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Publication date:
2010

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Dundee Discussion Papers in Economics

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Working Paper
No. 244
October 2010
ISSN:1473-236X

The Changing Inter-Industry Wage Structure of the Organised Manufacturing Sector in India, 1973-74 to 2003-04

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Abstract

This study examines the inter-industry wage structure of the organised manufacturing sector in India for the period 1973-74 to 2003-04 by estimating the growth of average real wages for production workers by industry. In order to estimate the growth rates, the study adopts a methodological framework that differs from other studies in that the time series properties of the concerned variables are closely considered in order to obtain meaningful estimates of growth that are unbiased and (asymptotically) efficient. Using wage data on 51 manufacturing industries at three digit level of the National Industrial Classification 1998 (India), our estimation procedure obtains estimates of growth of real wages per worker that are deterministic in nature by accounting for any potential structural break(s). Our findings show that the inter-industry wage structure in India has changed a lot in the period 1973-74 to 2003-04 and that it provides some evidence that the inter-industry wage differences have become more pronounced in the post-reforms period. Thus this paper provides new evidence from India on the need to consider the hypothesis that industry affiliation is potentially an important determinant of wages when studying any relationship between reforms and wages.

Keywords: Growth Rate, CAGR, AAGR, Unit Roots, Trend Stationary, Structural Breaks, Real Wages, Inter-industry Wage Structure

JEL Classification: C13, C18, C22, F16, J31, J62

October 2010

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1. Introduction

Common to most other developing countries, the Indian economy has undergone rapid trade liberalisation and industrial deregulation in the 1990s. Despite a considerable debate on the impact of these reforms on the Indian economy, little systematic empirical work has examined the effects of these reforms on industry wages. This paper is a part of an ongoing study of the changing wage structure of the organised manufacturing sector in India and presents new evidence on inter-industry wage differentials.

The modest but growing literature in this field has mainly focused on the relation between trade reforms and relative industry wages by empirically exploring different theoretical channels through which trade liberalisation affect wages. The general trend in the literature on India has been to investigate the determinants of wages and their implications on wage inequality. Two topical studies that deserve mention are by Goldar (2002) and Tendulkar (2003) both of which are mainly concerned with the estimation of wage, labour productivity and employment growth in the pre- and post- reforms period. Both of these studies examine the trends in employment and wages and their linkage with productivity for the Indian manufacturing sector. Similarly, Dutt (2003) and Goldar (2003), who examined the effect of trade protection on average industry product wage[1], did not find any significant relationship between trade and wage growth. On a different side, Banga (2005) examines the impact of FDI, trade and technology on wages and employment, using dynamic panel methods, thereby showing that FDI, trade and technological progress have differential impact on wages and employment. On the other hand, Topalova (2006) explores the causal link between liberalisation and changes in poverty and income inequality by exploiting the variation in the timing and degree of liberalisation across industries, and in the variation in the location of the industries in districts throughout India. He finds that rural areas, with high concentration of industries that were disproportionately affected by tariff reductions, experienced slower progress in poverty reductions. However, for these areas, there was no discernible effect on inequality. Another important issue that the literature has very commonly addressed is the issue of the changing gap in wages between the skilled and unskilled workers in the backdrop of the reforms. In this spirit, Banga (2005b) uses cross- industry panel data estimations to show that wage inequality between skilled and unskilled workers in India

[1] The product wage is the cost of hiring workers faced by the employer as opposed to the wage that workers actually receive.

has increased during the period 1991-92 to 1996-97. On a similar front, Chamarbagwala (2006) uses a non-parametric methodology to investigate the widening skill wage gap and the narrowing gender-wage differential in India in the 1980s and the 1990s. Her findings show that external sector reforms leading to increase in trade in manufactures benefited skilled men but hurt skilled women, whereas outsourcing of services benefited both skilled men and women. Similarly, Sen (2009) presents evidence of a widening wage gap between skilled and unskilled workers, and an increase in relative skill intensity in Indian manufacturing, which he shows to be the direct and indirect effects of the trade reforms.

The above discussion shows that in spite of a modest and growing literature there hasn't been any attempt to explore the inter-industry wage structure in India. The present study contributes to the literature by estimating the growth rates in average real wages for production workers by industry and examining whether there is any evidence of changing inter-industry wage inequality in the organised manufacturing sector in India. The motivation behind this exercise is the growing body of research that suggests that the industry affiliation of worker's is an important determinant of wage as a result of which there might be substantial differences in wages between similar type of workers but employed in different type of industries. Krueger & Summers (1987) point out that this is the case either because of returns to industry-specific skills that cannot be transferred in the short- to medium- run or because of industry rents arising out of imperfect competition. This suggests the possibility of similar types of workers being paid different wages in different industries. If this is really the case then it means that if there are some industries that remain low paying throughout then, workers stuck in such low paying industries will never be able to have higher pay, unless there is perfect mobility of workers across industries and geographical locations. And this becomes particularly serious in the backdrop of some evidence that labour reallocation in the wake of trade reforms is limited in developing countries, possibly due to labour market rigidities [Goldberg & Pavenik (2004)]. Topalova (2004, 2006) also find no evidence of any significant reallocation of labour in a sample of Indian states. Keeping such considerations in mind, this study investigates the inter-industry wage structure over time. The analysis is undertaken for 51 industries of the organised manufacturing sector at the three digit level of the National Industrial Classification, 1998 (NIC-98) for the period 1973-74 to 2003-04.

A handful of recent studies [e.g. Dutta (2007), Mishra & Kumar (2008)] using individual data on wages from household surveys in India estimates the returns to industry affiliation after controlling for individual characteristics[2] and then examines the effect of trade protection on such industry wage premiums. These two studies, using the same dataset on individual wages and using similar analytical approaches[3] convey very contrasting results, which served as a primary motivation behind this ongoing study. Our paper is similar to Dutta (2007) and Mishra & Kumar (2008) in its focus on inter-industry wage differences, rather than on wage differences between skilled and unskilled workers as in Banga (2005b), Chamarbagwala (2006) and Sen (2009). However, in spite of the similarity in spirit, our paper is different from Dutta (2007) and Mishra & Kumar (2008) in both nature and scope. Unlike them, our paper use industries rather than workers as the unit of analysis, as in Hanson and Harrison (1999) and Sen (2009). Since the data on wage rates for similar type of workers (production workers in our case) by industry is continuous and available annually spanning over 31 years, this allows us to explore the time dimension of the changing inter-industry wage structure in a more rigorous manner. As Sen (2009) points out, this is particularly relevant in the Indian case, where trade reforms have been incremental and have taken place very gradually over time and unevenly across sectors. In contrast the wage data for individuals used in Dutta (2007) and Mishra & Kumar (2008) is available for only five years, coinciding with the years that the NSSO conducted employment surveys in the country. Hence these studies based on the NSSO data may not fully capture the impact of the gradual and uneven diffusion of the reforms over many years.

The other significant contribution of this paper that distinguishes it from the existing literature is its methodology to analyse the changing inter-industry wage structure in India in the wake of the economic reforms. In order to study the potential differential impact of liberalisation in different industries, we conduct the analysis at the industry level by estimating, in the first instance, the growth of wages. However, our paper brings out the potential flaws in the conventional methods of measuring growth based on OLS principles that are prevalently used in academic research and highly

[2] The portion of individual wages that accrues to the worker's industry affiliation after controlling for worker characteristics is often referred to as wage premium in the labour economics literature.
[3] While their individual wages data is from the same source and they both use the same analytical framework, their trade data is from different sources. See Dutta (2007) for a detailed exposition.

popularised by international organisations like the World Bank and OECD. This approach, which is based on fitting an exponential trend to a time series, is to regress the natural logarithm of the variable on a constant and a linear trend, where the OLS estimate of the coefficient on the trend is the required growth rate of the variable. We argue that when the natural logarithm of the variable under study contains a unit root and hence is non-stationary, the OLS based technique to estimate growth of the variable will potentially give an estimate that is not a valid representation of the true growth rate. In fact, in the presence of a unit root, the growth rate of a series is not *well defined* in the sense that there is no deterministic component of the growth in the series and that the growth in the series is purely the cumulative impact of a stochastic process. On the other hand, the statistical representation of a series as containing a unit root is not easy to separate from an alternative description which represents the series as fundamentally deterministic (no unit root) but containing a structural break. We reserve a more detailed exposition of this to the methodology discussion in section three below.

The main goal of this paper is to therefore present an empirical basis as well as justification to further explore the relation between liberalisation and wages in India. The paper shows that there is a significant difference in the growth rates of wages by industry, thus implying a growing inter-industry wage inequality. This in turn means that the wage gap between similar types of workers but employed in different industries are increasing. Hence the study provides new empirical evidence from India to support the need to empirically verify the hypothesis that industry affiliation is an important determinant of wages. The rest of the paper is structured as follows. Section two presents a background of the economic reforms in India. A comprehensive discussion of the issues and appropriate techniques in estimating growth rate of wages by industry is presented in the methodology in Section three. In section four, we discuss the data that we use in this study. In section five, we examine the inter-industry wage structure for the organised manufacturing sector in India by presenting our results on the estimation of the growth rates of real wages per worker by industry and discussing the theoretical interpretations and empirical implications. Finally section seven summarises our findings, present some concluding remarks and policy implications of the findings.

2. Background to the economic reforms in India

Since her independence from the British rule in 1947, India had adopted an inward looking policy of import substitution industrialisation (hereafter, ISI) with the ultimate intention of self reliance and industrialisation. The Industrial Policy Resolution of 1948, which marked a fundamental departure from the earlier policy of laissez-faire, as under the British rule, laid the responsibility of initiating and regulating development in key sectors of the economy on the government through planning and state intervention [Kapila (2006)].

Bhagwati & Desai (1970), Bhagwati & Srinivasan (1975) and Srinivasan (2006) point out that throughout the 1960's and 1970's, an elaborate and complex system of government control over production, investment, technology and locational choice, prices and foreign trade was in existence in India following its institution in the mid-1950's. They further point out that such a strategy failed to produce rapid growth, self-reliance and eradication of poverty but rather led to lackluster growth, an internationally uncompetitive industrial structure, a perpetually precarious balance of payments, and, above all, extensive and often successful rent seeking and the corruption of social, economic and political systems.

2.1 Trade and Industrial Reforms: Initial Attempts in 1980s

A systematic analysis of the available literature on India's reform policies show that India's efforts at trade liberalisation roughly started as early as the beginning of the 1980's. The process of relaxation of regulation of industries began still earlier in the 1970's [Panagariya (2004)], although the pace of the reforms picked up significantly only after 1985. There was a gradual liberalisation of import controls in the 1980's as is clearly portrayed by a steady increase in the items of capital and intermediate goods in OGL[4] [see Das (2005) and Panagariya (2004) for a detailed review]. Another important

[4] OGL stands for Open General Licensing. OGL was an instrument of import licensing- one of the most pervasive non-tariff barrier. Any item under the OGL list was allowed to be imported almost freely subject to licensing. However, the use of OGL was circumscribed by the actual user policy, which allowed imports by the importer for his own use and not for trade in that item. Like the OGL, two other instruments of import licensing were the Banned List (did not allow any imports at all) and Restricted and Limited Permissible List (allowed imports under strict regulation). See Das (2001, 2003 and 2005) for a detailed exposition of Trade Policy Instruments and Choudhury (2007) for a review.

source of liberalisation was the decline in the share of the canalised[5] imports in total imports, which fell substantially since 1981 from 67 percent to 50 percent in 1985-86 [Das (2005)] and further declined to 27 percent in 1986-87 [Panagariya (2004)]. Furthermore, Pursell (1992, pg 441) highlights " imports that were neither canalized nor subjected to licensing increased from about 5 percent in 1980-81 to about 30 percent in 1987-88". As far as tariff rates are concerned, two major studies by Das (2003, 2005) pinpoint that most items on which tariff rates were lowered were not manufactured in India. This was essentially done to encourage the modernisation and development of industries which use these items.

It is important to point out here that even though the 1980's witnessed only mere changes in the trade restricting policies of India, with additions and deductions in various lists be it banned, restricted or OGL, mere reductions in tariff rates and fall in share of canalised imports in total imports; these developments represent the first signs of efforts at reducing the degree of trade restrictiveness facing the Indian industries. Apart from trade liberalisation this period also saw the relaxation of domestic industrial controls and related reforms including de-licensing of industries, broad banding (which allowed firms to switch productions between similar production lines), relaxations in the Monopolies and Restrictive Trade Practices (MRTP) 1969 Act, abolition of price and distribution controls on cement and aluminum and a major reform in the tax system including the introduction of MODVAT (Modified Value Added Tax) tax in March 1986. The relaxation of these industrial regulations further reinforced the ongoing trade liberalisation [Panagariya (2004)][6].

2.2 Trade and Industrial Reforms: Radical Changes in 1990s

The considerable but luke warm efforts at liberalisation in the 1980's paved the way for more substantial but systematic liberalisation in the 1990's and beyond. In 1991, a drastic reforms process including trade liberalisation was initiated in the wake of a severe macro-economic crisis faced by the Indian economy. Table 1 shows the reduction in average tariffs in several industrial sectors thus highlighting the immediate impact of the 1991 reforms.

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[5] Sometimes governments exercise control over imports by granting certain organisations (State Trading Agencies or other state owned enterprises) selective monopoly powers to import and export strategic commodities. This process has been termed as canalisation by World Bank (1994).

[6] For a detailed review of industrial liberalisation, see Panagariya (2004) and Joshi and Little (1996).

The economic reforms of 1991 did away with the practice of import licensing. Hasan *et al.* (2007) reports that 26 import licensing lists were eliminated though a "negative list" was created, which included items which required import licensing. The abolition of import licensing was mainly on virtually all intermediate and capital goods [Das (2003, 2005)]. But consumer goods, which accounted for about 30 percent of the tariff lines, still remained under licensing until recently in April 1, 2001, when they were freed of licensing, following a challenge by India's trading partners at the Dispute Settlement Body of the WTO [Panagariya (2004)]. In addition to these, import policy has also seen reforms in the form of substantial reduction in canalisation and a decrease in the share of products subject to Quantitative Restrictions. Table 2 shows the decline of import controls in India in the 1990s relative to the 1980s.

As far as the tariff rates were concerned, India witnessed substantial reductions in both levels and dispersions in tariffs in the 1990s. Average tariffs fell from more than 90% in 1987 to under 30% in 1997 and the standard deviation of tariffs fell by almost 70% between the same periods [Topalova (2004)] as portrayed in Figure 1. With respect to trade policy, the EXIM policies of 1992-1997 and 1997-2003 were aimed to rationalise the tariff structure, simplify the trade procedures and bring transparency to the regime.

The 1991 initiated reforms went beyond trade liberalisation to embrace domestic industrial policy and trade in services. The Industrial Policy of 1991 often termed in Indian economic literature as the New Industrial policy did away with industrial licensing with very few exemptions on grounds of health, safety, security and environmental standards. It also limited public sector monopoly to eight sectors only, which was further trimmed down to include railway transportation and atomic energy only. In addition to these the new industrial policy also relaxed most of the entry restrictions earlier prevalent under the MRTP Act. Furthermore it initiated a policy of automatic approval for foreign direct investment up to 51 percent which has been further relaxed in the subsequent years [Panagariya (2004)]. In addition to industrial policy and trade policy liberalisation, the reforms in the 1990s have witnessed a drastic liberalisation of the services sector including key sectors like banking, insurance and telecommunications, which prior to this were subject to excessive levels of government intervention.

Furthermore, the above reforms were also accompanied by relaxation of exchange controls that acted as an extra layer of restrictions on imports [Panagariya (2004)].

Panagariya highlights that as part of the 1991 reforms, the government devalued the rupee by 22 percent from INR 21.2 to INR 25.8 against the dollar. Later in February 1992, a dual exchange rate system was introduced, which further led India to accept the IMF VIII obligations in 1994, which made the rupee officially convertible on the current account, but importantly, not on the capital account.

2.3 Labour Market Reforms

The labour laws in India essentially cover workers working in the organised sector only. Labour market legislation is enforced through the provisions of different Central Acts and Laws- the Factories Act of 1948 regulates working conditions, the Industrial Disputes Act (IDA) of 1947 and the Industrial Employment (Standing Orders) Act of 1946 regulate employment security and the Trade Union Act (TUA) of 1926 regulates trade union activity.

While a comprehensive review of the labour market legislation in India is beyond the scope of this paper, it is important to highlight that the opinions on the pace and further need of labour market reforms in India remain highly polarised. On one hand, pro-reforms analysts [like, Datta Chaudhuri (1996), Panagariya (2007)] believe that the numerous labour laws in India have created rigidities in the labour market. On the other hand, there are analysts [like, Nagaraj (2002), Dutta (2003)] who offer counterarguments to the above view by highlighting that labour regulations in India are either ignored or circumvented thus rendering them ineffective. In addition to this, Besley and Burgess (2004) point out that firms located in different states in India face different and often confused regulatory environments due to the entitlement of both central and state governments to legislate on labour issues.

The labour market reforms in India have not picked up momentum despite the extensive and radical trade and industrial policy reforms. In fact, Dutta (2007) points out that reforms aimed at increasing flexibility with respect to laying off employees, outsourcing and sub-contracting were initialised only in 2002. Besides, there is a prevalent wage setting system in India, whereby the Wage Boards and Pay Commissions generally sets wages in the public sector, which sets the benchmark for private sector wages. The labour market regulations along with the wage setting system and labour redundancy have introduced rigidities in the organised labour market [Dutta (2007)].

2.4 A Summary of the Reforms

In the above assessment of the reforms in India, which clearly highlight that the economy is in a transition, three key features are worth noting. First, there has been a continuous attempt in the 1980s to relax and simplify certain policy regulations and carry out reforms, albeit half-hearted. This marks India's first attempt at reforms, which is much ahead of the otherwise hyped 1991 episode of reforms. Second, the reforms really took off in the 1990s following the IMF induced structural and macro-economic reforms in 1991. And third, the reforms in the 1980s and 1990s loosened both trade restrictions as well as domestic controls. However, labour market reforms have been weak and there are considerable polarised opinions whether the labour regulations in India have at all created any labour market rigidities.

3. Methodology

When it comes to estimating growth rate of a sufficiently long time series, the most commonly used method is the method of least-squares. The least-square growth rate is estimated by fitting an exponential trend to a time series variable, or alternately, by fitting a linear trend line to the logarithmic values of the variable in the relevant period. In other words, growth rates over long periods of time are estimated by regressing the logarithm of the variable under consideration on a deterministic trend, i.e.,

$$\ln(Y_t) = \alpha + \beta t + \varepsilon_t \qquad (1),$$

The growth rate of the series Y_t is calculated as $g = \exp(\beta)-1$, where β is typically estimated from (1) by OLS. For very small growth rates, β is approximately equal to g and hence the growth rate is often reported as the OLS estimate of β from (1) rather than g. [7] Thus, using (1) to estimate the growth rate of a series corresponds to fitting a trend line to the natural logarithm of the time series under consideration and hence such an estimate of growth rate is equivalent, in theory and principle, to the well known conventional compounded constant annual growth rate (CAGR)[8]. This technique is very

[7] For example, if $\beta = 0.01$, then $g = 0.01005$, or alternatively, when β implies 1% growth, g implies 1.005% growth. While, on the other hand, if $\beta = 0.1$ then $g = 0.1052$, or alternatively, when β implies 10% growth, g implies 10.52% growth.

[8] CAGR is the geometric mean growth rate on an annualised basis. If we assume continuous compounding (i.e. the compounding period is infinitesimally small) of a series, then we have $Y_t = Y_0 e^{\beta t}$, where Y_0 is the initial value of the series at $t = 0$ and β is the CAGR (also called exponential growth rate). Taking natural logarithms on both sides, we get $\ln(Y_t) = \ln(Y_0)+\beta t$, which is equivalent to (1). β can be estimated by OLS and represents the CAGR of the series.

commonly used in the social sciences including economics and financial research. For instance, international organizations like the World Bank and OECD generally use this log-linear trend model based on least square principles to estimate growth rates of various indicator variables for which a long time series is available. Least-squares growth rates are used in the World Bank publications when measuring trend-wise growth in economic variables such as GDP, and GNP per capita (World Bank Statistical Manual[9]). Similarly least-squares growth rates are used by the OECD whenever there is a sufficiently long time series to permit a reliable calculation [OECD (2005)].

The use of the log-linear trend model based on least-square principles to estimate growth rates, as presented in (1), is very common among empirical researchers and has almost become a norm in economic research. However, an important issue that is often not addressed, when using such a model to estimate growth rates, is that what happens when the natural log of the variable [$\ln(Y_t)$] in (1) contains a unit root i.e. it is non-stationary. This is important because to what extent the estimate of growth rate using (1) reflects the stochastic or deterministic component of the equation depends crucially on whether $\ln(Y_t)$ contains a unit root or not. If $\ln(Y_t)$ contains no unit root, then the series is stationary and hence the estimate of growth rate from (1) is a valid representation of the true growth rate. If, on the other hand, $\ln(Y_t)$ contains a unit root implying that the series is not stationary, then the average constant growth rate as hypothesised in (1) is not *well defined*. The reason behind this is that, if $\ln(Y_t)$ is a non-stationary process, then the error term, ε_t, in (1) is *not well-behaved* [10] and hence it is the stochastic component (i.e. ε_t) of (1) that drives Y_t rather than its deterministic component (i.e. t). In fact, it can be shown[11] that the growth in the series is purely the cumulative impact of a stochastic process and hence the OLS estimate of β from (1) would be like some spurious representation of growth, which actually does not exist. In the rest of the paper, we'll refer such an estimate of growth as "*pseudo growth rate*", which should be interpreted with caution. Further, econometrically speaking, under such a situation, α cannot be consistently

[9] For more on growth rate estimation methodology used by the world bank, see (permanent URL at world bank site) : http://go.worldbank.org/6ZTES0VQQ0

[10] This means that the error term is not an I(0) white noise process.

[11] See Chatterji and Choudhury (2010) for a detailed exposition of the theoretical issues and empirical implications on the estimation of growth rates in the potential presence of a unit root.

estimated by any method, and the OLS estimator of β is no longer asymptotically efficient.

Now, it can be argued that the typical way around the non-stationarity problem, as noted above, is to consider a first differenced variant of the log-linear trend model in (1), which gives,

$$\Delta \ln(Y_t) = \beta + u_t \qquad (2),$$

where Δ is the first difference operator, β is a constant and u_t is an I(0) white noise process. The OLS estimator of β in (2) is now asymptotically efficient and is our required estimate of the growth rate of the series. However, this first differenced variant of the log-linear trend model (hereafter, log-difference model) is not free from criticism and it is important to point out three key limitations of this model. First, this method gives an estimate of growth rate (if it exists), which is equivalent, in theory and principle, to the conventional average constant annual growth rate (AAGR)[12], rather than the CAGR. But since AAGR is simply the (linear) average of the period-to-period growth rates, it is more vulnerable to outliers than the CAGR and hence if the growth rate is particularly high (or low) between two consecutive periods for some reason, then this is going to pull up (or down) the estimate of the (constant) average growth rate for the entire period. Second, the conventional statistics (like adjusted-R^2, t-ratios etc.) associated with (1) and (2) would be very different from each other and hence any further statistical inferences based on (1) and (2) may potentially give contrasting conclusions. Third, and most importantly, if the natural log of the time series variable under study contains a unit root and hence is non-stationary at the very first place, then we have already argued that growth is cumulative impact of a stochastic process and under such a situation, it is not clear what does the point estimate from (2) even mean and it should be interpreted with caution. In fact it again gives us a "*pseudo growth rate*" even though, this time, the estimate is asymptotically efficient. Theoretically, when a series is trend-stationary and hence growth rate exists, its estimate from the log-linear method (CAGR) should be identical to that from the log-difference method (AAGR) [Altinay (2004)]. And it is probably for this reason that inferences based on (2) might give contrasting conclusions to that based on (1), as pointed out above.

[12] The AAGR, in principle, is the average of the period-to-period (annual) growth rate of a time-series variable.

While the above noted issue in the estimation of growth rates has not attracted any explicit attention in the economics literature, there have been some recent attempts to address this issue. For example, Baffes and Vallee (2003) and Altinay (2004) highlight that the trend-stationarity versus unit root dichotomy is an important issue to be considered when estimating growth rate of a series using the log-linear trend model. In particular, Baffes and Valle (2003) assess the performance of their growth regressions by exploring the stationarity properties of the error term of the log-linear trend equation [i.e. ε_t is (1)][13] on the basis of conventional Augmented Dickey-Fuller (ADF) tests as well as Monte Carlo simulations. In contrast, we argue that a simpler approach is to follow a two-step procedure. First, determine the stationarity properties of $\ln(Y_t)$, where Y_t is the time-series variable under study. Second, if $\ln(Y_t)$ is trend-stationary, then proceed with estimation of growth rates using (1), or alternatively, if $\ln(Y_t)$ is non-stationary, then proceed with estimation of growth rates using (2). However, we emphasise that when $\ln(Y_t)$ is non-stationary, then the estimate of growth rate of the series from (2) is asymptotically efficient but it is still a "*pseudo growth rate*" and hence should be interpreted with caution.

Thus, we emphasise the fact that the testing of the stationarity of a time series variable is a pre-condition to the estimation of growth rates using a log-linear model as described above. However, under a two step procedure as suggested above, the empirical concern is about the type of the unit root tests used in testing whether the natural log of the variable under study contains a unit root or not. It is now a well known fact in the econometrics literature that the conventional and commonly used Augmented Dickey Fuller (hereafter, ADF) test, based on the statistical methodology put forward by Dickey and Fuller (1979, 1981), is not a very powerful test. In the presence of structural break(s) in a time series variable, the ADF test is biased towards the "*acceptance*" of the null [Perron (1989)], i.e. it is biased towards the unit root hypothesis. The time series literature therefore argues that using such a test would lead one to believe that most series contain a unit root and are hence non-stationary [like in the seminal work of Nelson and Plosser (1982)] when in reality the series might simply be trend-stationary but

[13] In fact, if the error term in (1) follows a first order autoregressive process, $\varepsilon_t = \rho\varepsilon_{t-1} + u_t$, with ρ being the highest autoregressive root and u_t an I(0) white noise process, then it can be shown that $\ln(Y_t)$ is I(1) when ρ=1 and hence it is non-stationary. See Chatterji & Choudhury (2010) for a detailed exposition.

characterised by a structural break, which the test would fail to take into account. Under such circumstances, we would be forced to believe that using (1) to estimate the growth rate of the series would result in an *asymptotically inefficient* estimate which would not be a valid representation of the actual growth rate. This would lead us to take the first difference of (1) in order to ensure that natural logarithm of the series under study is stationary, giving us (2), the limitations of which we have already highlighted above. This clearly highlights the pitfalls of using the conventional ADF procedure to test for a unit root, whose inability to allow for a structural break(s), may wrongly lead to estimate the growth rate using the first differenced model (2), which in turn might result in spurious inferences.

Given the pitfalls of the ADF test, Perron (1989) proposed to allow for one exogenously dated structural break (level break, slope break or both) in the ADF test procedure. However, Christiano (1992) criticised Perron's known (or exogenous) assumption of the break date by arguing that it involves an element of "data mining". Similarly, Zivot and Andrews (1992) argue that Perron's assumption of known breakpoint is based on prior observation of the data and hence problems associated with "pre-testing" are applicable to his procedure. Since then, the ensuing literature addressed this problem of the known break date by adopting a completely agnostic approach, where a complete and systematic search is done to endogenously determine the break date. Some of these include Perron and Vogelsang (1992), Banerjee *et al.* (1992), Zivot and Andrews (1992), Amsler and Lee (1995), Perron (1997), Lumsdaine and Papell (1997), Clemente *et al.* (1998), Lee and Strazicich (2001, 2003), among others. However, in spite of the similarity in the assumption of the endogenous break(s), there are methodological differences among some of these tests. While a complete review of these methodological differences is beyond the scope of this paper[14], we would like to point out that the two key features on which these differences are based are (a) whether the test is based on ADF procedure or otherwise, (b) whether the break is imposed under the null or the alternate hypotheses or both.

[14] For a chronological review of the evolution of the literature on the unit root hypothesis, see Perron (2005) and Glynn *et al.* (2007) and for a detailed exposition of the theoretical issues in some of these methodologies, see Chatterji & Choudhury (2010).

In this paper, we carry out the ADF test, Perron (1989) test (with an exogenously specified date for the break at 1991) and the Lee and Strazicich (2003) test (which endogenously determines two breaks and hence, hereafter, referred as LS2 in the rest of the paper) to test whether the natural log of real wages per worker for a sample of 51 industries from the organised manufacturing sector in India for the period 1973- 2003 (see the data section for more details about the data) contains a unit root or not[15]. The justification for choosing 1991 as the break date in the Perron test is due to India's IMF induced structural and macro-economic reforms in 1991, which marks the change of a policy regime from inward looking industrialisation (ISI) regime towards a outward looking relatively market friendly regime. However, also keeping in view of the evidence that India also witnessed some half-hearted reforms in 1980s and more radical reforms in 1990s, as presented in Section 2, we carry out the LS2 test which endogenously determines two breaks. We summarise the null and alternate hypotheses of these tests that we adopt in this paper in Table 3. When using the Perron and LS2 test, we allow for structural break(s) in the series, based on Perron's (1989) original Model (C)[16], that allows for one level and one slope break and if we can reject the null hypothesis of a unit root, we can carry out the estimation of growth rate using (1). However, in this case, we will have two (or three) estimates of growth rate for a single series: one for the pre-break (or the pre- first break) sample and one for the post-break (or the post- first break/ pre-second break) sample (and one for the post- second break sample). But both (or all three) estimates would be a valid representation of the true growth of the two (or three) sub-samples of the entire period. This would be equivalent to fitting two (or three) separate trend lines, by ordinary least squares, to the two (or three) sub-samples of the natural log of the variable respectively[17].

[15] A more detailed comparison of the results of unit root tests on the same dataset used in this paper with some of the other unit tests [like Zivot & Andrews (1992) and Lumsdaine & Papell (1997)] is presented in our earlier work, Chatterji and Choudhury (2010).

[16] As model (C) is a more general model that allows for both level break and slope break, we prefer this model over Perron's models (A) and (B), which respectively allow for a level break and slope break.

[17] If $\ln(Y_t)$ is trend-stationary with a break, say, at $t = T_B$, where $1<T_B<T$ we cannot use (1) to obtain an asymptotically efficient estimate of the growth rate for the whole period. However, we can use (1) to fit two separate trend lines by OLS to the two sub-periods, $t = 1, 2, \ldots, T_B$ and $t = T_B+1, \ldots, T$, or, alternately, we can use dummy variables for the two different sub-samples, and estimate the growth rates for the two sub-periods by fitting a single equation, as follows: $\ln(Y_t) = \alpha_1 D_1 + \alpha_2 D_2 + \beta_1 D_1 t + \beta_2 D_2 t + u_t$, where D_j is a dummy variable which takes the value 1 in the j-th sub-period and 0 otherwise. The estimates of β_1 and β_2

4. Data and Data Treatment

This study draws data from the EPW Research Foundation (India) who has collated data from the Annual Survey of Industries (ASI), published by the Central Statistical Organisation, Ministry of Statistics and Programme Implementation, Government of India. ASI provides reasonably comprehensive and reliable industrial estimates at a disaggregated level for the organised manufacturing sector in India. It covers the entire factory sector except factories under the control of Defence Ministry, Oil storage depots and technical training institutes. 'Factories' are those which are registered as such under 2m(i) and 2m(ii) of the Factories Act, 1948 which respectively relates to units which employ 10 or more workers with the aid of power and units which employ 20 or more workers without the aid of power. ASI carries out complete enumeration of large factories on a census basis, and the remaining on a sample basis, where 'large units' are defined as factories employing 50 or more workers with aid of power or 100 or more workers without the aid of power. The EPW Research Foundation has collected the primary data from the ASI and has made available continuous annual data on industries from 1973-74 to 2003-04 after carrying out concordance of different series, wherever necessary.

The data from EPW Research Foundation, used in this study, is for 51 industries defined at three digit level of the National Industrial Classification, 1998 (NIC-98) for the period 1973-74 to 2003-04 (henceforth 1973 to 2003). A description of the three digit industry codes is presented in Appendix Table1. This data is particularly interesting because it covers a long and continuous period of time which coincides with India's episode of substantial economic reforms in 1991 that marks the change in the policy regime from a highly restrictive ISI regime to a regime that was characterised by radical reforms of trade, industrial and foreign exchange policies. We therefore emphasise that 1991, which marks the change in the policy regime, potentially represents a structural break in our data. But given the fact that there were some half-hearted reforms in the 1980s, before they fully took off in the 1990s, we might potentially have two structural breaks- one in the 1980s and one in the 1990s.

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are the required growth rates (CAGR) for the two sub-periods. This example can also be extended to a series that is trend-stationary with multiple breaks.

The paper draws raw data on wages paid to production workers (blue-collar workers) reported in current rupees along with data on total number of workers by industry. Using the consumer price index (CPI) for industrial workers (with base 1982) to deflate wages to workers, we arrive at real wages to workers which we further divide by the total number of workers to arrive at real wages per worker (i.e. annual average real wages by industry). The data on CPI used to deflate the nominal figures is taken from the Handbook of Indian Statistics, Reserve Bank of India, 2001.

5. The changing inter-industry wage structure in India

In this section, we analyse the changing inter-industry wage structure in India by comparing the growth of wages by industry. In particular, to study any potential differential impact of liberalisation on different industries, we estimate the growth rates in average real wages by industry based on the techniques discussed in the methodology section above and examine whether there is any evidence of changing inter-industry wage inequality in the organised manufacturing sector in India.

We first estimate the growth rate of real wage per worker for each industry by using (1) without considering whether each series is stationary or not. These results, which are estimates of CAGR of real wage per worker for the 51 industries, are presented in Table 4. A quick glance at the table shows that the growth in real wages in the period 1973-2003 has been very diverse across the 51 industries- industries like 311 (Manufactures of electric motors, generators and transformers), 154 (Manufacture of other food products) and 281 (Manufacture of structural metal products, tanks, reservoirs and steam generators) have very strong positive growth rates of 5.3%, 4.2% and 3.9% respectively, while industries like 312 (Manufacture of electricity distribution and control apparatus), 192 (Manufacture of footwear) and 300 (Manufacture of office, computer and accounting machinery) have very low growth rates of -1.1%, -0.4% and 0.76% respectively. However, since we haven't tested for the stationarity of the natural logarithim of real wage per worker for each industry, we cannot be certain that the estimates of growth rates presented in Table 4 are a valid representation of the true growth rates. Hence we conduct an ADF test on each series and find that the natural logarithm of real wages per worker is trend-stationary only for 21 out of 51 industries. This shows that 30 of the estimates of growth rates presented in Table 4 are not only asymptotically *inefficient* but are also "*pseudo growth rates*". We therefore retain the estimates of growth rate of real wages per worker based on (1) for the 21 industries, for which the series are trend-stationary and use (2) to estimate the growth rates for the rest of the 30 industries, for which the series are non-stationary. Note that using (1) gives us estimates of CAGR, while (2) gives estimates of AAGR. However the AAGR estimates of real wages per worker for the 30 industries should be interpreted with caution as they still represent some kind of meaningless "*pseudo growth rate*", even though they are now asymptotically efficient. We present the ADF test results and the CAGR and AAGR estimates in Table 5.

Theoretically, when a series is trend stationary, then the growth rate estimate from the log-linear method in (1) which gives CAGR should be identical to that from the log-difference method in (2) which gives AAGR, a point that we highlighted earlier. In Table 5, we can see that the growth rate estimates from both the methods yield very similar results for the series which are trend-stationary, while that for the series which are non-stationary, the growth rate estimates from the two methods differ significantly for majority of the cases. But interestingly, no matter which method we trust more, we still observe a trend of growing inter-industry wage inequality. Table 5 shows that there is considerable variation in the growth rates of real wage per worker between industries. The top five industries that saw the highest growth in average real wages for the whole period, 1973-2003, are industry 311 (Manufacture of electric motors, generators and transformers), industry 281 (Manufacture of structural metal products, tanks, reservoirs and steam generators), industry 321 (Manufacture of electronic valves and tubes and other electronic components), industry 341 (Manufacture of motor vehicles) and industry 221 (Publishing), which witnessed very strong positive growth rates of 5.2%, 3.9%, 3.8%, 3.6%, 3.3% and 3.1% respectively. While on the other hand, the bottom five industries that saw the lowest growth in average real wages for the same period are industry 312, industry 192, industry 323, industry 171 and industry 242, which witnessed very low (and even negative, in some cases,) growth rates of -1.33%, -0.44%, 0.18%, 0.37% and 0.58% respectively. On an average, the whole period growth rate of average real wages, for all the industries, is 1.68%, while the median stands at a moderate 1.54%. We summarise this information in Table 6, which clearly highlights a changing inter-industry wage structure for production workers in manufacturing industries in India during the period 1973-2003.

But given the criticism of the power of the ADF test, due to its inability to account for any existing structural breaks, as noted in section 3, we test whether the ADF tests used above were biased because possible structural break(s) were ignored. We therefore consider Perron's (1989) test which allows for one exogenous break (both intercept and slope break). Despite the criticism that such an assumption is based on prior observation of the data and hence problems associated with "pre-testing" are applicable to the test, we argue that such an assumption of an exogenous break is relevant to our data on real wages for the 51 Indian industries as India witnessed a substantial change in her policy regime in 1991, as discussed in section 2. Prior to 1991 India was a staunch believer of inward looking ISI policies, while in 1991 there was a radical change in outlook resulting in the adoption of a massive economic reforms program, of which trade liberalisation was an important component. We therefore emphasise that 1991, which marks a change in the policy regime, potentially represents a structural break in our data and hence we use Perron's (1989) methodology to test the unit root hypothesis allowing for an exogenous break in 1991. We present the results[18] for the Perron test with one exogenously specified break at 1991 in Column 2 of Table 7.

Table 7 shows that, when we introduce an exogenous break in 1991, the logs of real wages per worker for 23 industries out of 51 industries are trend-stationary. This is slightly better than the ADF test results where 21 out of 51 series were trend stationary. But if we compare the results of the ADF test (Table 5) with that of the Perron test (Table 7) that allows for a structural break (both level and slope) in 1991 more carefully, we find that the logs of real wage per worker for 15 industries which were not stationary according to the ADF test become trend-stationary when we allow for a break in 1991 using Perron's (1989) methodology. However, interestingly, the logs of real wage per worker for 13 industries which were earlier trend-stationary according to the ADF test are now shown to be non-stationary when we introduce a break in 1991.While the remaining

[18] For compactness, we just present the final results of the test along with the break date(s). For majority of the series, the *t*-statistics on estimated coefficients are significant at conventional levels of significance. Detailed output files (GAUSS files) are available from the authors upon request.

23 industries out of the 51 industries does not exhibit any change in the conclusions[19] of the ADF test, even when we allow for the break in 1991- 15 of the series which were non-stationary according to the ADF test also remain non-stationary according to Perron's test, while 8 of the series which were trend-stationary according to the ADF test are still shown to be trend-stationary by Perron's test. We present these comparisons in Table 8. The implications of these findings on growth rate estimation is that we can now use (1) to obtain meaningful estimates of growth rate (CAGR) for the 15 series which were shown to be non-stationary by the ADF test (see Table 5) earlier but are now trend-stationary when we account for the break at 1991 (see Table 7). However, we will have to use a dummy variable to distinguish the two periods[20]- the pre-break and the post-break periods- which will thus give us two growth rates for the two sub-periods. These estimates of growth rates will be not only be unbiased and asymptotically efficient but will also be valid representation of the true growth of the series for the two sub-periods. These results are presented in Table 9. This time, we can see that in the pre-break period, which represents the pre-reforms period (1973-1991), the growth rates of real wage per worker for the 15 industries are all strongly positive and for 9 out of the 15, the growth rates are more than 3%. On an average, the pre-reforms growth of real wages per worker, for all 15 industries, is 3.1% (with a standard deviation of 0.005), while the median stands at 3.2% (see Table 9). However, in the post-break period which represents the post-reforms period (1992-2003), only 1 out of 15 industries has growth rate higher than 3% and 9 out of 15 have negative growth in real wages per worker. The average post-reforms growth of real wages per worker, for all 15 industries, stands at -0.42% (with a standard deviation of 0.016) and a median of -0.39% (see Table 9). Two immediate conclusions follow from these findings. First, these results reinforce our previous finding based on Table 5 and Table 6 that the inter-industry wage structure in India has constantly changed in the period 1973-2003. Second, this change has been more prominent and adverse in the post-reforms period thus suggesting that the reforms have not been favourable for the growth of real wages for production workers and that the

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[19] Of course, the *t*-statistics on the estimated coefficients are different between the ADF test and Perron's test and hence the statistical level of significance at which the null is rejected or not will be different for the two tests, even though the final verdict on whether the series is stationary or not still remains the same.

[20] Or alternately, we can fit two separate trend lines to the two sub-samples of the entire period as discussed in section 3.

dispersion in the rate at which the inter-industry wage structure is changing has become more pronounced in the post-reforms period of 1992-2003.

But, we still recognise the criticism of the exogeneity assumption of the break in Perron's (1989) test that it involves an element of 'data mining'. Furthermore, there has been recent evidence, as presented in section 2, that the reforms in India have actually been initialised much before 1991 and that the effect of these reforms were not felt immediately but with a lag [see, for example, Das (2001), Panagariya (2004, 2007), Choudhury (2007), Sen (2009)] and hence the break date might not coincide with the year in which the major reforms were initialised. Given this, we therefore consider Lee and Strazicich's (2003) unit root test (hereafter, LS2) that allows for two breaks under both the null and the alternate hypothesis. We present the results[21] for this test along with the break dates in Column 3 of Table 7.

Turning back to Table 7 this time, we can see that when we use the LS2 test that allow for two breaks that are determined endogenously, we find that the log of the real wages per worker becomes stationary for a greater number of industries. In particular, we find that 49 out of 51 series are trend-stationary, with two endogenously determined breaks, which are statistically significant for majority of the cases[22], and range from 1983 to 2000, as presented in Table 7. The first break occurs in the pre-reforms period (prior to 1991) for 47 industries, while the second break occurs in the post-reforms period (post 1991) for 42 industries. Given the results of the LS2 test, we can use (1) to estimate three sub-period growth rates (CAGR) of real wage per worker for the 49 industries, for which the series were found to be trend-stationary with two endogenously determined breaks. We use the dummy variable method as discussed in Section 3. However, we present the results for only those industries, the break dates for which are identical to that of at least one other industry. For example, both industries 151 (Production, processing and preserving of meat, fish, fruits, veg., oils and fats) and 210 (Manufacture of paper and paper products) have 1985 as their first break and 1997 as their second break. Similarly, industries 181 (Manufacturing of wearing apparel, except for fur apparel), 314 (Manufacture of accumulators, primary cells and primary batteries) and 361

[21] See footnote 18.

[22] Since the second break is statistically significant for majority of the series, we conclude that it is reasonable as well as justifiable to account for two breaks when conducting the LS2 unit root tests. Detailed GAUSS output files are available from the authors, upon request.

(Manufacture of furniture) have their first break in 1983 and their second break in 1986. The purpose of this is to compare how these industries have performed in terms of growth of real wages within the same sub-period and hence we keep those industries out, which do not have break dates which are identical to those of at least one other industry, even though the growth rate estimates (CAGR) for them are well defined and asymptotically efficient. We present these results in Table 10.

The growth rate (CAGR) estimates of real wages per worker for production workers by industry presented in Table 10 highlight a clearer picture of the inter-industry wage structure and throw light to the dynamics in both the pre- and post- reforms period. However, since the break dates occur at different points in time for different industries, it is not possible to highlight a comparison of all the industries together. Nevertheless, the analysis leads us to present three important results. First, the impact of liberalisation has not been uniform across all the industries. The fact that the break dates occur at different time points for different industries (see Table 7) highlight the differential impact of the reforms on different industries. In each industry, this amounts to imparting two (deterministic) shocks to a wage growth process that is intrinsically stationary. Hence we find, for each industry, wage growth varied across three sub-periods. Second, in the case of the 49 industries out of 51, for which the natural log of real wage per worker is trend-stationary with two endogenously determined breaks, the first break occurs in the pre-liberalisation period (prior to 1991) for 47 industries, while the second break occurs in the post-liberalisation period (post 1991) for 42 industries (see Table 7). This result lends support to the conjectures that the reforms in India have actually been initialised much before 1991 and that the impacts of the radical reforms episode of 1991 were not felt immediately, but with a lag. Third, the CAGR estimates of the real wage per worker, presented in Table 10, show that the inter-industry wage structure in India has changed a lot in the period 1973-2003 and that it provides some evidence that the inter-industry wage differences have become more pronounced in the post-reforms period. For example, the CAGR of real wages per worker for industries 171 (Spinning, weaving and finishing of textiles), 201 (Saw milling and planing of wood), 252 (Manufacture of plastic products) and 321 (Manufacture of electronic valves, tubes and other electronic components) for the sub-period 1973-87 are 2%, 2%, 3.8% and 4.6% respectively, while for the sub-period 1988-2000, the CAGRs are -1.1%, -1.4%, -0.03% and 2.2%

respectively. The first sub-period, which coincides with a policy regime in the Indian economy that was characterised by restrictive inward looking ISI policies, saw strong positive growth in real wages per worker for each of the four industries with an average of 3.1% (and standard deviation of 0.013) thus implying that real wages for the average worker in each industry was going up. While, on the other hand, the second sub-period, which coincides with a policy regime that was characterised by radical reforms of trade and industrial policies, witnessed not only a slump in the growth but even negative growth rates for some industries, with an average of -0.09% (and standard deviation of 0.016), thus implying that the inter-industry wage structure deteriorated in the post-reforms period. Similarly, the CAGR for real wage per worker for industries 181 (Manufacture of wearing apparel, except for fur apparel), 314 (Manufacture of accumulators, primary cells and primary batteries) and 361 (Manufacture of furniture) for the sub-period 1973-1983 are 0.5%, 3.4% and 6.6% respectively, for the sub-period 1984-86 are 4.4%, 4.9% and 15.5% respectively, while for the sub-period 1986-2003, the CAGRs are 1.2%, -0.01% and 2.7%. In this case, the first and second sub-periods, which again coincides with the pre-reforms period saw moderate to high growth in real wages for the 3 industries, while the second sub-period, which overlaps the post-reforms period saw negative growth in real wage for 1 industry and moderate to high growth in the other two industries. Similarly, a close look at the CAGR estimates of different sub-periods for the other industries, in Table 10, shows that the inter-industry wage structure has changed more rapidly in the post reforms period.

The above analysis on the estimation of growth of average real wages for production workers (or blue collar workers) from 51 industries of the organised manufacturing sector in India for the period 1973-2003 highlights that whatever way one estimates the growth of real wages per worker by industry, we find that there is considerable variation in the growth of wages across industries, which seems to have aggravated further in the post-reforms period. These findings clearly show that the inter-industry wage differentials have increased in India over time and provide some evidence that it has become more pronounced in the post reforms period. An obvious implication of these findings is that wages earned by similar type of workers (production workers in our case) but employed in different industries are different. But since, individual worker wages will obviously depend on the quality of labour and we do not know anything about the quality of labour in our dataset, we cannot clearly conclude that being in different industries is the most important source of difference in wages among similar type of workers. Nevertheless, we argue that, since it is highly unlikely that labour quality will be significantly different between industries (given that all industries are manufacturing industries and that we are mainly focussing on production workers only), the real wage earned by the average production worker significantly depends on the industry he works in. This thus provides some evidence to the hypothesis that industry affiliation is an important determinant of wage.

Furthermore, our finding that there has been a tendency for the inter-industry wage structure to deteriorate more rapidly in the post-reforms period implies that the labour market has failed to adjust despite substantial reforms in the economy. In an ideal world with perfect competition in both output and factor markets and perfect factor mobility, we would expect that there would be movement of labour from low paying industries to high paying industries, particularly in case of similar type of workers. As a result of this inter-industry wages would tend to converge thus leading to a fall in growth of wages in the high paying industries and an increase in growth of wages in low paying industries. And we would expect to observe this more prominently in an economy that moves from a highly restrictive, regulated and distorted policy regime to one that is relatively more open, less regulated and less distorted. However, in our case, we observe that growth in wages for production workers have been moderate to high across all the industries in the pre-reforms period. But after massive reforms in trade and industrial policy, in the post reforms period we observe that growth in wages not only fall in majority of the industries relative to the pre-reforms period, but in fact it becomes negative in some cases. This shows that in spite of the reforms, no improvement took place in the inter-industry wage structure. In fact the inter-industry wage inequality has tended to grow. This clearly provides evidence that the labour market has not responded to the reforms in India thus highlighting the immobility of labour across industries. This is in line with the findings of Topalova (2004, 2006) that there is no evidence of any significant relocation of labour in a sample of Indian industries. Now, even though it might be difficult to identify an appropriate explanation for this, we would like to highlight three potential explanations. First, there exists considerable policy induced rigidities in the labour market, as highlighted in section 2, which stands as an impediment to labour relocation between industries. Second, there might be substantial structural bottlenecks like lack in infrastructure or concentration of particular type of industries in particular geographical locations, which might also affect movement of labour between industries. Third, labour market non-adjustment may also be due to the existence of returns to industry-specific skills that cannot be transferred in the short- to medium- run [Kruegers & Summers (1987)], which is further complemented by a lack of easily accessible and affordable re-training opportunities for workers who want to move from one type of industry to another. Fourth, as pointed out by Ghose (1995), there is substitution of labour with capital resulting in a fall in growth of wages in the post-reforms period across all industries. Fifth, skill biased technological change resulting in more favourable conditions for highly skilled (non-production) workers than for production workers resulting in lower growth in wages for production workers in the post-reforms period- a case which has attracted recent attention and some evidence has emerged [see Ramaswamy (2008), Hasan *et al*. (2007) and Sen (2009)].

6. Summary and Conclusions

This study explores the changing inter-industry wage structure in India by estimating the growth of average real wages for production workers by industry for 51 manufacturing industries in the organised sector in India for the period 1973-2003. In order to estimate the growth rates, the study adopts a methodological framework that differs from other studies in that the time series properties of the concerned variables are closely considered in order to obtain meaningful estimates of growth that are both unbiased and (asymptotically) efficient. The study brings out the flaws of the conventional log-linear trend model to estimate growth using OLS principles by highlighting the importance of the dichotomy of whether the log of the variable is stationary or non-stationary. If the log of the variable under study is not stationary then the growth in the series would be purely the cumulative impact of a stochastic process rendering comparison between growth rates of different series meaningless. Our methodology obtains estimates of growth that are deterministic by accounting for potential structural break(s), and this is a significant contribution of our paper. In each industry, this amounts to identifying (deterministic) shock(s) to a wage growth process that is intrinsically stationary.

The estimates of growth of real wages per worker by industry highlight three important conclusions. First, the fact that the break dates occur at different time points for different industries bring to light the differential impact and speed of the reforms on different industries. Second, the fact that the first break occurs before 1991 provide evidence to the argument that the reforms started much before the much hyped drastic reforms of 1991; and, the second break occurs after 1991 for majority of the industries highlight that the effects of the radical reforms episode of 1991 was not felt immediately but with some lags, which were different for different industries. Third, and most importantly, the growth estimates of the real wage per worker show that the inter-industry wage structure in India has changed a lot in the period 1973-2003 and that it provides some evidence that the inter-industry wage differences have become more pronounced in the post-reforms period. The latter conclusion is particularly interesting as it implies that wages earned by similar type of workers but employed in different industries are different, which in turn has implications for the inter-industry wage inequality. This also suggests that there is immobility of labour between these sectors implying that the labour market in India has failed to respond in the wake of the reforms, may be due to rigidities in the labour market induced by policy or structural bottlenecks.

Some immediate policy implications that follow from the above discussion are to carry out labour market reforms and remove structural bottlenecks in order to remove distortions that are causing rigidities that are serving as impediments to labour relocation. It might be appropriate to carry out an extensive study on how the labour legislation works in India and what are their effects on the dynamics of the labour market. In order to form conducive policy, it is important to identify the different channels through which the labour market outcomes are affected. For instance, in this study, our findings provide some evidence that similar type of workers have different rates of growth in wages in different industries. This finding supports the need to further explore the hypothesis that industry affiliation is an important determinant of wage. Such a case may arise because of returns to industry specific skills which cannot be transferred in the short- to medium- run or because of industry rents arising out of imperfect competition. If the former is true then a suitable policy recommendation would be to provide opportunities for appropriate re-training to workers that is easily accessible and affordable to workers who want to switch between industries. On the other hand, if the latter is true, then policies that would increase competition should be adopted. That is why, it is important to consider the different channels through which the labour market is affected. This clearly brings out the need and scope for further research in this area.

This paper presents an empirical justification to further explore the relationship between trade reforms and the inter-industry wage structure. In particular, it would be interesting to find out how the inter-industry wage structure would look like after controlling for individual worker characteristics and the relationship between trade reforms and the changing inter-industry wage structure, especially in the light of contrasting results of recent studies [see Dutta (2007) and Mishra & Kumar (2008)], which is our next research objective. The wage data used is this paper is average industry wage for production workers and hence has been used to show the differences in wages between average workers in different industries.

Table 1: Average Tariffs in different Sectors

Tariffs	**1990-91**	**1991-92**	**% Change**
Diversified	127.7	94.3	35.41
Electrical Machinery	127.6	95.6	33.47
Non-electrical Machinery	143.1	107.5	33.11
Electronics	99.6	76	31.05
Transport Equipment	120.6	93	29.67

Source: Krishna & Mitra (1998)

Table 2: Non- Tariff barriers on imports in India in the 1980s and 1990s

1987-88	*Banned*	*LP*	*OGL*	*Canalized*	*NI*	*Total*
In percent of HS Codes	33	18	13	7	29	100
In percent of imports	16	23	16	27	18	100
1992-93	*Banned*	*Restricted*	*Free*	*Canalized*	*NS*	
In percent of HS Codes	1	56	40	2	1	100
In percent of imports	0	21	46	33	0	100
1994-95	*Banned*	*Restricted*	*Free*	*Canalized*	*NS*	
In percent of HS Codes	0	43	55	2	0	100
In percent of imports	0	20	55	25	0	100
1997-98	*Banned*	*Restricted*	*Free*	*Canalized*	*NS*	
In percent of HS Codes	0	41	57	2	0	100
In percent of imports	0	15	64	21	0	100

Notes: LP = Limited Permissible, OGL = Open General License, NI = Not Identified, NS = Not Specified

Source: Topalova (2004)

Table 3: Null and Alternate Hypotheses under the different Unit Root Tests	
Unit Root Test	**Null (H_0) and Alternate (H_1) Hypothesis**
ADF	H_0: Series contains a unit root, i.e. its is non-stationary H_1: Series is trend-stationary
Perron (1989)	H_0: Series contains a unit root with a once only exogenous change in the level (intercept) and an exogenous change in the drift parameter occurring at the break-point, T_B. H_1: Series is trend stationary with a change in both the level (intercept) and growth (slope) of the trend function occurring at the break-point, T_B
Lee and Strazicich (2003)	H_0: Series contains a unit root with once only endogenous changes in the level (intercept) at two break-points, T_{B1} and T_{B2} respectively, and two endogenous changes in the drift parameter occurring at the break-points, T_{B1} and T_{B2} respectively. H_1: Series is trend stationary with two changes in both the level (intercept) and growth (slope) of the trend function occurring at the endogenously determined break-points, T_{B1} and T_{B2} respectively.

Table 4: CAGR of Real Wages Per Worker			
$Y_{it} = \alpha_i + \beta_i t + \varepsilon_{it}, i = 1, 2, .., 51; t = 1973, ..., 2003$ Y_{it} is the natural logarithm of real wage per worker for industry i at time t, β estimate is required growth rate			
Industry Code	**CAGR ($\hat{\beta}_i$)**	**Industry Code**	**CAGR ($\hat{\beta}_i$)**
151	0.0278	**269**	0.0171
152	0.0268	**271**	0.0248
153	0.0258	**272**	0.0240
154	0.0423	**281**	0.0391
155	0.0251	**289**	0.0178
160	0.0176	**291**	0.0202
171	0.0076	**292**	0.0230
172	0.0104	**293**	0.0163
173	0.0168	**300**	0.0076
181	0.0125	**311**	0.0530
182	0.0161	**312**	-0.0111
191	0.0106	**313**	0.0113
192	-0.0044	**314**	0.0120
201	0.0126	**319**	0.0008
202	0.0154	**321**	0.0388
210	0.0171	**323**	0.0018
221	0.0334	**331**	0.0250
222	0.0155	**332**	0.0244
231	0.0217	**333**	0.0278
232	0.0289	**341**	0.0368
241	0.0249	**342**	0.0155
242	0.0106	**351**	0.0120
251	0.0151	**352**	0.0141
252	0.0198	**359**	0.0245
261	0.0311	**361**	0.0273
		369	0.0129

Source: Author's Calculations based on ASI Data

Table 5: ADF Test and CAGR & AAGR of Real Wages Per Worker

ADF Test:
H_0: There is a unit root i.e the series is non-stationary or I(1)
H_1: There is no unit root i.e the series is trend-stationary or I(0)
$CAGR : Y_{it} = \alpha_i + \beta_i t + \varepsilon_{it}$; $AAGR : \Delta Y_{it} = \beta_i + \varepsilon_{it}$; where Y_{it} is the natural log of real wage per worker for industry i = 1-51 at time t = 1973-2003, β estimate is the required growth rate

Industry Code	ADF test	CAGR	AAGR	Industry Code	ADF test	CAGR	AAGR
151	NS	0.0278	0.0179	**269**	NS	0.0171	0.0142
152	NS	0.0268	0.0203	**271**	TS***	0.0248	0.0259
153	TS**	0.0258	0.0203	**272**	NS	0.0240	0.0253
154	NS	0.0423	0.0204	**281**	TS**	0.0391	0.0365
155	NS	0.0251	0.0188	**289**	NS	0.0178	0.0129
160	NS	0.0176	0.0109	**291**	NS	0.0202	0.0141
171	NS	0.0076	0.0037	**292**	NS	0.0230	0.0201
172	NS	0.0104	0.0059	**293**	TS*	0.0163	0.0125
173	NS	0.0168	0.0091	**300**	TS**	0.0076	0.0115
181	TS***	0.0125	0.0082	**311**	TS*	0.0530	0.0521
182	TS**	0.0161	0.0243	**312**	NS	-0.0111	-0.0133
191	NS	0.0106	0.0065	**313**	NS	0.0113	0.008
192	TS**	-0.0044	-0.0049	**314**	NS	0.0120	0.0112
201	NS	0.0126	0.0092	**319**	NS	0.0008	0.0109
202	TS***	0.0154	0.011	**321**	TS***	0.0388	0.0287
210	NS	0.0171	0.0122	**323**	TS**	0.0018	0.0036
221	TS**	0.0334	0.0292	**331**	NS	0.0250	0.0161
222	NS	0.0155	0.0076	**332**	TS**	0.0244	0.0175
231	TS***	0.0217	0.0169	**333**	TS***	0.0278	0.0257
232	NS	0.0289	0.0211	**341**	TS***	0.0368	0.0337
241	NS	0.0249	0.0241	**342**	TS**	0.0155	0.0122
242	NS	0.0106	0.0058	**351**	NS	0.0120	0.0094
251	NS	0.0151	0.0109	**352**	NS	0.0141	0.0112
252	NS	0.0198	0.0126	**359**	NS	0.0245	0.0233
261	TS**	0.0311	0.0217	**361**	TS*	0.0273	0.0278
				369	TS*	0.0129	0.0129

Total Number of TS series: 21

Notes:
1. NS and TS stands for Non-stationary and Trend-stationary respectively.
2. In a trend stationary series, the star stands for the statistical level of significance at which the Null Hypothesis that the series contains a unit root is rejected; ***, **, * denotes significance levels of 1%, 5% and 10% respectively.
3. When a series is NS, then the CAGR is not a valid representation of the true growth rate of the series. We nevertheless report it for the sake of comparison and completeness.
4. When a series is TS i.e I(0) then its first difference is also I(0). Hence we can also estimate the AAGR of the series. However AAGR is subject to outlier bias, see section 2.4

Source: Author's Calculations based on ASI Data

Table 6: Growth rates of real wages per worker				
	Top Five		Bottom Five	
	Industry	Growth Rate	Industry	Growth Rate
	311	0.052976	312	-0.0133
	281	0.039052	192	-0.00442
	321	0.038787	323	0.00181
	341	0.036824	171	0.0037
	221	0.033411	242	0.0058
Average (all)	0.016827			
Median (all)	0.015438			
SD (all)	0.011529			

Notes
1. Growth rates are CAGR or AAGR depending on stationarity properties of the series
2. For trend-stationary series, CAGR is identical to AAGR

Source: Author's calculations based on ASI data

Table 7: Unit Root Tests with Break(s) for natural log of real wages per worker				
Industry Code	**Perron**	**Lee-Strazicich**		
	Result (Exogenous Break at 1991)	**Result**	**Break Dates**	
151	NS	TS**	1985	1997
152	TS***	TS***	1983	1989
153	TS***	TS***	1983	1990
154	NS	TS***	1987	1999
155	TS***	TS***	1985	1996
160	NS	TS***	1983	1990
171	NS	TS***	1987	2000
172	TS**^	TS***	1984	1992
173	NS	TS***	1984	2000
181	NS	TS***	1983	1986
182	NS	TS**	1983	1996
191	TS*	TS***	1986	1995
192	NS	TS*	1983	1994
201	TS***	TS***	1987	2000
202	TS*	TS*	1986	1998
210	TS*	TS**	1985	1997
221	TS***	TS***	1985	1995
222	TS***	TS***	1986	1998
231	NS	TS***	1984	2000
232	TS**^	TS***	1988	2000
241	TS**^	TS***	1983	1994
242	TS***	TS***	1993	1996
251	NS	TS***	1991	2000
252	TS*	TS***	1987	2000
261	TS***	TS***	1985	1998
269	NS	TS***	1983	1997
271	NS	TS***	1986	1995
272	NS	TS***	1992	1999
281	NS	TS*	1984	1997
289	NS	TS***	1983	1989
291	NS	TS***	1986	2000
292	TS***	TS***	1989	2000
293	TS*	TS***	1990	1997
300	NS	NS	1990	2000
311	NS	NS	1987	1996
312	NS	TS***	1983	1999
313	NS	TS*	1984	2000
314	NS	TS***	1983	1986

319	NS	TS***	1983	1988
321	NS	TS***	1987	2000
323	TS*	TS***	1986	1989
331	TS**	TS***	1988	2000
332	NS	TS***	1986	1999
333	NS	TS***	1992	2000
341	NS	TS***	1986	1997
342	NS	TS***	1984	1994
351	NS	TS***	1984	1987
352	TS*	TS***	1984	1999
359	TS***	TS***	1989	2000
361	TS***	TS***	1983	1986
369	TS***	TS**	1983	1991
Total TS Series	23	49		

Notes:

1. NS and TS stands for Non-stationary and Trend-stationary respectively.
2. In a trend stationary series, the star stands for the statistical level of significance at which the Null Hypothesis that the series contains a unit root is rejected; ***, **^, **, * denotes significance levels of 1%, 2.5%, 5% and 10% respectively.
3. For all the tests, the model that allows break(s) in both level(s) and slope(s) is considered. This corresponds to Perron (1989) Model C and Lumsdaine and Papell (1997) Model CC. We also tried a model that allowed only level breaks, analogous to Perron's (1989) original Model A, but in majority of the cases, the t-statistics on estimated coefficients for Model C are significant at conventional levels of significance and hence we just present the results for Model C.
4. For compactness, we just report the final result of the concerned unit root test with the break dates. But the detailed output files are available from the authors upon request.
5. The tests are conducted in GAUSS and uses critical values as reported in Perron (1989) and Lee and Strazicich (2003). We gratefully acknowledge Junsoo Lee for making the GAUSS codes used in Lee and Strazicich (2003) and the codes for the Perron (1989) tests freely available in his website: http://cba.ua.edu/~jlee/gauss . We had to slightly modify these codes for our purpose and had to fix a bug in the code for the Perron test. These codes are available from the authors upon request.
6. In each test, we use lags of the dependent variable to correct for any serial correlation, and the optimal lag length (*k*) is determined by following the general-to-specific approach used by Perron (1989) and suggested by Ng and Perron (1997, 2001).
7. In order to eliminate end-points, we choose a 'trimming region' to search for the possible break(s) over the time interval [0.1T, 0.9T].

Source: Author's calculations based on ASI data

Table 8: Comparison of ADF test and Perron's test (with exogenous break at 1991) results				
	Different conclusions		**Same conclusions**	
Industry Codes that are:	**NS (ADF) and TS (Perron)**	**TS (ADF) and NS (Perron)**	**NS (ADF) and NS (Perron)**	**TS (ADF) and TS (ADF)**
	152	181	151	153
	155	182	154	202
	172	192	160	221
	191	231	171	261
	201	271	173	293
	210	281	251	323
	222	300	269	361
	232	311	272	369
	241	321	289	
	242	332	291	
	252	333	312	
	292	341	313	
	331	342	314	
	352		319	
	359		351	
Total No. of series	**15**	**13**	**15**	**8**

Notes:
1. NS and TS stand for non-stationary and trend-stationary.
2. The variable in question here is the natural log of real wages per worker

Source: Author's calculations based on ASI data

Table 9: Growth rate estimates of real wage per worker for the 15 industries presented in column 2, Table 7			
	Sub-periods		**Whole Period**
Industry Codes	**1973-1991**	**1992-2003**	**1973-2003**
152	0.038592	0.002494	0.026797
155	0.033969	0.002858	0.025124
172	0.024402	-0.015879	0.010441
191	0.02061	-0.016017	0.010604
201	0.025356	-0.008507	0.01258
210	0.026515	-0.003972	0.017123
222	0.027587	-0.020612	0.015451
232	0.024062	0.033559	0.028921
241	0.034361	0.016002	0.024872
242	0.030942	-0.022681	0.010637
252	0.035708	-0.003821	0.019789
292	0.032511	0.001515	0.02298
331	0.039488	-0.025911	0.024992
352	0.031766	-0.017071	0.014072
359	0.036106	0.015144	0.024492
Mean	0.030798	-0.004193	0.019258
Median	0.031766	-0.003972	0.019789
SD	0.005754	0.016643	0.006590

Notes:

1. The sub-period growth rates (CAGR) are estimated by using dummy variables, as follows, $Y_{it} = \alpha_{1i} D_1 + \alpha_{2i} D_2 + \beta_{1i} D_1 t + \beta_{2i} D_2 t + \varepsilon_{it}$, where Y_{it} is the natural log of real wage per worker for industry i = 1, 2, ..., 15 at t = 1973,..., 2003; D_j (j = 1, 2) is a dummy variable which takes the value 1 in the *j-th* sub-period and 0 otherwise. β_j (j=1, 2) estimate is the required growth rate for the *j-th* sub-period.
2. The sub-period growth rates are unbiased and asymptotically efficient.
3. We also report the whole period growth rates (CAGR) for the sake of completeness even though these estimates are not asymptotically efficient.

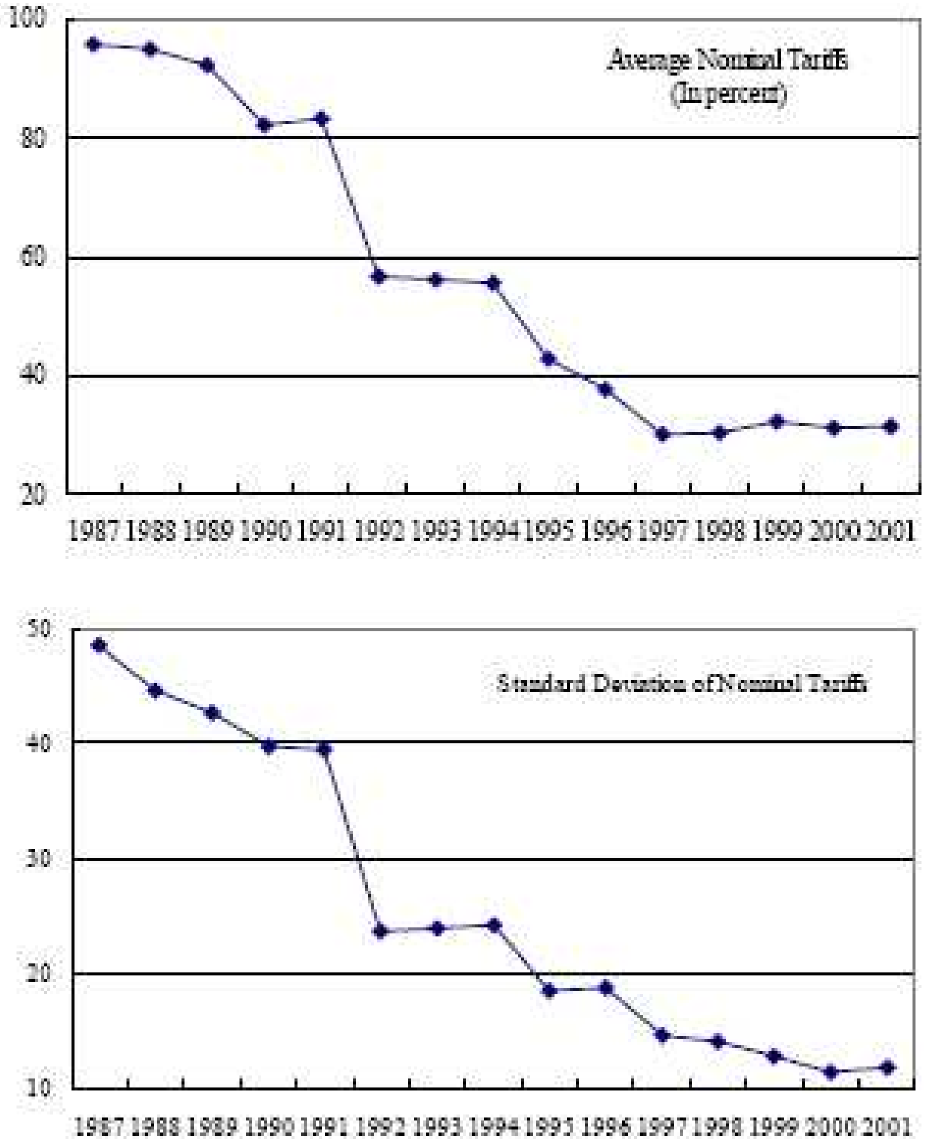
Source: Author's calculations based on ASI data

Table 10: Growth rate estimates of real wage per worker for selected industries (see note 1)						
	Breakpoints		Growth Rates			Whole Period
Industry Codes	**TB_1**	**TB_2**	**1973 – TB_1**	**(TB_1+1)- TB_2**	**(TB_2+1)- 2003**	**1973-2003**
181	1983	1986	0.005606	0.04452	0.011998	0.012503
314	1983	1986	0.034634	0.049705	-0.010284	0.011974
361	1983	1986	0.066336	0.15503	0.009752	0.027349
152	1983	1989	0.044448	0.036976	0.003201	0.026797
289	1983	1989	0.036713	0.032641	-0.007303	0.017813
153	1983	1990	0.039007	0.040074	0.011657	0.025773
160	1983	1990	0.011582	0.018492	0.002624	0.017587
192	1983	1994	0.009482	-0.018279	-0.013889	-0.004423
241	1983	1994	0.042959	0.017992	0.018232	0.024872
173	1984	2000	0.031211	0.004873	-0.006961	0.016815
231	1984	2000	0.021952	0.01657	-0.051679	0.021742
313	1984	2000	0.034733	-0.003605	-0.043497	0.011294
151	1985	1997	0.043182	0.01701	0.020981	0.027766
210	1985	1997	0.023993	0.017762	0.007123	0.017123
191	1986	1995	0.020702	0.018226	-0.014603	0.010604
271	1986	1995	0.022662	0.026887	0.027476	0.024824
202	1986	1998	0.023406	-0.000801	-0.011877	0.015438
222	1986	1998	0.026039	0.00948	0.025044	0.015451
171	1987	2000	0.020258	-0.011056	-0.019219	0.007635
201	1987	2000	0.020167	-0.014046	0.019112	0.01258
252	1987	2000	0.038443	-0.000307	-0.008125	0.019789
321	1987	2000	0.046817	0.021664	-0.008163	0.038787
232	1988	2000	0.016444	0.033577	-0.02363	0.028921
331	1988	2000	0.033983	-0.008446	-0.048186	0.024992
292	1989	2000	0.03238	0.00624	0.007729	0.02298
359	1989	2000	0.035093	-0.00086	0.036682	0.024492

Notes:
1. This table present the growth rate estimates of real wage per worker for only those industries, the break dates (based on the LM test results in Table 6) for which are identical to that of at least one other industry.
2. The sub-period growth rates (CAGR) are estimated by using dummy variables, as follows,
$Y_{it} = \alpha_{1i}D_1 + \alpha_{2i}D_2 + \alpha_{3i}D_3 + \beta_{1i}D_1t + \beta_{2i}D_2t + \beta_{3i}D_3 + \varepsilon_{it}$, where Y_{it} is the natural log of real wage per worker for industry i = 1, 2, ..., 49 (we report results for 25 industries only- see explanation in note 1) at t = 1973,..., 2003; D_j (j = 1, 2, 3) is a dummy variable which takes the value 1 in the *j-th* sub-period and 0 otherwise. β_j (j=1, 2, 3) estimate is the required growth rate (CAGR) for the *j-th* sub-period.
3. The sub-period growth rates are unbiased and asymptotically efficient- we just report 25 of them here.
4. We also report the whole period growth rates (CAGR) for the sake of completeness even though these estimates are not asymptotically efficient.

Source: Author's calculations based on ASI data

Figure 1: Fall in average nominal tariff rates and its standard deviation, 1987-2001



Source: Topalova (2004)

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Appendix Table1: National Industrial Classification 1998 at three digit level of industry aggregation, India

NIC-98 Code	Industry Description
151	Production, processing and preserving of meat, fish, fruits, veg., oils and fats
152	Manufacture of dairy product
153	Manufacture of grain mills products, starches and strach produtcs and prepared animal feeds
154	Manufacture of other food products
155	Manufacture of beverages
160	Manufacture of tobacco products
171	Spinning, weaving and finishing of textiles
172	Manufacture of other textiles
173	Manufacture of knitted and crocheted fabrics and articles
181	Manufacturing of wearing apparel, except for fur apparel
182	Dressing and dyeing of fur, manufacture of articles of fur
191	Tanning and dressing of leather, manufacture of luggage hand bags, saddlery & harness
192	Manufacture of footwear
201	Saw milling and planing of wood
202	Manufacture of products of wood, cork, straw and plaiting materials
210	Manufacture of paper and paper product
221	Publishing
222	Printing and service activities related to printing
231	Manufacture of coke oven products
232	Manufactured refined petroleum products
241	Manufacture of basic chemicals
242	Manufacture of other chemical products
243	Manufacture of man-made fibres
251	Manufacture of rubber products
252	Manufacture of plastic products
261	Manufacture of glass and glass products
269	Manufacture of non-metallic mineral products n.e.c
271	Manufacture of basic iron and steel
272	Manufacture of basic precious and non-ferrous metals
273	Casting of metals
281	Manufacture of structural metal products, tanks, reservoirs and steam generators
289	Manufacture of other fabricated metal products, metal working service activities
291	Manufacture of general purpose machinery
292	Manufacture of special purpose machinery
293	Manufacture of domestic appliances, n.e.c
300	Manufacture of office, accounting and computer machinery
311	Manufacture of electric motors, generators and transformers
312	Manufacture of electricity distribution and control apparatus
313	Manufacture of insulated wire and cable
314	Manufacture of accumulators, primary cells and primary batteries
315	Manufacture of electric lamps and lighting equipment
319	Manufacture of other electrical equipment n.e.c
321	Manufacture of electronic valves and tubes and other electronic components
322	Manufacture og TV and radio transmitters and apparatus for line telephony and line telegraphy
323	Manufacture of TV and radio receivers, sound or video recording or reproducing apparatus, and associated goods
331	Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and other purposes except optical instruments

332	Manufacture of optical instruments and photographic equipment
333	Manufacture of watches and clocks
341	Manufacture of motor vehicles
342	Manufacture of bodies for motor vehicles, trailer and semi trailers
351	Building and repair of ships and boats
352	Manufacture of railway and tramway locomotives and rollick stock
353	Manufacture of air craft and space craft
359	Manufacture of transport equipment n.e.c.
361	Manufacture of furniture
369	Manufacturing n.e.c

Source:National Industrial Classification, 1998, CSO, MOSPI, Govt. of India