Did Gujarat Switch to a Higher Growth Trajectory Relative To India under Modi?

A Rejoinder

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In our essay "Did Gujarat's Growth Rate Accelerate under Modi?" (EPW, 12 April) we tried to answer the question whether Gujarat's growth rate accelerated relative to the national trend after Narendra Modi became chief minister in 2001. Here we present additional evidence in support of our basic finding: there does not appear to be any differential acceleration in Gujarat's growth in the 2000s, when Modi was in power, relative to the 1990s, both with respect to the country as a whole, as well as other major states. This is robust to using alternative measures of state income, alternative methods of computing growth rates, alternative methods of testing for differential trend break, and keeping or dropping the year 2000-01, an outlier year for which Gujarat experienced negative growth rate due to the earthquake. Due to space constraints and for the sake of comparability with related work (Dholakia 2014), we only report results that use the level of GSDP as the measure of state income, and the log-linear method of calculating the trend rate of growth. We also respond to some points raised by critics of our approach (e g, Ravindra Dholakia in this issue of EPW).

1 Testing for Trend Break using the Difference-in-Difference Method

To show Modi's rule had a positive effect on Gujarat's growth path, one could argue that Gujarat grew faster than other states during this period, or that it grew faster compared to its own previous growth record. Both methods are unsatisfactory. It is possible Gujarat increased its growth rate under Modi, but all-India growth rates may also have increased during the same period. Similarly, it is possible Gujarat grew faster than rest of India under Modi, but that may have been true in the earlier period too. Given this, the standard approach is to use the method of "difference-in-difference". Let γ_T^G and γ_T^I denote the growth rate of Gujarat and India over some time interval T (=1,2). The difference-in-difference estimate is:

$$\delta = (\gamma^G_2 - \gamma^G_1) - (\gamma^I_2 - \gamma^I_1) = (\gamma^G_2 - \gamma^I_2) - (\gamma^G_1 - \gamma^I_1).$$

Notice that we can have $\gamma_2^G - \gamma_1^G > 0$ or $\gamma_2^G - \gamma_2^I > 0$, and yet have δ positive, zero, or negative.

Let s and t (=0,1,2,..) denote state and time, respectively y denote state income, and ε denote the error term. The equation to estimate log-linear trend is:

$$\log y_{st} = a_s + \alpha t + \varepsilon_{st}.$$

Suppose we want to test for a trend break in year $t = T$. Let D_T be a dummy variable that takes on the value 1 for $t \geq T$, and 0 otherwise. The standard method allows for a break both in the intercept and the slope:

$$\log y_{st} = a_s + \alpha t + \beta D_T + \gamma t * D_T + \varepsilon_{st}.$$

The coefficients α and γ capture the average growth rate over the entire period, and the increase (if any) in the growth rate from time T onwards, respectively.

We carry out two sets of empirical exercises.

First, we look at Gujarat and all-India data for the period 1981-2011. Let $s = G$ stand for Gujarat and $s = I$ stand for India. Then to test for trend break in the differences in differences, we look at $\frac{y_{Gt}}{y_{It}}$. Taking logs, this is $\log(y_{Gt}) - \log(y_{It})$. We estimate an equation similar to the one above, except for now α and γ will capture the average difference between Gujarat's growth rate and the national growth rate, and by how much this increased starting 2001, respectively. With T=2001, we find that γ is positive but not statistically significant at 1% or 5% levels (see Table 1, column 5). Since 2000-01 is an outlier due to negative growth rate in Gujarat owing to the earthquake, we test the trend break model excluding 2000-01 and the results are qualitatively similar (column 6). On the other hand, when we test for trend break in 1991 *and* 2001, we find that the former is significant at 5% while the latter continues to remain insignificant,

Table 2: Testing for Differential Trend Break in 1991 and 2001, GSDP

	Log(GSDP Gujarat) – Log(GSDP India)	
	All Years	Excluding 2000
	(1)	(2)
Trend (1981-2011)	-0.002	-0.002
	(0.007)	(0.006)
Trend (1991-2011)	0.010	0.021**
	(0.009)	(0.009)
Trend (2001-2011)	0.010	-0.000
	(0.009)	(0.008)
Post 1991	0.053	0.025
	(0.054)	(0.048)
Post 2001	-0.068	-0.146**
	(0.053)	(0.053)
Constant	0.200***	0.200***
	(0.035)	(0.031)
Adj R-sq	0.57	0.68
No of observations	31	30

Table 1: Testing for Trend Break in 2001, GSDP

	Log(GSDP Gujarat)		Log(GSDP India)		Log(GSDP Gujarat) – Log(GSDP India)	
	All Years	Dropping 2000	All Years	Dropping 2000	All Years	Dropping 2000
	(1)	(2)	(3)	(4)	(5)	(6)
Trend (1981-2011)	0.041***	0.042***	0.034***	0.033***	0.007***	0.009***
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
Trend (2001-2011)	0.040***	0.039***	0.029***	0.029***	0.011	0.009
	(0.007)	(0.007)	(0.002)	(0.002)	(0.006)	(0.006)
Post 2001	-0.059	-0.081	-0.005	0.002	-0.055	-0.083
	(0.050)	(0.051)	(0.016)	(0.016)	(0.044)	(0.043)
Constant	2.643***	2.634***	2.476***	2.479***	0.167***	0.155***
	(0.029)	(0.029)	(0.009)	(0.010)	(0.026)	(0.025)
Adj R-sq	0.98	0.98	1.00	1.00	0.58	0.63
No of observations	31	30	31	30	31	30

Standard errors in parenthesis. ** and *** indicate statistically significant at 5%, and 1% in this and the subsequent tables.

when 2000-01 is excluded (see Table 2, column 2).

Second, we use data from all 16 major states, and estimate the following equation (and some variants of it):

$$\log y_{st} = a + \alpha t + \beta D_T + \gamma t * D_T + \text{Gujarat} + \alpha' \text{Gujarat}.\, t + \beta' \text{Gujarat} * D_T + \gamma' t * \text{Gujarat} * D_T + \varepsilon_{st}.$$

The differential trend growth rate estimate in Gujarat compared to rest of India after the trend break year T relative to before is captured by γ'. Table 3 reports the results using this alternative method. Our results remain similar to that of Table 1: there is no significant trend break in 2001 (column 1), and that the trend break in 1991 is highly significant once 2000-01 is dropped (column 4). We also estimate a similar equation but with a full set of year and state fixed effects (column 2), as well as estimate both equations dropping 2000-01 (columns 3 and 4). The results remain similar.

We also tested this non-parametrically by interacting the Gujarat state dummy with individual year fixed effects. This is related to Figure 2 in Ghatak and Roy (2014), except here we have the level of GSDP rather than NSDP per capita. Also, here we use state-level observations from all 16 major states, controlling for state- and year-fixed effects, as opposed to Gujarat and all-India only. We find that the regression coefficients (capturing the differential growth rate in Gujarat relative to rest of India for each given year) are statistically significant at the 1% level since 1992 for all years except for one.

2 The Results Presented by Dholakia

Now we turn to discussing the evidence that Dholakia presents. In Table 1 of his comment he presents results from two methods of computing growth rates of GSDP for both Gujarat and India. It turns out that the difference-in-difference estimate that he obtains is actually *higher* for the method he criticises us for using (average growth rates) than the one he prefers (log-linear trend rate). That aside, both these estimates are higher than the estimates we obtain. Our estimates for trend growth rates of Gujarat and India are very similar to Dholakia's for the 1990s, but are lower for the 2000s. Our estimates for the 2000s include 2011 while Dholakia stops at 2010. In 2011, growth in most states in India, including Gujarat, slowed somewhat and this may be one reason behind the discrepancy between these estimates for the 2000s. Given that there are only 11 and 12 observations available to calculate the growth rates between 1990 to 2000 and 2000-11, one data point can make a big difference in the estimates. For exactly the same reason, how the observation for 2000-01 is treated turns out to be important. In this year, GSDP in Gujarat *fell* by 4.9% due to the Bhuj earthquake while the all India GSDP *increased* by 4.3%.

We too found the difference-in-difference estimate to be higher when we use Dholakia's choice of time periods irrespective of which method of computing growth rates are used. In Table 4, we present our estimates. Our difference-in-difference estimate is 1.01. When we drop 2000-01, this goes down to -0.07.

Table 4: Growth Rate of GSDP Level (Log-Linear Trend)

State	All Years			Excluding 2000-01		
	1990-2000	2000-11	Diff in Diff	1990-99	2001-11	Diff in Diff
Gujarat	7.07	9.82		7.97	9.85	
India	5.92	7.66		5.93	7.88	
Diff	1.15	2.16	1.01	2.04	1.97	-0.07

What Table 4 suggests is that the estimates would vary depending on whether one is using the 2000-01 observation, or the start year and the end year. What we meant by the results being qualitatively similar is not that they will not change at all. Rather, the fact that the estimate never being very high (Dholakia's own calculation finds it to be 1.55) and are highly variable, suggests that they are unlikely to be statistically significant. This is precisely what we have rigorously established in the earlier section.

Turning to Dholakia's evidence on trend break, it appears that he is looking at Gujarat's growth rate only. The entire point of difference-in-difference analysis is to show whether there was a *differential* trend break in Gujarat, since there was a trend break for India starting 2001 as well. Still, interestingly, he finds that using the latest base year (2004-05, the same as ours) the endogenously identified trend break points are 1971-72, 1984-85, and 1999-2000. This is obviously not the most convincing evidence in favour of a Modi effect, as he came

Table 3: Testing for Trend Break in 1991 and 2001, GSDP (using data from all states)

	Log(GSDP)			
	All Years		Excluding 2000	
	(1)	(2)	(3)	(4)
Trend (1981-2011)	0.050***	0.046***	0.050***	0.046***
	(0.019)	(0.004)	(0.019)	(0.004)
Trend (1991-2011)	0.004	0.005	0.005	0.005
	(0.027)	(0.005)	(0.030)	(0.005)
Trend (2001-11)	0.023	0.023***	0.022	0.023***
	(0.026)	(0.005)	(0.029)	(0.005)
Post 1991	-0.013		-0.016	
	(0.157)		(0.160)	
Post 2001	-0.061		-0.070	
	(0.160)		(0.184)	
Gujarat	0.278***		0.278***	
	(0.103)		(0.103)	
Gujarat*Trend (1981-2011)	-0.001	-0.001	-0.001	-0.001
	(0.020)	(0.005)	(0.020)	(0.005)
Gujarat*Trend (1991-2011)	0.019	0.019	0.029	0.029***
	(0.030)	(0.012)	(0.032)	(0.011)
Gujarat* Trend (2001-11)	0.004	0.004	-0.006	-0.006
	(0.028)	(0.011)	(0.030)	(0.011)
Gujarat*Post 1991	0.037	0.037	0.010	0.010
	(0.172)	(0.066)	(0.173)	(0.062)
Gujarat*Post 2001	-0.055	-0.055	-0.130	-0.130**
	(0.173)	(0.064)	(0.192)	(0.060)
State fixed effects	No	Yes	No	Yes
Year fixed effects	No	Yes	No	Yes
Adj R-sq	0.36	0.99	0.37	0.99
No of observations	496	496	480	480

to power in 2001. If Dholakia himself finds no evidence of trend break in the post-Modi period, then what is the debate about? He does report that relevant 95% confidence interval for the last break point is 1998-2001 but our results suggest that this effect will disappear if the observation for 2000-01 is dropped. Hence what Dholakia identifies as a possible trend break in 2001 can be explained as recovery from the earthquake.

3 Response to Dholakia's Criticisms of Our Approach

Dholakia raises a number of questions about our approach. He does make some points that are correct, and some points that are relevant. Unfortunately, the points that are correct are not relevant, and the points that are relevant are not correct. To rebut his comments point by point would take us far beyond the constraints on space here. We will mention just a salient few.

First, he repeats some well-known properties of geometric vs arithmetic means and criticises us for using simple average of year-on-year growth rates in environments where there is volatility. He is correct, and that is precisely why we presented our key results for both methods of computing growth rates, namely, the simple average, as well as the log-linear trend rate. He appears to have overlooked this when he asserts that we have rejected the log-linear trend rate over other "less rigorous methods".

Second, he writes at length about the growth rate in the 1980s, which is not at all central to our argument. We mentioned it because Arvind Panagariya ("Here's Proof That Gujarat Has Flourished under Modi", *Tehelka*, 29 March 2014) mentions it as evidence in favour of the view that it is not true that Gujarat has always grown faster than India, citing Dholakia's earlier work. Our goal was to check the robustness of this conclusion. The core issue is whether there was a relative acceleration in Gujarat's growth rate in the 2000s relative to the 1990s, not what happened in the 1980s.

Third, he quotes us saying that our results are unchanged irrespective of how growth rates are calculated. He then asserts how wrong we are since our own paper shows evidence to the contrary. He misses the fact that we are referring not to the growth rates but to the difference-in-difference results. Indeed, they do not change qualitatively when different methods of calculating the growth rates are used, from the point of statistical significance.

Fourth, he claims we misinterpret our own results, which show an improvement in Gujarat's relative growth performance in the 2000s than in the 1990s. All we can say is that statistical significance is the key, and point the reader to the relevant parts of our discussion in Sections 1 and 2.

4 Conclusions

We believe academic debates should be aimed at generating more light than heat. In any case, given the norms of our discipline, a single t-statistic that shows whether some effect is statistically significant or not, is far more persuasive than thousands of words of criticism or accusations of bias or splitting hairs over peripheral issues.

We are all entitled to our opinions and biases, partisan or otherwise. However, we are not entitled to our own facts, or methods of analysing the facts. It is well known that in empirical analysis the results change if we change the method of estimation or use different time intervals or keep or drop outliers. Therefore, it is perfectly possible for two pieces of research to come up with different estimates. But that is precisely why it is important to do robustness checks – for example, in this context, varying the method of estimating growth rates, the start or the end dates in computing the growth rates, or the measure of state income used. Since the results are likely to vary, rather than cherry pick them, the correct procedure is to test for statistical significance. This is what we have done here, and have reached the same conclusion as before: Gujarat grew faster than India in the 1990s and 2000s, but the margin of difference between its growth rate and the national growth rate did not increase significantly after 2001.

This does not mean that Modi does not deserve any credit for sustaining an already good growth performance or that there may not exist other economic indicators in terms of which Gujarat has done well under Modi. However, in terms of the most obvious economic indicator, namely, state income, there is no statistically significant evidence in favour of the view that Modi had a transformative effect on the Gujarat economy given the path it was already on since the early 1990s. We understand the compulsions of political campaigns. However, it is baffling when scholars push a view that their own research shows not to have convincing empirical support.

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