So what difference did six years make? Major trends are reported along five dimensions: national averages, rural-urban differentials, gender differentials, wealth-induced inequalities, and regional inequalities by states. We first look at national averages to present performance and trends with respect to general differences between rural and urban areas and between boys and girls (section 2). We find that significant improvement was made in reducing or eliminating cases of total system failure (when children do not receive any immunization) but major inequalities persist in full immunization. Section 3 addresses the issue of heterogeneity between states using partial and full immunization records as well as changes in wealth-based inequalities using Wagstaff's measure. In section four, we explore the tradeoff between efficiency and equity in immunization outcomes and find no evidence that distributional improvements necessarily slow down overall performance. The final section summarizes our findings.

2. The big picture: national averages, wealth and gender inequalities

The news is mixed at the national level. Although full immunization rates are still low and do not appear to have improved significantly on average --from 30 to 35 percent in rural areas and 53 to 57 percent in urban areas-- efforts have paid off in reaching a much larger part of the population.[3] Looking at the percentage of children who received no immunization at all, the improvement is striking in both rural and urban areas. In 1992/3, 38 percent of rural children and 17 percent of urban children had not received any vaccine. In 1998/99 the percentages were cut in more than half (18 and 6 percent respectively).

Wealth-based inequalities were significantly reduced in urban areas where the concentration ratio for full-immunization went from 0.18 to 0.10, but they did not decrease in rural areas where the concentration ratio stayed at 0.24. [4] Figure 1 reveals that the improvement is unambiguous in urban areas (the concentration curves do not cross) whereas there is some indication that inequality slightly increased in rural areas.[5]

Figure 1: Concentration Curves for Full Immunization, Rural and Urban India



[3] Note that full immunization in the 1998/99 data has to happen between one and three years of age instead of the one to five years window used before.
[4] The concentration ratio is calculated as a Gini coefficient by measuring the area between the line of perfect equality and the concentration curve (the concentration curves measure the relationship between cumulative wealth and cumulative percentage of the immunized population). A score of zero indicates perfect equality and a score of 1 perfect inequality (where only the richest person is immunized).
[5] The 1998/99 rural areas concentration curve is below the 1992/93 one for lower quintiles and above for higher quintiles, leaving the area between the equality line and the concentration curve unchanged. The concentration ratio stays constant, but inequality increased.

When considering no-immunization results instead of full-immunization, wealth-based inequalities appear to have increased overall (with a concentration ratio increasing from -0.37 to -0.43 in urban areas and from –0.18 to –0.26 in rural areas).[6] However, this does not indicate that immunization efforts did not reach the poor. Total system failure tends to touch different income groups more equally so improved access is likely to increase inequality. Since reducing inequalities by denying access to those who would have access otherwise would not be considered a positive result, it is important to consider both equity and efficiency results to assess performance. Using the methodology developed by Wagstaff (2002), we can now present performance in levels and incorporate distributional considerations using a single measure. The Wagstaff extended achievement index is used to adjust overall immunization levels by assigning different weights to different segments of the population.[7] The parameter *v* measures the degree of inequality aversion. Higher levels of *v* decrease the weight on higher income groups and increase the weight on lower income groups. When *v*=1, the adjusted immunization score gives a number equal to the raw overall immunization level; when *v*=8, most of the weight falls on the lowest income quintile, therefore performance in higher income groups makes no difference. Table 1 reports the average inequality-adjusted immunization scores for rural and urban India in 1998/99 and the change from 1992/3. Adjusted immunization scores that increase more for lower values of *v* are evidence that richer portions of the population benefited most from the change and vice-versa. In rural areas, although immunization rates increased across the board, most of the improvement occurred in richer segments of the population. In urban areas, however, performance looks better with higher degrees of inequality aversion.

Table 1 : Inequality-Adjusted Immunization Scores for All India 1998/9

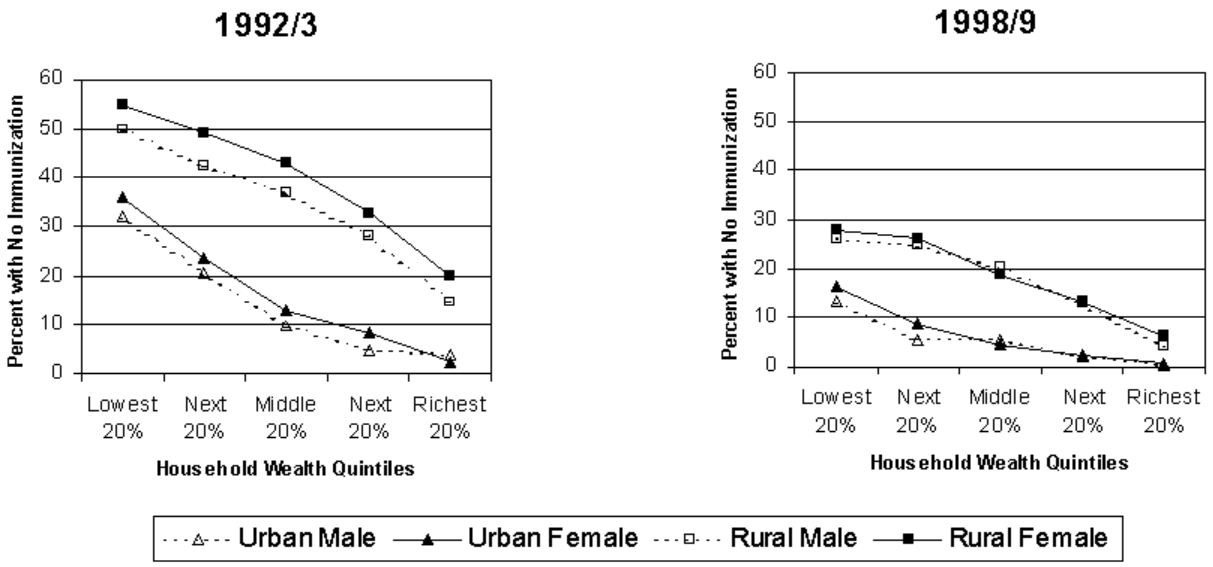
	Inequality-Adjusted Immunization Scores [a/ b/]				
Inequality aversion: [b/]	***v=1***	***v=2***	***v=4***	***v=6***	***v=8***
Rural Areas, 1999	35.52 (+ 5.52)	26.93 (+ 4.10)	20.83 (+ 2.54)	18.64 (+ 2.19)	17.26 (+ 2.18)
Urban Areas, 1999	56.85 (+ 3.69)	50.89 (+ 7.06)	44.41 (+ 8.81)	40.36 (+ 9.01)	36.98 (+ 8.87)

[a/] Changes from 1992/3 are given in parenthesis
[b/] *v* =1 corresponds to an equal weight on all individuals so the score is the percentage of population immunized; v=2 uses the implicit weight of the standard concentration ratio; v=8 gives most of the weight to immunization in the lowest wealth quintile. Methodology from Wagstaff (2002)

[6] Concentration ratios take a negative sign for no-immunization to indicate that the concentration curve lies above the line of perfect equality.
[7] The *Wagstaff (extended achievement) index* applied to immunization, gives an *inequality-adjusted immunization score*. We use the terminology interchangeably in the rest of the paper.

Looking at gender differentials in no immunization, gaps between boys and girls have been reduced both in rural areas and urban areas. In six years, the difference between the percentages of girls and boys not immunized went from 5.4 to 1.3. In urban areas the gap decreased from 2.8 to 1.8 percentage points, although the female to male ratio of children not immunized increased from 1.17 to 1.33. The break down between boys and girls in rural and urban areas by wealth quintiles reveals that gender-based inequalities in no-immunization were significantly reduced, eliminated, and sometimes reversed in all income groups in rural areas and all but the lowest in urban areas. In the middle and higher classes, no evidence of gender discrimination remains (Figure 2).

Figure 2: Gender and Wealth Inequalities: No-Immunization, Rural and Urban India



Results are less encouraging when it comes to full immunization (Table 2). Gender differentials for fully immunized children under three years of age have worsened in urban areas in the second and third wealth quintiles. In rural areas, the gender gap worsened in the second lowest quintile only. The largest improvement was in the top wealth quintile but it was also the one with the most striking differential in 1992/3. The fact that results in full immunization are not as good as those for no-immunization indicate that problems of discrimination are more likely occuring at the level of the family rather than the health care system, since it is when the family needs to return to the health facility to complete immunization that boys are still largely favored.

Table 2: Gender Differentials in Full Immunization: Urban and Rural India 1998/99

	Gender Gap % Boys Immunized-% Girls immunized [a/]	
Wealth Quintile	**Rural Areas**	**Urban Areas**
Lowest 20%	-1.59 (-2.52)	5.22 (-2.52)
Next 20%	4.83 (+2.53)	2.81 (+0.44)
Middle 20%	1.91 (-0.33)	6.44 (+1.17)
Next 20%	0.99 (-0.50)	-3.03 (-6.57)
Richest 20%	2.84 (-3.33)	1.94 (-0.65)

[a/] Changes from 1992/3 are given in parenthesis

3. Regional Variations in Immunization: Inequality-Adjusted Performance

Immunization performance by state is presented in Table 3 (rural areas) and 4 (urban areas). The tables record overall achievement in partial and full immunization (v=1) as well as inequality-adjusted achievement with increasing degrees of inequality aversion (Wagstaff, 2002). It is apparent that the numbers for all India hide important variations among states. Coefficients of variation indicate that heterogeneity between states is significantly larger in rural areas where it is also increasing. Urban areas, in contrast, show signs of convergence. The North-South division is still strong, especially when looking at full immunization. The four "bimaru" states, Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh are still lagging. Add Assam to the list and we still have the worst performing states in terms of full immunization outcomes both in levels and in rates of change. The picture looks very different, however, when we take account of partial immunization (first column). Indeed, all states have significantly increased the percentage of children partially immunized. States that worsened or improved the least in full immunization were among the most improved in partial immunization. In Rural Bihar, for example, while the rate of full immunization is still below 10 percent and slightly dropped since 1993, the percentage of children that received partial immunization more than doubled to 83 percent.[8] Consequently, the gap between the worst and best state in partial immunization significantly decreased (from 56 to 35 percentage points in rural India and from 40 to 15 in urban India).

[8] Note that for full immunization the drop is likely overestimated due to the fact that the time span during which immunization had to occur was shortened by two years between the two surveys.

In order to capture the distribution of gains and losses along with overall performance, inequality-adjusted immunization scores are calculated for 1992/93 and 1998/99 for increasing levels of risk aversion.[9] Dispersion between states is greater when looking at the Wagstaff indices with different degrees of inequality aversion (the coefficient of variation increases as v increases). The best performing state in urban and rural areas and most improved in rural areas, Tamil Nadu, touched all income groups evenly in rural areas while decreasing inequality in urban areas. Himachal Pradesh (second best performing state in levels) shows substantial improvement in rural areas but the lower income groups contributed less to the overall increase in immunization. The same state shows a different pattern for urban areas where the unadjusted immunization rate went down, but adjusted scores indicate improvement in low-income groups. Jammu, a state in political turmoil that saw a large decrease in overall immunization rates in both rural and urban areas actually improved when using higher degrees of inequality aversion. In Bihar, the worst performing state in both 1992/3 and 1998/9, overall immunization rates decreased, but a look at inequality-adjusted measures reveal significant improvement in urban areas while rural areas became more unequal.

Finally, there were significant movements in state rankings. Table 5 gives 1999 rankings in raw immunization rates and changes in state rankings for inequality-adjusted measures. Tamil Nadu now leads all states in overall performance (v=1) and all adjusted measures in both rural and urban areas. Urban West Bengal jumped nine places up (from second to last place in 1992/3) by doubling immunization rates in six year. Larger increases in inequality-adjusted scores indicate that even larger improvements were recorded in poorer families. Unlike urban areas of the state, rural areas of West Bengal still performed below par with a rank of 12 for all degrees of inequality aversion. In rural areas, it is Andhra Pradesh that showed the most striking improvement in ranking at all levels of inequality aversion. Punjab, Madhya Pradesh and Jammu performed worse in rural areas, although the situation in rural Jammu looks better using inequality-adjusted measures. New Delhi, Rajasthan, and Madhya Pradesh performed worst in urban areas, although Madhya Pradesh' s bad relative performance can be attributed to increasing inequality only.

[9] Inequality-adjusted immunization scores are calculated in a similar fashion as Wagstaff's extended achievement index (Wagstaff, 2002).

Table 3 : Inequality-Adjusted Immunization by State - Rural India

	Percent Partially Immunized[a/]	**Inequality-Adjusted Full-Immunization Scores** [a/ b/]				
Inequality aversion: [b/]	*v=1*	*v=1*	*v=2*	*v=4*	*v=6*	*v=8*
Andhra Pradesh	94.95 (+ 20.48)	53.54 (+ 13.62)	50.81 (+ 15.31)	49.31 (+ 17.90)	48.29 (+ 19.40)	46.78 (+ 20.11)
Assam	64.34 (+ 13.55)	16.53 (+ 1.54)	13.38 (+ 3.43)	11.42 (+ 3.85)	10.37 (+ 3.69)	9.38 (+ 3.40)
Bihar	82.92 (+ 45.48)	9.80 (- 0.19)	6.09 (- 0.69)	4.21 (- 1.06)	3.62 (- 1.26)	3.24 (- 1.34)
Gujarat	94.13 (+ 18.15)	47.36 (+ 1.49)	40.88 (+ 2.19)	33.85 (+ 1.45)	29.44 (+ 0.36)	26.30 (- 0.21)
Haryana	91.83 (+ 15.41)	64.35 (+ 14.95)	58.49 (+ 15.65)	50.84 (+ 14.22)	46.14 (+ 12.82)	42.33 (+ 11.61)
Himachal Pradesh	95.53 (+ 8.59)	81.14 (+ 21.17)	74.00 (+ 23.64)	63.46 (+ 21.98)	56.70 (+ 19.58)	51.73 (+ 17.81)
Jammu	88.89 (+ 11.56)	51.19 (- 10.15)	44.39 (- 4.68)	38.76 (+ 1.99)	35.43 (+ 3.91)	32.43 (+ 3.94)
Karnataka	91.04 (+ 14.33)	57.35 (+ 7.96)	51.69 (+ 8.99)	46.38 (+ 8.35)	43.06 (+ 7.79)	40.11 (+ 7.64)
Kerala	96.32 (+ 9.89)	67.42 (+ 12.65)	65.78 (+ 15.70)	62.21 (+ 17.07)	59.00 (+ 16.97)	55.36 (+ 16.36)
Maharashtra	97.5 (+ 10.71)	73.75 (+ 14.74)	68.46 (+ 17.06)	61.75 (+ 16.93)	56.87 (+ 15.67)	52.37 (+ 14.31)
Madhya Pradesh	83.24 (+ 23.43)	16.14 (- 8.65)	10.83 (- 9.21)	7.43 (- 9.09)	6.14 (- 8.49)	5.35 (- 7.78)
Orissa	91.96 (+ 26.99)	42.36 (+ 14.69)	36.52 (+ 14.39)	30.91 (+ 12.60)	27.97 (+ 11.37)	25.55 (+ 10.27)
Punjab	89.67 (+ 6.32)	68.01 (+ 3.05)	57.05 (+ 1.48)	45.51 (- 1.02)	39.11 (- 2.59)	34.52 (- 3.19)
Rajasthan	75.51 (+ 34.84)	16.04 (+ 2.26)	11.15 (- 0.23)	8.31 (- 1.76)	7.17 (- 2.37)	6.39 (- 2.64)
Tamil Nadu	99.79 (+ 5.92)	85.96 (+ 25.98)	82.35 (+ 27.30)	76.84 (+ 26.38)	72.30 (+ 25.21)	67.93 (+ 24.45)
Uttar Pr.	69.05 (+ 19.35)	19.00 (+ 3.08)	15.71 (+ 3.48)	13.77 (+ 3.81)	13.02 (+ 4.06)	12.34 (+ 4.15)
W. Bengal	82.11 (+ 14.85)	39.76 (+ 15.98)	33.77 (+ 13.33)	28.29 (+ 10.16)	24.94 (+ 8.16)	22.29 (+ 6.82)
Coeff. of Variation [c/]	**0.56 (+0.12)**	**0.70 (+ 0.05)**	**0.90 (+ 0.13)**	**1.08 (+ 0.24)**	**1.13 (+ 0.28)**	**1.15 (+ 0.29)**

[a/] Changes from 1993 are indicated in parenthesis

[b/] v=1 corresponds to an equal weight on all individuals so the score is the percentage of population immunized; v=2 uses the implicit weight of the standard concentration ratio; v=8 gives most of the weight to immunization in the lowest wealth quintile. Methodology from Wagstaff (2002)

[c/] Calculated as the standard deviation of the index divided by the all India average.

Table 4: Inequality-Adjusted Immunization by State - Urban India

	Percent Partially Immunized[a/]	**Inequality-Adjusted Full-Immunization Scores** [a/ b/]				
Inequality aversion :[b/]	*v=1*	*v=1*	*v=2*	*v=4*	*v=6*	*v=8*
Andhra Pr.	96.39 (+ 11.77)	58.76 (+ 9.53)	57.90 (+ 12.94)	55.14 (+ 14.67)	51.56 (+ 14.87)	47.77 (+ 15.20)
Assam	86.73 (+ 8.34)	43.36 (+ 12.65)	44.05 (+ 21.01)	43.64 (+ 26.08)	41.68 (+ 26.88)	38.46 (+ 25.85)
Bihar	89.44 (+ 31.54)	22.54 (- 0.45)	19.42 (+ 4.45)	15.51 (+ 6.63)	12.73 (+ 6.20)	10.76 (+ 5.51)
Gujarat	94.85 (+ 15.72)	60.14 (+ 2.61)	51.65 (+ 5.47)	44.19 (+ 7.59)	39.67 (+ 7.40)	35.68 (+ 6.74)
Haryana	92.45 (+ 5.14)	69.18 (+ 1.56)	63.96 (+ 6.46)	55.62 (+ 8.63)	49.31 (+ 8.61)	43.35 (+ 7.33)
Himachal Pr.	98.58 (+ 1.89)	80.14 (- 1.64)	76.61 (- 0.42)	70.92 (+ 2.62)	66.75 (+ 5.03)	62.85 (+ 6.67)
Jammu	97.52 (+ 1.21)	73.91 (- 6.29)	67.27 (- 4.36)	60.04 (- 1.68)	55.25 (- 0.08)	50.97 (+ 1.38)
Karnataka	92.65 (+ 9.58)	56.33 (- 2.90)	46.19 (- 1.80)	38.43 (+ 1.87)	34.45 (+ 3.85)	31.07 (+ 4.28)
Kerala	100 (+ 5.49)	73.39 (+ 7.46)	73.91 (+ 14.05)	71.69 (+ 18.35)	67.96 (+ 17.90)	62.69 (+ 15.12)
Maharashtra	99.37 (+ 8.33)	69.59 (+ 6.74)	65.08 (+ 9.35)	58.27 (+ 9.02)	53.10 (+ 8.12)	48.91 (+ 8.09)
Madhya Pr.	94.5 (+ 18.17)	39.50 (- 6.50)	28.49 (- 8.22)	19.87 (- 8.99)	15.88 (- 9.37)	13.44 (- 9.20)
Orissa	88.76 (+ 12.41)	53.25 (+ 9.16)	43.28 (+ 7.18)	32.88 (+ 1.85)	27.02 (- 1.54)	22.94 (- 3.22)
Punjab	95.78 (+ 3.59)	81.93 (+ 1.85)	76.88 (+ 4.76)	68.90 (+ 7.35)	62.73 (+ 7.58)	56.97 (+ 6.84)
Rajasthan	85.14 (+14.61)	28.38 (- 13.44)	19.01 (- 11.36)	12.41 (- 8.56)	9.95 (- 7.43)	8.54 (- 6.76)
Tamil Nadu	100 (+ 1.68)	91.48 (+ 16.00)	91.00 (+ 19.72)	88.32 (+ 22.64)	84.80 (+ 22.73)	79.91 (+ 21.33)
Uttar Pr.	85.78 (+ 16.39)	32.57 (- 1.67)	25.72 (- 0.33)	20.29 (- 0.73)	17.80 (- 1.28)	15.98 (- 1.74)
W. Bengal	95.45 (+ 16.51)	67.48 (+ 37.03)	61.87 (+ 42.72)	54.45 (+ 44.17)	49.39 (+ 42.33)	44.95 (+ 39.48)
New Delhi	96.39 (+ 11.77)	48.36 (- 10.68)	46.42 (- 3.85)	42.26 (- 0.45)	38.61 (+ 0.30)	34.70 (+ 0.31)
Coeff. of variation [c/]	**0.76 (+0.11)**	**0.34 (- 0.01)**	**0.41 (- 0.03)**	**0.48 (- 0.05)**	**0.52 (- 0.05)**	**0.54 (- 0.05)**

[a/] Changes from 1993 are indicated in parenthesis

[b/] v=1 corresponds to an equal weight on all individuals so the score is the percentage of population immunized; v=2 uses the implicit weight of the standard concentration ratio; v=8 gives most of the weight to immunization in the lowest wealth quintile. Methodology from Wagstaff (2002)

[c/] Calculated as the standard deviation of the index divided by the all India average.

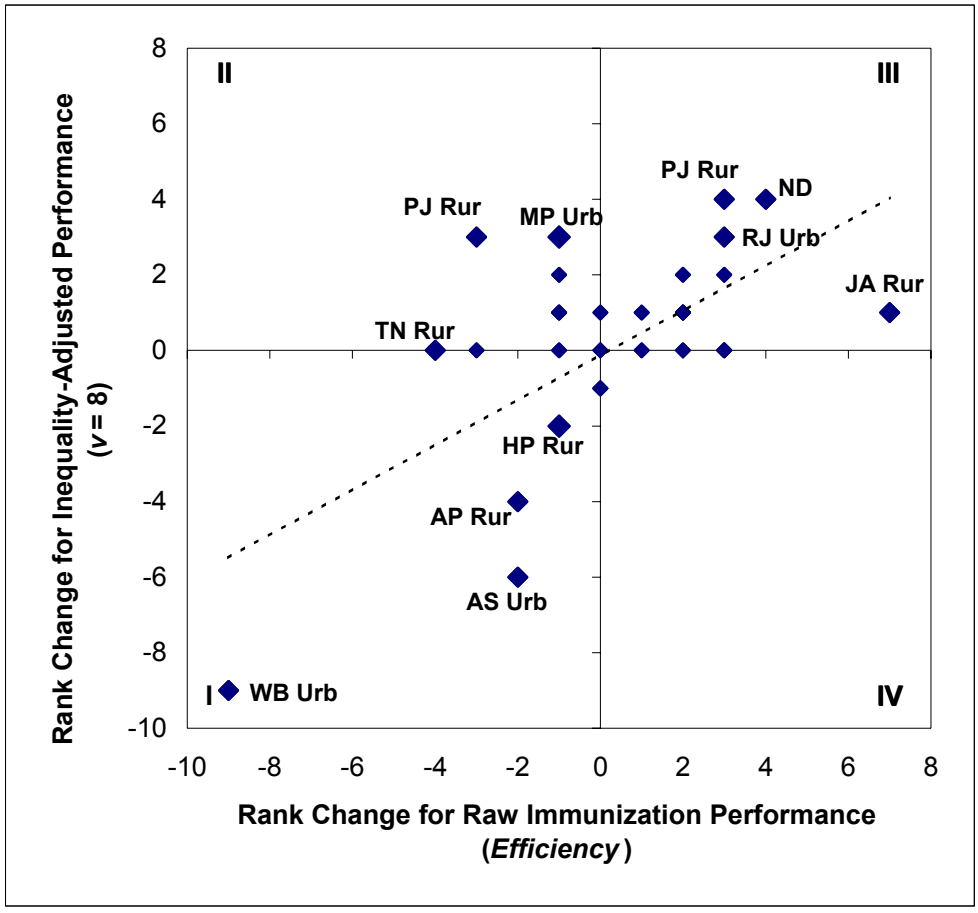
Table 5: State Rankings

Immunization level	State	Rank Change for Inequality-Adjusted Immunization Scores, 1992/3 to 1998/9				
Raw Rank 1998/9	*Inequality aversion:* [a/]	*v=1*	*v=2*	*v=4*	*v=6*	*v=8*
	Rural Areas					
1	Tamil Nadu	- 4	- 1	0	0	0
2	Himachal Pr.	- 1	- 2	- 4	- 2	- 2
3	Madhya Pr.	- 3	+ 3	+ 3	+ 3	+ 3
4	Punjab	+ 3	+ 5	+ 6	+ 5	+ 4
5	Kerala	- 2	- 2	0	0	0
6	Haryana	+ 2	0	0	+ 1	+ 1
7	Karnataka	- 1	- 1	0	0	0
8	Andhra Pr.	- 2	- 2	- 4	- 5	- 4
9	Jammu	+ 7	+ 2	+ 1	+ 1	+ 1
10	Gujarat	+ 1	+ 1	+ 1	+ 1	0
11	Orissa	0	0	0	- 1	- 1
12	W. Bengal	- 1	0	0	+ 1	+ 1
13	Uttar Pr.	- 1	- 1	- 2	- 2	- 2
14	Assam	- 1	- 2	- 2	- 2	- 2
15	Maharashtra	+ 3	0	0	- 1	0
16	Rajasthan	0	0	+ 1	+ 1	+ 1
17	Bihar	0	0	0	0	0
	Urban Areas					
1	Tamil Nadu	- 3	- 3	- 1	0	0
2	Punjab	- 1	0	0	0	+ 1
3	Himachal Pr.	+ 2	+ 2	+ 2	+ 1	0
4	Jammu	+ 2	+ 2	+ 2	+ 2	+ 1
5	Kerala	- 1	- 1	- 3	- 3	- 2
6	Madhya Pr.	- 1	+ 3	+ 3	+ 3	+ 3
7	Haryana	+ 2	+ 1	0	+ 2	+ 2
8	W. Bengal	- 9	- 9	- 8	- 9	- 9
9	Gujarat	- 1	0	0	+ 1	+ 1
10	Andhra Pr.	- 1	- 2	- 1	- 2	- 2
11	Karnataka	+ 3	+ 3	+ 2	+ 2	+ 2
12	Orissa	- 1	+ 1	+ 2	+ 2	+ 2
13	New Delhi	+ 4	+ 3	+ 4	+ 4	+ 4
14	Assam	- 2	- 3	- 5	- 6	- 6
15	Maharashtra	+ 3	- 1	0	0	0
16	Uttar Pr.	+ 1	+ 1	+ 1	+ 1	+ 1
17	Rajasthan	+ 3	+ 4	+ 3	+ 3	+ 3
18	Bihar	0	- 1	- 1	- 1	- 1

[a/] v =1 corresponds to an equal weight on all individuals so the score is the percentage of population immunized; v=2 uses the implicit weight of the standard concentration ratio; v=8 gives most of the weight to immunization in the lowest wealth quintile. Methodology from Wagstaff (2002)

A graphical representation of changes in rankings helps classify states into efficiency achievers or/and equity achievers. Figure 3 represents movements in rankings of each state's immunization performance in urban and rural areas along dimensions of efficiency (measured by the overall mean immunization level, or v=1 of the Wagstaff index) and equity (measured by the Wagstaff index with the highest level of inequality aversion, v=8). [10] Quadrant I represent areas that improved their rankings in both efficiency and equity while quadrant III includes areas that dropped on both efficiency and equity rankings. Quadrants II and IV include states that improved in one dimension but lost ground in the other.

Figure 3: Rank Changes by State and Urban/Rural Areas - Equity versus Efficiency



[10] Urban areas are ranked against other urban areas and rural areas against other rural areas in each of the 1992/93 and 1998/99 surveys.

The largest movement up the rankings for both efficiency and equity was the urban areas of the state of West Bengal, moving up 9 spots on both scales. [11] Other good performers are urban Assam, rural Andhra Pradesh, and rural Himachal Pradesh. Each of these areas was able to improve their national position in terms of the level of immunization and the degree to which it is reaching the poor. Notable among states that lost ground in both efficiency and equity are the capital New Delhi, rural Punjab, and urban Rajhastan.

4. Efficiency versus Equity

The absence of states in quadrant IV of Figure 3 indicates that no states have improved their equity rankings while losing ground in overall immunization performance. This deserves a closer look as we often assume the existence of an equity-efficiency tradeoff. A trend-line fitted to the data in Figure 3 indicates that relative efficiency and equity achievements are positively correlated. The correlation coefficient between changes efficiency rankings and changes in equity rankings by states is 0.61 (using both rural and urban areas). The strongest relationship is in urban areas with a correlation coefficient of 0.77 (0.31 in rural areas).

When looking at changes in achievement rather than rankings, a few states show sign of a tradeoff but the pattern is by no means prevalent. [12] Jammu is the only state in rural India where improvement at the low-income levels was accompanied by lower overall performance. In urban areas, four states show that pattern (New Delhi, Jammu, Karnakata, and Bihar; New Delhi showing the largest tradeoff).

In order to better quantify the relationship between efficiency and equity improvements, we calculate correlation coefficients between different measures of efficiency and equity using Wagstaff indices (Table 2). Let W_a be the Wagstaff index for immunization with inequality aversion coefficient v=a, and let dW_a be the six-year change in W_a. The get a measure of equity using the Wagstaff index we can look at the ratio of the adjusted measures to the unadjusted levels (W_a/W_1). A positive correlation indicates that states with higher immunization rates are also relatively less unequal. We find that this is the case in India although the correlation decreases with the degree of inequality

[11] The state of West Bengal appears to have gained from having a variety of health sector projects related to immunization occurring in urban areas during the 6 year period between the two surveys. Examples include a project on integrated population activities that address health and population services in the urban setting. It is likely that this specific project contributed to the jump in efficiency and equity that is documented in this paper, but detailed evaluation of all possible contributing factors is needed to help other states learn from the success in West Bengal.

[12] To really get at the notion of tradeoff we normally would need to keep total resources devoted to immunization constant. In the following we use the word tradeoff to indicate a negative or positive relationship between efficiency and equity improvements recognizing that different states used different amounts of resources to improve immunization outcomes and health care in general.

aversion (Table 6). We also look at the six-year improvement in the non-adjusted immunization rates (dW_1) and the change in the Wagstaff index with highest degree of inequality aversion (dW_8). We find the correlation to be positive and high both for urban and rural areas (0.89 and 0.85 respectively), indicating some evidence of complementarity. Finally, to better get at the notion of tradeoff, we look at the correlation between changes in levels and the difference between inequality-adjusted changes and the non-adjusted change. A large negative difference (dW_a-dW_1) indicates that higher income groups benefited most; a large positive difference indicates higher income groups benefited less; and a small or no difference indicates that improvements were evenly distributed among wealth quintiles. A positive correlation therefore indicates that higher efficiency improvements are accompanied by improvements in equity whereas a negative correlation indicates a tradeoff. Table 6 reports the correlation coefficients. We note some evidence of a tradeoff in rural areas for inequality aversion v=4 and higher. There is no evidence of a tradeoff in urban areas.

Table 6: Efficiency-Equity Relationship: Rural and Urban India

	Correlation Coefficients	
	W_1	
With:[a/]	Rural Areas	Urban Areas
W_2/W_1	0.84	0.63
W_4/W_1	0.77	0.63
W_6/W_1	0.72	0.65
W_8/W_1	0.69	0.67
	dW_1	
With:[b/]	Rural Areas	Urban Areas
dW_8	0.85	0.89
dW_2-dW_1	0.14	0.33
dW_4-dW_1	-0.11	0.27
dW_6-dW_1	-0.22	0.21
dW_8-dW_1	-0.29	0.13

[a/] W_a is the Wagstaff index where the immunization level is adjusted with inequality aversion v = a
[b/] dW_a is the change in W_a between 1993 and 1999

Finally we pool the rural and urban data to run ordinary least square regressions on the 35 state level averages (17 states divided into rural and urban areas plus New Delhi) to obtain the following relationships:

$$\text{Model 1:}\quad dlnW_1 = \underset{(0.08)}{0.45} \underset{(0.001)}{- 0.004 \times W93} \underset{(0.07)}{+ 0.41 \times GAP93} \underset{(0.04)}{+ 0.48 \times dlnW_8} + e_1$$

$$\text{Model 2:}\quad dlnW_8 = \underset{(0.19)}{-1.36} \underset{(0.003)}{+ 0.015 \times W93} \underset{(0.07)}{- 0.44 \times GAP93} \underset{(0.23)}{+ 1.53 \times dlnW_1} + e_2$$

where $dlnW_a$ is the six-year change in the $ln(W_a)$, W93 is the initial unadjusted immunization level, GAP93 is the initial gap between W_8 and W_1 (W_8-W_1), and e_1 and e_2 are the OLS residuals. Standard errors are given in parenthesis below the estimated coefficient. All coefficients are statistically significant with α=0.01 or better and adjusted R-squares are 0.81 for model 1 and 0.73 for model 2. The negative coefficient on W93 in model 1 indicates overall convergence in levels whereas the positive coefficient in model 2 indicates that the higher the initial immunization level, the easier it is to reach lower income groups. The signs of the coefficients on the GAP93 variable reveal that states with higher initial wealth-based immunization inequality have least improved in lower income groups but most improved in higher income group. This finding indicates divergence on the equity front but could be explained by persistent state-specific preferences rather than inertia. Finally, the positive coefficients on $dlnW_8$ in model 1 and $dlnW_1$ in model 2 indicate that the higher the overall improvement, the more lower income groups benefit and vice versa. The analysis overall tends to support the hypothesis of complementarity between efficiency and equity. At least, the data does not provide any strong evidence of a tradeoff. We conclude that efforts directed toward the poor are not necessarily made at the expense of overall performance in immunization rates and are likely to contribute positively to overall outcomes.

5. Summary of findings and conclusions

The availability of nationally representative household surveys with almost identical sets of questions completed six years apart offers a wonderful opportunity to measure and evaluate the performance of the health sector in India. Immunization is used as a health system output marker for the public effort and commitment to improving the health of the population because immunizing children is a proven cost effective health service, which continues to be dominated by the public sector in India.[13] Another attractive element of the two household surveys being used in this paper is that the samples sizes are large enough to allow not only to look at the national picture but construct measures of performance (equity and efficiency) at the sub-national level.

At the national level, we find major improvements in outreach in urban and rural areas with a clear drop in the percentage of children that received no immunization, while at the same time full immunization rates are almost stagnant. The data seems to indicate a successful effort in addressing complete system failure that is captured by the no immunization variable, but an expanding partial failure of continuity of services that is reflected in the increasing population of children with only

[13] While most clinical and some preventive services are dominated by the private sector in India –mostly unqualified private providers– more than 90 percent of immunization services are delivered by the public sector (Peters et al, 2002).

partial immunization.[14] The distributional analysis using the concentration index as in Pande and Yazbeck (2003) shows a decrease in wealth-based inequality in urban but not rural areas. More revealing than the concentration index, Wagstaff's extended achievement index applied to immunization allows us to pinpoint whether the gains over the six-year period were more or less equally distributed across wealth quintiles. The numbers at the national level show that higher inequality aversion reduces the achievement index for rural India whereas it greatly increases that of urban areas. Looking at gender inequality, the issue of continuity emerges again. Indeed, we find that the gender gap decreases, disappears, or even reverses when looking at cases of complete system failure but holds steady or increases for full immunization.

Pande and Yazbeck (2003) showed the importance of looking beyond national averages in the case of India. The state level findings summarized here confirm a strong and continuing heterogeneity between states and the persistence of a North/South divide, especially when looking at full immunization.[15] All Indian states have greatly reduced or eliminated cases of total system failure and efforts need now be directed to encouraging families to complete immunization shots for all their children. The analysis of change over the six-year period at the state level was particularly useful in assessing whether efforts in improving the distribution of immunization outcomes, and in particular to reach the poorest income groups, were made at the expense of overall improvement in immunization rates. We found no evidence of such a tradeoff in India.

Learning from failure in some parts of India is as important as learning from the success in other parts, and having the outcome data summarized in this paper provides policymakers in India and elsewhere both the ability to focus their policy research agenda and establish benchmarks that they can use in defining realistic objectives and targets for the future.

[14] Continuity in this context refers to demand and supply failures where children that get some of the immunization package fail to complete the set of immunization available at the public sector; for a discussion of continuity of health services failure see Claeson et al., 2001.

[15] State level results on gender inequalities are not reported in this paper but are available from the authors. States that noticeably focused on reducing total system failure for girls include Karnakata, Kerala and West Bengal although results for full immunization showed that urban areas of Kerala improved more for boys than girls and so did both urban and rural areas of West Bengal. Noticeable among states where progress in partial immunization was significantly lower for girls than boys were Haryana, Jammu, and Andhra Pradesh, while Madhya Pradesh looks worst in full immunization.

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