# Monitoring Structural Changes in NER: -An Empirical Analysis of Mizoram

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# Monitoring Structural Changes in NER:
## *-An Empirical Analysis of Mizoram*

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**Abstract**:

*This paper adopts a recent development in the estimation and testing of multiple structural breaks in linear growth model to identify the phases of economic growth in Mizoram since 1980. Breakdates and growth rates of different phases are estimated using the recent developed methodology of Bai and Perron(2003). It is evident from the estimation that most of the breakdates lie mainly in 1984-85, 1992-93, and 1998-99. From the estimation, it is further noticed that GSDP (Gross State Domestic Product) of Mizoram has two breakdates 1984-85 and 1990-91. Corresponding to these breakdates there are three different growth phases are also noticed. During 1980/81-1984/85, the first phase of growth, the economy grows at 11.7% which is declining to 6.55% during 1984/85-1990/91, the second phase and slightly increases the annual growth rate to 6.8% during 190/91-2008/09, the third phase.*

JEL Classification: O11, O47, C13
*Keywords:* Structural breaks, BIC, OLS-CUSUM test, Sectoral linkage.

## 1. Introduction

In this paper, a recent development in the econometrics of estimating and testing for multiple structural breaks in linear models is used to throw light on a topic of some interest to researchers currently the engine of growth in the economy of Mizoram. The main issue of contention is the turning point(s) of economic growth since the 1980s and what has contributed to it. We adopt a methodology that identifies growth regimes endogenously rather than one based on exogenous information such as the date of initiation of a policy change. This immunises the methodology to a researcher's prior assumptions regarding the timing of growth shifts and their likely causes. The methodology that we use is the one developed by Bai and Perron (1998, 2003) to estimate and test for multiple structural breaks in a time series, and subsequently applied by Perron and Zhu (2005) to historical data for 10 OECD economies. We find that this yields results that enhance our understanding of economic growth in Mizoram for close to the half a century just passed.

This paper is an attempt to identify the shift in growth regimes and their respective growth rates by applying a method developed by Bai and Perron and the pattern of changes in sectoral composition that characterizes the economic dynamics using a multi-sectoral endogenous growth framework of Mizoram. Johansen procedure of cointegration analysis is used in order to identify the existence of long-run and dynamic short-run inter-sectoral linkages among different sectors in the economy. The study will be significant since the region is a part of our NER and India. So, understanding the growth regimes and inter-sectoral linkages of different sectors could shed important insights on the development process, and such information should assist policymakers to identify the optimal policies to continue further economic growth in these NER regions. Study of small states of NER is significant because the development of our country is impossible without such small states.

The objectives of this study are:

(1) to monitor the breakdates of the growth of the components of different sectors,

(2) to estimate the phase wise growth rates of different sectors such as primary, secondary and tertiary sectors and their components,

## 2. Methodology and Data

The methodology of the present study consists of two parts. The first part describes the method of finding the breakdates and estimation of period wise growth rates of Mizoram. The second part describes the method of estimation of inter sectoral linkages between the sectors for finding long run and short run linkages between the different sectors.

*2.1 Monitoring economic growth*

The growth rates of aggregate and sectoral GDP may be estimated using the exponential function $\boldsymbol{lnY_t = a + gt + u_t}$, where ***lnY, g, t*** and ***u*** denote the log of income, growth rate, time trend and random disturbance term, respectively. The subscript *t* denotes time. The parameters of the above regression model ***a*** and ***g*** would vary from one growth regime to another, making it necessary to identify the change point. Therefore, we first estimate the breakdates of the above model for aggregate and sectoral GDP and accordingly partition the data to estimate the period wise growth rates. The methodology for estimating the breakdates is explained as follows:

The exponential growth model containing m+1 growth regimes and m break dates ($T_1$ ,…, $T_m$ ) can be written as follows:

$$\left.\begin{array}{ll} lnY_t = a_1 + g_1 t + u_t & t = 1, \ldots . T_1 \\ lnY_t = a_2 + g_2 t + u_t & t = T_1 + 1, \ldots . T_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & \\ lnY_t = a_{m+1} + g_{m+1} t + u_t & t = T_{m+1} + 1, \ldots . T \end{array}\right] \quad (1)$$

Here we adopt the convention that $T_0$=0 and $T_m$=T the total number of observations. The number of break points m and the break dates ($T_1$ ,…,$T_m$ ) are treated as unknown and estimated from the data.

Bai and Perron (1998, 2003) have developed an approach to the problem of identifying breaks in a series based on the least squares principle common to regression analysis. Its superiority draws from the feature that it allows for the simultaneous estimation of multiple breaks. The breakdates are estimated as global minimisers of the sum of squared residuals from an OLS regression of (1) using a dynamic programming algorithm [Bai and Perron 2003]. The procedure is as follows. Given the number of breaks m, for each partition ($T_1$ , …,$T_m$) denoted {$T_p$ } the associated least squares estimates $ß_p$ = (a, g)$_p$ are obtained by minimising the sum of squared residuals $\sum_{j=1}^{m+1} \sum_{T_{j-1}+1}^{T_j} \left[lnY_t - a_j - g_j t\right]^2$, The resulting estimates $\widehat{ß}_p$ are used to compute the sum of squared residuals – denoted $S_T$ ($T_1$ , …,$T_m$ ) associated with the partition {$T_p$ }. Now the estimated breakpoints ($\hat{T}_1$ , …,$\hat{T}_m$ ) are such

that ($\hat{T}_1$ , …,$\hat{T}_m$ ) = $argmin_{(T_1 ,\ldots,T_m)}$ $S_T$ ($T_1$ , …$T_m$), where the minimisation is over all possible partitions ($T_1$ …. $T_m$) such that $T_i - T_{i-1} = h$. Note that h is the minimum length assigned to a segment and T is the *i*th breakpoint. The procedure considers all possible combination of segments and selects the partition that minimises the sum of squared residuals. Thus the least squares estimates of break dates are those that minimise the full sample sum of squared residuals in (1).

The above procedure is used to sequentially estimate the optimal break points for the series starting from one to the maximum allowed by T and h. The next step is to select the number of breaks in the time series. When the number of break points is unknown, a test based on the supF statistic has been proposed [Bai and Perron 1998], to choose the number of breakpoints. An approach which accommodates trending regressors is to use the m Bayesian Information Criteria (BIC). This has been demonstrated to be superior to other information criteria in the determination of the number of structural breaks [Wang 2006]. Here the number of breaks selected is that for which BIC is at a minimum. We adopt this procedure to choose the number of breaks, starting from zero to the maximum. The criterion is particularly appropriate when multiple breaks are considered because it introduces a penalty factor for additional break points which necessarily reduces the sum of squared residuals, as is apparent from below:

$$BIC(m) = ln\hat{\sigma}^2(\mathrm{m}) + \frac{\mathrm{p}^* \ln(\mathrm{T})}{\mathrm{T}}$$

$$p^* = (m+1)q + m + p$$

$$\hat{\sigma}^2 = T^{-1}\sum_{t=1}^{T} \hat{u}_t^2$$

where ***m*** is the number of breaks, q is the number of explanatory variables whose coefficients are subjected to shift and p is the number of explanatory variables whose coefficients are constant. However, a practical problem is that the estimated change in the intercept cannot be a good guide due to contamination and feedback effects between the estimated level shifts and break dates. Here, along with an examination of the estimated intercept shift a visual comparison of the OLS-CUSUM test and ME (Moving Estimates) test has been suggested to verify whether the intercept shift is a true level shift rather than a random deviation away from the trend line. We adopt this approach.

In our estimation of the breakdates the minimum length of a segment 'h' has been fixed at 0.15. This implies a maximum of three breaks or two growth regimes in our sample extending over 1980-81 to 2008-09. A trimming of 15 per cent of the total observations, implied by h = 4, is considered appropriate for a sample size of the present study. Also, a minimum of four years per segment seems reasonable to us when studying long-run growth. We are aware that an element of judgment is involved here; however, the sensitivity of the estimated breakdates to the choice of interval length may be subjected to analysis. Now the search for possible break would be confined to the period 1984-85 to 2004-05. The growth rates across regimes are estimated by imposing kinks at the estimated breakpoints according to a procedure due to Boyce (1986). This maintains the continuity of the exponential trend line at the break points.

## 3. Empirical Analysis, Results and Their Interpretation

The estimated breakdates[1] are presented in Table 1 and the growth rates for the associated sub-periods in Table 2. The breakdate has been estimated allowing for a shift in the intercept alongside a change in the slope coefficient, the case of a pure structural change. Our visual comparison of the OLS-based CUSUM test and moving estimates test (ME) showed that in almost all cases the change in the slope is accompanied by a shift in the intercept.

Table 1: Estimated Breakdates of different sectors of state economy of Mizoram

| Sl. No | Sectors of GSDP | First break | Second break |
|---|---|---|---|
| 1 | **GSDP** | 1984-85(-,t) | 1990-91(-,t) |
| 2.0 | **Primary Sector** | 1984-85(-,t) | |
| 2.1 | Agriculture | 1984-85(-,t) | 1999-00(-,t) |
| 2.2 | Forest and logging | 1987-88(-,t) | 1996-97(+,t) |
| 2.3 | Fishing | 1986-87(-) | 1992-93(-,t) |
| 2.4 | Mining and quarrying | 1999-00(+,t) | |
| 3.0 | **Secondary Sector*** | 1984-85(+,t) | 1998-99(+,t) |

[1] Estimation of breakdates were done using the software package 'Strucchange' in R written by Zeileis, Leisch, Hansen, Hornik, Kleiber and Peters. For details see Zeileis et al (2005).

| | | | |
|---|---|---|---|
| 3.1 | Manufacturing | 1992-93(-,t) | 1996-97(-,t) |
| 3.2 | Construction | 1992-93(+) | |
| 4.0 | **Tertiary Sector** | 1988-89(+,t) | 2001-02(-,t) |
| 4.1 | Trade, Hotels, and Restaurants | 1992-93(-,t) | |
| 4.2 | Transport, Storage and communication | 1992-93(-,t) | |
| 4.3 | Banking and Insurance | 1984-85(-) | 1998-99(+) |
| 4.4 | Real Estate, Ownership of dwellings, Business services and legal services | 1992-93(+,t) | 1998-99(-,t) |
| 4.5 | Public Administration | 1999-00(-,t) | |
| 4.6 | Other Services | 1998-99(-) | |

Note: + and – in parenthesis denote acceleration or deceleration of growth rates and t denotes the trend breaks.

Our first finding is that the growth rate of GSDP shows two shifts, in 1984-85 and 1990-91. This is broadly not in line with the findings of other researchers who have employed, as we have done, the methodology of determining structural break without an arbitrary partitioning of the time series based on priors held. According to the study of Balakrishnan et al (2007), the GDP of India had only one shift which is in 1978-79. Further, the study of Wallack (2003) reported that the GDP series breaks in 1980. During 1980/81-1984/85, the first phase of growth regime the economy grows at 11.7%, which is declining to 6.55% during 1984/85-1990/91, the second phase of growth regime, and further slightly accelerated to 6.8% during 1990/91- 2008-09, the third phase of growth regime.

We find that primary sector, the main components of GSDP which occupy 60% of Mizoram's economy, show deceleration from the shift in 1984-85. Before the shift the economy grows at 13.5% and after the shift, it grows at 2.29%. Similar pattern is also found in Forest and logging and Fishing also. The secondary sector shows two shifts, one at 1984-85 and the other at 1998-99. Before the first shift in 1984-85 the secondary sector of the economy grows only at 4.2% after the first shift the growth rate accelerated to 5.03% and further accelerated to 9.38% after the second shift in 1998-99. Similarly, we found that the tertiary sector has two shifts one at 1988-89 and other at 2001-02. Before the shift, this sector grows at 9.3% and after the first shift it grows at 10.09% and after the second shift the growth rate is 4.4% which is decelerating. The growth rate of aggregate GSDP is found to be

decelerated; the growth rates of secondary and tertiary sectors are accelerating but the growth rates of primary sector is decelerating. Indicating that primary sector occupy the larger share of the economy. We find change in the trend growth rate across all sectors in the economy.

Table 2: Estimated Growth Rates

| Sl. No | Sectors of GSDP | Period I | Period II | Period III |
|---|---|---|---|---|
| 1.0 | **GSDP** | 11.7(5.4)<br>1980/81-1984/85 | 6.55(58.97)<br>1984/85-1990/91 | 6.8(25.13)<br>1990/91-2008/09 |
| 2.0 | **Primary Sector** | 14.25(3.1)<br>1980/81-1984/85 | 2.29(7.16)<br>1984/85-2008/09 | |
| 2.1 | Agriculture | 13.5(2.34)<br>1980/81-1984-85 | 6.39(7.18)<br>1984/85-1999/00 | 1.25(3.04)<br>1999/00-2008/09 |
| 2.2 | Forest and logging | 16.09(3.1)<br>1980/81-1987-88 | -2.89(-0.56)<br>1987/88-1996/97 | 3.43(3.83)<br>1996/97-2008/09 |
| 2.3 | Fishing | 11.8(5.29)<br>1980/81-1986-86 | 5.11(1.2)<br>1986/86-1992/93 | 2.43(3.62)<br>1992/93-2008/09 |
| 2.4 | Mining and quarrying | -6.18(1.89)<br>1980/81-1999/00 | 4.16(0.782)<br>1999/00-2008/09 | |
| 3.0 | **Secondary Sector*** | 4.2(1.59)<br>1980/81-1984/85 | 5.03(8.07)<br>1984/85-1998/99 | 9.38(11.9)<br>1998/99-2008/09 |
| 3.1 | Manufacturing | 14.8(22.3)<br>1980/81-1992/93 | -9.5(-2.19)<br>1992/93-1996/97 | 4.14(2.47)<br>1996/97-2008/09 |
| 3.2 | Construction | 6.65(6.07)<br>1980/81-1992/93 | 9.36(14.27)<br>1992/93-2008/09 | |
| 4.0 | **Tertiary Sector** | 9.3(13.57)<br>1980/81-1988/89 | 10.09(21.4)<br>1988/89-2001/02 | 4.4(10.53)<br>2001/02-2008/09 |
| 4.1 | Trade, Hotels, and Restaurants | 5.2(2.56)<br>1980/81-1992/93 | 1.8(1.49)<br>1992/93-2008/09 | |
| 4.2 | Transport, Storage and communication | 17.9(19.92)<br>1980/81-1992/93 | 7.34(6.96)<br>1992/93-2008/09 | |
| 4.3 | Banking and Insurance | 22.08(8.53)<br>1980/81-1984/85 | 7.8(8.8)<br>1984/85-1998/99 | 14.81(8.83)<br>1998/99-2008/09 |
| 4.4 | Real Estate, Ownership of dwellings, Business services and legal services | 3.8(14.19)<br>1980/81-1992/93 | 10.45(5.33)<br>1992/93-1998/99 | 9.9(13.3)<br>1998/99-2008/09 |
| 4.5 | Public Administration | 7.7(24.36)<br>1980/81-1999/00 | 4.4(3.55)<br>1999/00-2008/09 | |
| 4.6 | Other Services | 7.68(12.3)<br>1980/81-1998/99 | 1.9(2.31)<br>1998/99-2008/09 | |

Notes: (i) All estimates are significant at 1 per cent level, and (ii) in brackets is the concerned period for the reported growth.

Agricultural growth shows a trend break in 1984-85 when growth decelerates. During period I from 1980-81 to 1984-85, the agricultural growth was 13.5% per annum. During the second shift, agricultural growth was declined to 6.39% per annum and further declined to 1.25% per annum. The reason for declining in the agricultural growth is not because of seeds but it also owe to shifting of agricultural labour from agriculture to the mining and quarrying.

The manufacturing sector has two shifts in the growth process, one at 1992-93 and other at1996-97. Before the first shift, this sector grows at 14.8% but after the shift the growth rate become negative and is -9.6%. This shows that a sharp decline in the growth rate of manufacturing after the first shift indicates that there is negative impact of reform process to the economy of Mizoram. The growth of construction is reverse in nature with that of Manufacturing. The sharp decline of growth rate of Manufacturing in Mizoram is because of its starting of the reform process without any proper initiation of industrialisation.

The tertiary sector is disaggregated into four components: "Trade, Hotels and Restaurants", "Transport, Storage and Communications", "Banking and Insurance", "Real Estate, Ownership of dwellings, Business services and legal services", and "Community and Personal Services". Out of the components only Real Estate, Ownership of dwellings, Business services and legal services shows acceleration in its growth rates and before the first shift it grows at 3.8% and after it is accelerated to10.45% and the same rate is maintained after the second shift. Even though the main components of tertiary sector shows deceleration in the growth regimes, the growth rates of each sector remain high as compared to other components of primary and secondary sector. Thus, tertiary sector is very important sector for economic growth in Mizoram.

## 4. Conclusion

We have identified growth regimes in Mizoram since 1980 using a method developed by Bai and Perron. The advantage of this method is that no prior information is imposed on the data, i e, in the language of econometric practice, we have "allowed the data to parametrise the model. There is across-the-board dynamism in the economy of Mizoram during this period of study in that some of the major sectors show acceleration in their rate of growth and some other show deceleration. This converges strongly with the finding of the only other comparable study, by Balakrishnan et al (2007), that break in the growth rate can be established for individual sectors. However, at least two of the three main components of GSDP accelerate prior to that date giving us some idea of the factors underlying the acceleration in aggregate growth. These are the secondary and tertiary sectors, or at least their major components. The acceleration of the secondary sector is owed to construction but not by manufacturing sector.

We find that primary sector, show deceleration from the shift in 1984-85. Before the shift the economy grows at 13.5% and after the shift, it grows at 2.29%. The secondary sector shows two shifts, one at 1984-85 and the other at 1998-99. Before the first shift in 1984-85

the secondary sector of the economy grows only at 4.2% after the first shift the growth rate accelerated to 5.03% and further accelerated to 9.38% after the second shift in 1998-99. Similarly, we found that the tertiary sector has two shifts one at 1988-89 and other at 2001-02. Before the shift, this sector grows at 9.3% and after the first shift it grows at 10.09% and after the second shift the growth rate is 4.4% which is decelerating. The growth rate of aggregate GSDP is found to be decelerated; the growth rates of secondary and tertiary sectors are accelerating but the growth rates of primary sector is decelerating. Indicating that primary sector occupy the larger share of the economy.

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The manufacturing sector has two shifts in the growth process, one at 1992-93 and other at1996-97. Before the first shift, this sector grows at 14.8% but after the shift the growth rate become negative and is -9.6%. This shows that a sharp decline in the growth rate of manufacturing after the first shift indicates that there is negative impact of reform process to the economy of Mizoram. The growth of construction is reverse in nature with that of Manufacturing. The sharp decline of growth rate of Manufacturing in Mizoram is because of its starting of the reform process without any proper initiation of industrialisation.

Out of the four components of tertiary sectors, only Real Estate, Ownership of dwellings, Business services and legal services shows acceleration in its growth rates and before the first shift it grows at 3.8% and after it is accelerated to10.45% and the same rate is maintained after the second shift. Even though the main components of tertiary sector shows deceleration in the growth regimes, the growth rates of each sector remain high as compared to other components of primary and secondary sector. Thus, tertiary sector is very important sector for economic growth in Mizoram.

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