The Decline of the Labor Share in India*

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Abstract

The aggregate labor share of income in India declined by seven percentage points in thirty years since the 1980s. While the decline in the labor share of income has been observed globally, the decline is particularly sharp in India. I show that changes in the within-industry labor shares alone can explain half of the overall decline, and structural change is a key contributor in explaining the other half of this decline. Motivated by this, I construct a multi-sector general equilibrium model to investigate how structural change interacts with two leading factors of the decline - a fall in the relative price of investment goods (RPI) and an increase in markups. To quantify the relative importance, I first estimate markups in India using firm-level data from the Annual Survey of Industries and measure the decline in RPI using the Penn World Tables. I calibrate the model to match KLEMS data from the Reserve Bank of India (RBI) and run counterfactual exercises. I find that a decline in RPI is more consistent with the co-movement of industry labor shares and value-added shares observed in the data.

Keywords: *Labor share, Structural Change, Capital Labor Substitution*

JEL classification: *E23, E25, J21, J23, O5*

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1 Introduction

The labor share of income in India declined from fifty-five percent in 1980 to forty-eight percent 30 years later.[1] Many countries experienced a decline in their labor share of income over this time period[2], however, the magnitude of decline has been relatively sharp in India. At the same time, India experienced a dramatic change in the structural composition of the economy. Unlike many countries, India transitioned from being an Agricultural economy to a Service economy. In light of increasing concern over automation replacing labor (Acemoglu and Restrepo (2019)), the increase in the share of workers employed in the services sector, which faced a decline in the labor share of income, raises the question of why the labor share of income is falling in India.

In this paper, I explore the role of structural changes in explaining the decline of the labor share of income in India and quantify its interplay with the leading factors of the decline in labor share globally - a fall in the relative price of investment goods and an increase in markups.

In an empirical exercise, I find that while the manufacturing sector remained around 15% of the GDP during the entire period, the value-added share of the Agriculture sector decreased from 35% to 20%, and Services increased from 50% to 65%. Simultaneously, the labor share of income declined by approximately seven percentage points in the services sector and by twelve percentage points in the manufacturing sector. Agriculture, on the other hand, experienced a high and stable labor share of around 55%.

Starting with these facts in hand, I decompose the change in aggregate labor share into (i) change in the labor shares within an industry, (ii) change due to the structural transformation of the economy, and (iii) covariance term between change in labor share in an industry and change in value-added share of that industry. Using dis-aggregated data of twenty-seven industries from KLEMS[3] data set, I look into the decline of the labor share of income in India over the three decades starting 1980.[4] I find that fifty-five percent of the decline in aggregate labor share comes from a fall in the labor share of incomes within the industries. Structural change is necessary to explain the other half of the decline - fourteen percent of the fall comes from just the changes in the value-added shares, and thirty-one percent of the fall is explained by the covariance term, i.e., industries with falling shares of labor income are becoming larger in size (value-added share).

Motivated by the importance of structural change in the empirical findings, I proceed to analyze the causes of the decline in the labor share of income by building a three-sector general equilibrium model. I aggregate the data into - Agriculture, Manufacturing, and Services. I apply exogenous changes to the relative price of investment goods (RPI) and markup levels and compare the labor share of income and the value-added shares of the three sectors in the before and after. The relative price of investment goods affects the relative wage rate, and firms in different sectors change their input ratio differently because of the varying elasticity of substitution between labor and capital. Markups, on the other hand, affect the labor share of income directly by changing the profit share in the output. While cheaper investment good increases capital and output in all three sectors, markups suppress output. With non-homothetic household preferences, a change in total income in the economy changes the value-added shares of the three sectors. Such a model thus captures the interaction of changes in within-sector labor shares and changes in the value-added shares of the different sectors in the economy.

Changes in the relative price of investment goods and changes in markups are some of the previously investigated causes of decline in the labor share of income in a single-sector economy

[1] According to the Penn World Table (PWT), the labor share of income in India has taken an even more dramatic plunge from 74% to 51% during that period. I compute a more conservative estimate of the drop using industry-level data available at KLEMS. The difference in the values arises from the difference in the treatment of mixed-income while computing the labor shares for the economy.

[2] I find that the labor share of income fell from 62% in 1980 to 58% in 2010 in the USA and from 60% in 1980 to 56% in 2008 in Canada. In the literature, Karabarbounis and Neiman (2013) document a decline of 5 percentage points in the global corporate labor share with a starting value of 64% in 1975 to 59% in 2012 (Their dataset includes income structure at a corporate-sector-level in 59 countries.)

[3] KLEMS refers to data on capital, labor, energy, material and service inputs at detailed industry level. India KLEMS is prepared by the Reserve Bank of India (RBI).

[4] To ignore the effects of the Great Recession, I exclude the period after 2007.

globally in the literature. To my knowledge, no study has looked at those factors in the context of India. The decline in the RPI in India has been particularly sharp. In Johri and Rahman (2022), this decline has been partly attributed to the liberalization policies adopted in India in 1991.[5] In an empirical exercise, I compute a decline of approximately 50% percent from 1980 to 2011 in the RPI in India.[6]

With regard to changes in markup, one difficulty in evaluating the importance of those is the absence of data on markups in India during this period. Using the data from the Annual Survey of Industries (ASI) published by the Ministry of Statistics and Implementation (MOSPI), Government of India, I estimate markup levels for India starting in 1998 using the production function estimation method Olley and Pakes (1996). I estimate an average markup level of 22% from 2003 - 07.[7] In the exercises I run in this paper, I, therefore, consider two extreme scenarios - no change in markups starting at a value of 22% in 1980 - 84 and an increase in markups starting from no markup in the 1980s.

In the case of no change in markups, i.e., a value of twenty-two percent markup in all sectors in both periods and a 50% decline in RPI from 1980 to 2007, the covariance term explains 15.6% of the total fall in the labor share of income in the model. This exercise generates a 6.5 percentage point fall in the aggregate labor share of income (as compared to the 6.8 percentage point decrease in the data). Moreover, this result closely matches the three sector aggregated data where the covariance term explains 16.4 percentage points of the fall in the labor share of income. In the other scenario, where both RPI declines and markups in the economy rise from no markup to twenty-two percent, the model generates a 5.8 percentage point decrease in the aggregate labor share of income. Moreover, the very high increase in markups reduces the within sector labor shares by so much that the aggregate labor share would have fallen by even more had there been no structural change. Unlike in the data, all of the decline in the aggregate labor share of income comes from decline in the labor shares within the sectors.

Although the experiments conducted in the context of the model point to potential roles for both the RPI decline and the increase in markups in explaining the declining labor share, they also point to reasons why the RPI story is more in line with the actual experience. A decline in RPI only generates 96% of the decline, as observed in the data. On the other hand, an increase in markups, along with the decline in RPI, generates 84% of the decline. More importantly, the sharp decline in RPI with constant high markups generates the same covariance term in the decomposition of the aggregate labor share of income as in the data, while the large increase in markups reduces the impact of the covariance term and reverses the effect of changes in value-added only on the aggregate labor share, i.e., the value-added share of sectors with high labor shares increase. The former does better also when we look at the distribution of labor employment across sectors in that it matches the changes in the labor employment shares as observed in the data. The share of workers employed moves from Agriculture to Services, while the latter leads to a decrease in the share of workers employed in Agriculture and the Manufacturing sector. A detailed comparison is covered in subsection 5.3.

From these results, I can say that a decline in RPI alone better explains the decline in the labor share of income. The calibrated values of elasticity of substitution are greater than 1 for all three sectors in this scenario. A decrease in RPI increases the relative wage rate, and firms substitute labor for capital. This decline in individual sectors alone contributes to the aggregate fall in labor share by eighty percent (compared to the eighty-four percent contribution observed in the data). Additionally, cheaper and more abundant capital increases the output and income of the economy. With subsistence consumption of agricultural goods and a high share of services market goods

[5] Johri and Rahman (2022) explains the rise of the relative price of investment in the 80s and the fall in the 90s through the capital import substitution policies in India and liberalization reforms in 1991. They find that before the reforms, the import licensing requirements and the high tariffs created a scarcity of machinery in India. Their model generated a 31% decline in the relative price of investment following the removal of quantity restrictions and tariff rates as a part of the liberalization reforms in 1991.

[6] I use data from the Penn World Tables (PWT) and PIRIC series from the Federal Reserve Bank at St. Louis to compute RPI in India. PWT contains national accounts for several countries adjusted in common currency. The data is currently hosted by UC Davis. Details on data are covered in section 2.

[7] Due to insufficient data, markups for the 1980s cannot be computed using the ASI data.

in the household utility function, the value-added share of the Service sector rises from fifty to sixty-one percent, and that of the Agriculture sector falls from thirty-six to twenty-one percent while the labor share of income in Agriculture stays approximately the same at fifty-five percent. Moreover, A decline in the labor share of income in the Manufacturing sector from forty-six to thirty-six percent is accompanied by an increase in the value-added share from fourteen percent to eighteen percent. This leads to the covariance-term contributing to 15.6% of the fall in the aggregate labor share of income in the model (compared with the 16.4% fall in the data.)

An additional argument in favor of RPI causing the decline is the markup values that I estimate from 27 industry data in KLEMS by the Reserve Bank. Using various variables as a proxy, I get very high markup values for the 1980 period that challenge the assumption of having a markup value of 1 in the 1980s to begin with. Maiti (2019) describes that the Indian economy was highly monopolized by a limited number of firms in the 1980s, which also points away from having a zero markup assumption.

In the literature, the decline in the labor share of income globally has been attributed to a decline in the relative price of investment goods (Karabarbounis and Neiman (2013)), an increase in markups (De Loecker et al. (2020)), the increasing importance of intangible assets (Koh et al. (2020)), or/and to labor outsourcing by advanced countries (Elsby et al. (2013)). In the context of India, Maiti (2019) studies the impact of trade on the labor share of income in formal industries through changes in market imperfections induced via trade.

This paper closely follows Karabarbounis and Neiman (2013), which attributes roughly half of the decline in the global labor share of income to the decline in the relative price of investment goods. This paper contributes to the literature on RPI or technology change to explain the decline in the labor share of income by introducing the sectoral component to it. While cheaper capital can induce firms to substitute labor for capital, different sectors have varying degrees of substitution between labor and capital and, hence, respond differently. I find that the Manufacturing sector has the highest substitutability between labor and capital and that the elasticity of substitution is lower in the Services sector.[8] Had the Indian economy transitioned from Agriculture to Manufacturing, the labor share would have fallen even more.

I also find that RPI affects the aggregate labor share of income through another channel, i.e., changing the value-added shares of various sectors in the economy. An improvement in technology that reduces the cost of investment goods increases the output and income of the economy. In my model, depending on the preferences in the demand for final goods in the economy, the structural composition would change. For India, it changed towards the Services sector and away from Agriculture. In a three-sector model, change in value-added shares contributes to 20% of the decline in the aggregate labor share. Therefore, the relative price of investment goods affects the aggregate labor share of income also via the structural change that it induces.

Karabarbounis and Neiman (2013) includes markups in their model. However, they assume only a five percentage point increase in markups[9], starting a state of no markup. Their estimate of the elasticity of substitution stays robust, and they conclude with RPI driving half of the decline of the labor share of income. In an extension to their finding, I find that a large enough increase in the markups can change the calibrated values of elasticity of substitution (see A.2). In a counterfactual exercise in section 5.2.2, I find that a high increase in markups in the model reverses the effect of a decline in RPI such that the decline now puts upward pressure on the aggregate labor share of income.

This paper also contributes to the markup literature. I follow this literature starting with Olley and Pakes (1996), Baqaee and Farhi (2020), De Loecker et al. (2020) and estimate markups for India using firm-level data for the manufacturing sector using the Annual Survey of Industries. I also compute markups following the Petrin et al. (2004) method on industry-level data available in KLEMS India (see A.3).

The rest of the paper is organized in the following way - section 2 describes the data sources and the data that has been used in the paper, section 3 describes the markup estimation process

[8]My findings are similar to Herrendorf et al. (2015) find an elasticity of substitution for the US, wherein they find that the elasticity of substitution is higher in Manufacturing than in Services.

[9]They calculate 5% markup using data across countries.

in detail, and section 4 describes the model. Section 5 documents the calibration process and the results. Lastly, section 6 concludes the paper.

2 Data

2.1 Labor Share and Value-Added Shares

In this section, I describe the data that I use to compute the aggregate labor share of India and I decompose the change in the aggregate labor share of income due to changes in the within-sector labor share of income, changes in value-added shares of the sectors and the interaction of the two changes. The data that I use is provided by the Reserve Bank of India to the World KLEMS database. KLEMS is data on capital, labor, energy, material and service inputs at the industry level. India KLEMS provides industry-level data on variables such as gross output, value-added, labor share, employment, and wages that are computed following the KLEMS approach. The disaggregated data covers Agriculture, Mining, Manufacturing sub-industries such as Paper, Electrical Components, Transport Equipment, Textiles etc., services sub-industries such as Education, Hospitality etc. and Public Administration. The variables I use are Gross Value Added at constant (2005) prices by each industry and the labor income share in Gross Value Added by the industry from 1980 to 2011. I compute the aggregate labor share of income for the Indian economy at period t (LS_t) as the weighted average of within-industry labor shares ($LS_{i,t}$) using the share of value added by that industry in the GDP ($VAS_{i,t}$) as the respective weights i.e.

$$LS_t = \sum_i LS_{i,t} VAS_{i,t}$$

where,

$$VAS_{i,t} = \frac{\text{value added by industry i}}{\text{GDP}} = \frac{VA_{i,t}}{\sum_i VA_{i,t}}$$

The labor share of income fell from 55.47% in 1980 to 48.5% in 2011. While the economy experienced a 6.9 percentage point decline over the period, not all industries experienced a decline or the same decline. Utilities, Hotels and Public Services experience an increase in the labor share of income. At the same time, the Wholesale and Retail industry and the Agriculture sector observe a <1 percentage point decline in the labor share of income. The labor share of income fell from 50.6% to 28.7% in Finance and Business Services during the same period. At the same time, the combined value-added share of the Finance and Business Services grew by 364.5% from 1980 to 2011, from 3% to 14% of GDP. I further investigate the fall in the aggregate labor share of income in India to quantify how much of the fall is owing to a decline in within-industry labor share changes and how much is due to the structural changes in the economy, i.e., if the aggregate labor share is declining due to an increase in value-added shares of sectors with low within sector labor shares. The decomposition of the total fall is into the following three effects - Labor share effect, Value added effect and the covariance term i.e.

$$\text{Total Change} = \text{VA effect} + \text{LS effect} + \underbrace{\sum_i (LS_t^i - LS_0^i)(VAS_t^i - VAS_0^i)}_{\text{Covariance Term}}$$

where the VA effect is the change in aggregate labor share keeping within industry labor shares constant at 1980 values

$$\text{VA Effect}: \textstyle\sum_i LS_0^i VAS_t^i - \sum_i LS_0^i VAS_0^i,$$

LS effect is the change in the aggregate labor share, keeping the structure of the economy constant at 1980 values.

$$\text{LS Effect}: \textstyle\sum_i LS_t^i VAS_0^i - \sum_i LS_0^i VAS_0^i,$$

The additional term is the covariance between the change in value-added share in an industry and the change in the labor share of income in that industry. Using the data on the 27 industries, I get the following decomposition of the change in the aggregate labor share of income with 1980-84 as the initial period.

	% of the total change
VA Effect	14
LS Effect	55
Covariance Term	31
Total decline	6.9 % points

Table 1: Decomposed change in labor share of income

Of the total decline of 6.8 percentage points in the aggregate labor share of income in India, the change in the labor shares of income within industries explains half of the total decline. Structural change is necessary to explain the remaining half. Nearly one-third of the drop comes from the cross term, i.e., value-added shares of industries went up within which the labor share of income fell. Change in the value-added share of industries alone, with no change in within-industry labor shares of income, explains 14% of the total change in the aggregate labor share of income. The graph below shows the VA effect and the LS effect over time. The decomposed labor shares for three scenarios - actual (*blue, solid line*), keeping within industry labor share constant (*red, dashed line*), and keeping value-added shares of the industries constant at 1980 values (*yellow, dotted line*).

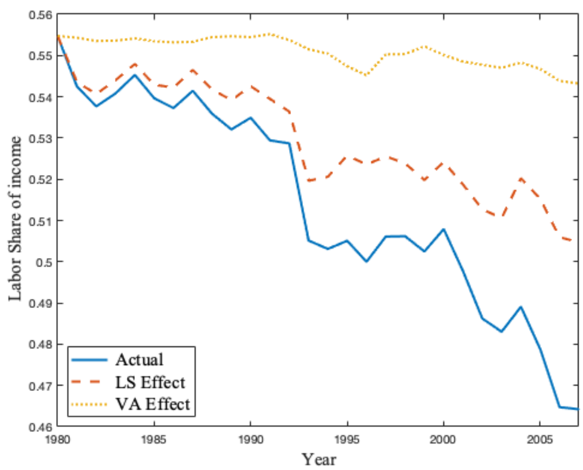


Figure 1: Decomposed labor share of income

The LS effect curve is the time series of the weighted average of the labor share of income within industries, keeping the weights, i.e., the respective value-added share of the industries constant at 1980 value. It represents the trend in the aggregate labor share of income that comes only from changes in the within-industry labor share of income. The VA Effect curve is the time series of the weighted average of the within-industry labor share of income, allowing only the weights to change. It, therefore, represents the changes in the aggregate labor share of income accruing to only the structural change in that period. The LS Effect curve closely follows the actual labor share of income till the early 90s. In that period, the VA Effect curve is almost constant. Post the mid-90s, the gap between the LS Effect curve and the Actual curve increases and there is a decline in the VA Effect curve.

From Figure 1, we can see that changes in within-industry labor shares alone cannot explain the changes in the aggregate labor share of income. From Table 1, the covariance term shows that the labor share of income was declining in industries that were increasing in their relative size in the GDP. This contributed to 31% of the decline in the aggregate labor share of income in that period.

Three-sector data

In light of these empirical findings, I use a multi-sector model to include the effects of structural change in changes in the aggregate labor share of income in the economy. For tractability in the use of the model, I aggregate the labor shares and the value-added shares in the 27 sectors available in KLEMS into three broad sectors - Manufacturing, Agriculture and Services using the relation -

$$LS_{i,t} = \sum_j LS_{i,j,t}\ VAS_{i,j,t}$$

i.e., the labor share in sector i at time t is the weighted average of labor share in sub-industry j in sector i at time t, where the weights are the value added by sub-industry j in sector i, as a share of the total value added by the sector

$$VAS_{i,j,t} = \frac{VA_{i,j,t}}{\sum_j VA_{i,j,t}}$$

Value added share of sector i at time t, i.e., $VAS_{i,t}$ is the sum of value added of the sub-industry j in sector i, as a share of the GDP.

$$VAS_{i,t} = \frac{\sum_j VA_{i,j,t}}{\sum_i \sum_j VA_{i,j,t}}$$

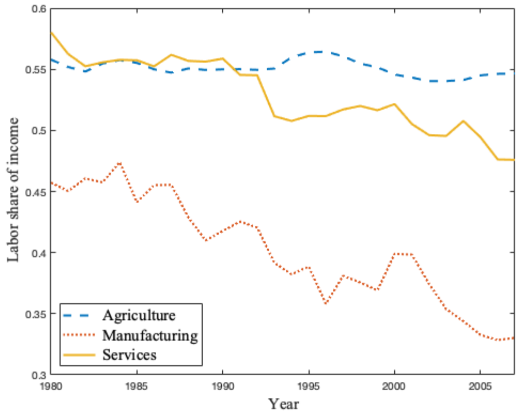
Following are the value added and the labor shares that I compute for the three sectors in India

	Labor Share		**Value Added Shares**	
	1980-84	2003-07	1980-84	2003-07
Agriculture	.55	.54	.36	.18
Manufacturing	.46	.34	.14	.16
Services	.56	.49	.50	.66

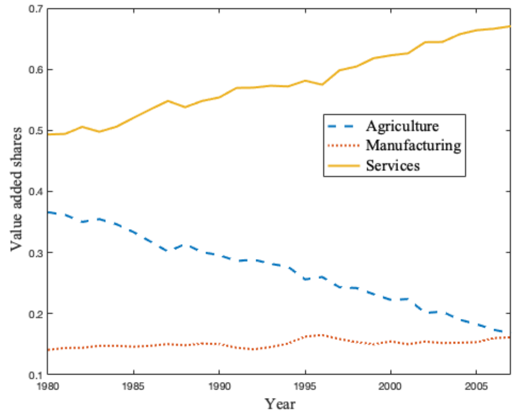
Table 2: Aggregated Data for the three sectors

The value-added share of Agriculture fell from an average of 35.6% to 18.4% from 1980-84 period to 2003-07. This decline is compensated by a much larger increase in the value-added share of the Services sector, from 49.9% to 66%, and an increase in the Manufacturing sector from 14.5% to 15.6%. This aggregation captures $\sim$ 50% of the interaction term, i.e., the sectors in which the labor share of income is falling (Manufacturing and Services) have increasing relative size in the GDP. The labor share of income in Manufacturing fell from an average of 46% in 1980-84 to 33.8% in 2003-07 and from 56.2% to 49% in the Services sector. The sharp secular decline in the value-added share of agriculture is accompanied by a relatively stable labor share of income in that sector.

Table 3 and Figure 3 below compare the decomposition into LS and VA effect for the aggregated and disaggregated data. The table gives the share of contribution of each of the three components in the total decline of the aggregate labor share of income. This aggregation gives half of the covariance term (change in within-sector labor share and change in value-added share of the sector) as in the disaggregated data. $\sim$ 80% of the decline in the aggregate labor share of income

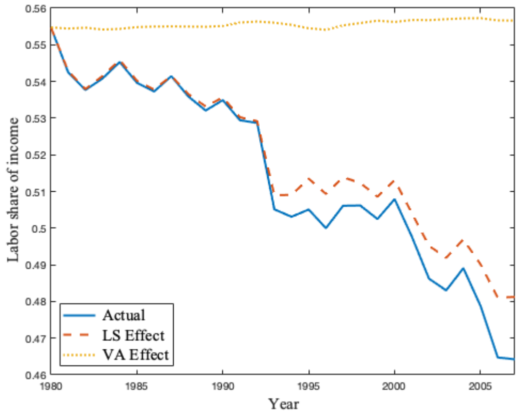


(a) Labor shares

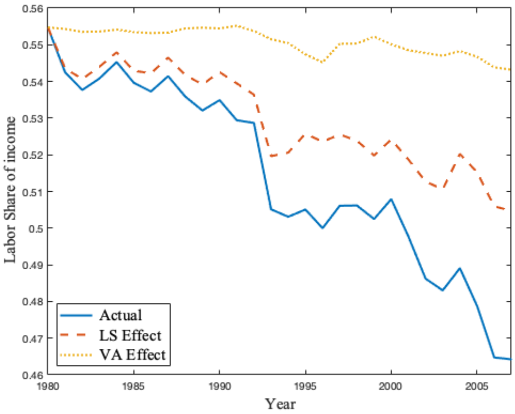


(b) Value Added shares

Figure 2: Three sector data



(a) Three sector data



(b) Industry level data

Figure 3: Decomposition of Trend in Labor Share of Income in Aggregated v/s Disaggregated data

can be explained by a within-sector decline in labor shares. In the absence of change in within-sector labor shares, changes in value-added shares of the three sectors do not contribute to the decline in the overall labor share of income.

	3 Sector (%)	Disaggregated Data (%)
VA Effect	0	14
LS Effect	84	56
Covariance Term	16	31

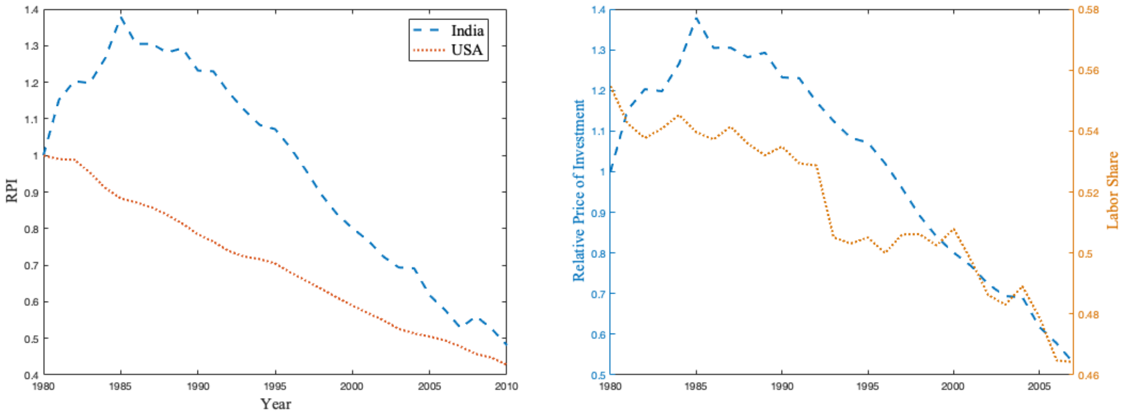
Table 3: Comparison of the three-sector aggregation with the disaggregated data.

2.2 RPI

In this section, I document a substantial drop in the relative price of investment goods (RPI) in India from 1980 upto 2019. I use data from Penn World Tables (PWT) and from Federal Reserve Economic Data (FRED) to compute the series on RPI (relative to consumption goods). PWT provides data on national accounts variables adjusted in common currency (US dollars) using detailed data on prices. The variable that I use is pl_i - price level of capital formation in country i relative to the world benchmark. In order to get the prices of investment goods relative to the price of other goods in the economy, I create a series of relative prices of investment goods relative to consumption goods. This series is comparable to the RPI series available for the US at FRED. I divide the price level of investment goods in India by the price level of investment goods in the US as provided in the PWT. I used this series normalized to 1 for 1980 and multiply it with respective values of RPI in the US (PIRIC[10]) series i.e.

$$\frac{pl_i(India)}{pl_i(US)} \times RPI_{US}$$

The figure 4 shows the series of RPI for both India and the US starting in 1980 as 1. RPI in India increased in the '80s with a peak in 1985. The RPI in India falls sharply in the late 90s and early 2000s, with some increases during the Great Recession. For the calibration and counterfactual exercise in section 6 of the paper, I use the average value of 1.24 in the period 1980-84 in the first steady state, and the average value of 0.55 in the period 2003-07 as the second steady state.



(a) Relative Price of Investment Goods

(b) India: RPI and Labor Share

Figure 4: Relative Price of Investment Goods

2.3 Markup

Markups are important in determining the labor share of income and, as a result, changes in markups over time could play an important role in changes in the labor share (De Loecker and Eeckhout (2018)). To obtain a quantitative evaluation of the causes for labor share declines, having a good sense of markups is therefore crucial. I use firm-level data to estimate markups using the production function estimation (Olley and Pakes (1996) (OP)) method. This method deals with the endogeneity problem in production function estimation by including a productivity shock in the estimating equation. The productivity shock evolves according to Markov Process and each firm has a unique history of productivity shocks. This requires a panel data set and the data set that I use is the Annual Survey of Industries (ASI), collected annually by the Ministry of

[10]DiCecio (Dec 2022)

Statistics and Program Implementation (MOSPI), Government of India. The data set is covered under two categories - Census Firms covering data for all firms with more than 200 workers and Sample Firms covering data for a sample of smaller firms. It contains detailed information on firms' working capital, capital stock, employment details, inputs and gross output. Unfortunately, the same firms are not included in the Sample set every year which takes away the panel feature that I need from the data. On the other hand, Census firms are followed on a complete enumeration basis and hence, I use firms in this sample set for the estimation process. While the ASI does not provide unique firm IDs to follow a firm over a period of time, the ASI incorporated time-invariant variables from 1998-1999 onward that can be used to create firm IDs across time. I use the methodology described in Bollard et al. (2013) to match observations across years to create unique firm IDs. Through my matching algorithm, I create panel data of around 12,000 census firms on average for each year for the period 2000 - 2018. The matching algorithm gives a match rate of $\sim$ 36 % on average per year. Details of the matching algorithm are provided in Appendix A.1.

To estimate the parameters of the production function through the Olley Pakes method, the relevant variables of interest in the ASI are Gross Sale Value, Net Value of (sub-total) Capital, Investment of (sub-total) capital during the year, and Cost of Production. The Gross Sale Value is the reported value of all sales made by the firm during the year from all its products. The gross sale value of a firm in the sample is, on average, 1.75b INR($\sim$ 21m USD). However, the data is highly skewed where a firm in the 50^{th} percentile has a gross sale value of 0.2b INR, and a firm in the 75^{th} percentile has a gross sale worth 0.8b INR. The top 1% of the firms have a gross sale value of 20b INR or more. ASI provides data on different fixed assets - land, plant and machinery, transport equipment, etc. I picked the sub-total category, which includes all fixed assets except Land and Capital work in progress. The data provides both year-opening and closing values of the net value of capital. I use the net value of capital at the beginning of the year. While the average value of capital is 450m INR, a firm in the 50^{th} percentile owns capital worth 30m INR. The top 1% of firms own assets worth 6b INR or more.

The bottom 10% of the firms do not invest annually on average. While the mean investment is 85m INR, the median firm invests 2.5m INR on average. Lastly, the total Cost of Production includes wages, the value of indigenous and imported inputs consumed, and costs such as rent paid for land/buildings, repair costs, insurance charges etc. The average cost of production in the period was 1.3b INR, wherein a median firm spent 152m INR on production, and the top 1% of the firms spent 15b INR. The table below gives some descriptive statistics of the variables above.

Variable	Mean	Median	Std dv.
Gross Sale Value	1.75b	221m	23.2b
Net Value of capital	451m	27.8m	5.72b
Investment	102m	4.7m	1.79b
Cost of Production	1.3b	152m	19b

Table 4: Descriptive Statistics of key variables.

Using the production function estimation approach, I use this panel data to compute markup values for the manufacturing sector from 2000 - 2018[11] (Olley and Pakes (1996)). Details of the estimation process are explained in section 5. I compute an average markup of 1.21 for the period 2000 - 2018. The Figure 5 shows the annual markup computed for each year. Although there was a sharp fall in markups during the Great Recession, there does not seem to be a clear upward or downward trend after 2000.

[11] The data prior to 1999 does not include the time-invariant variables necessary to match and create unique firm IDs.

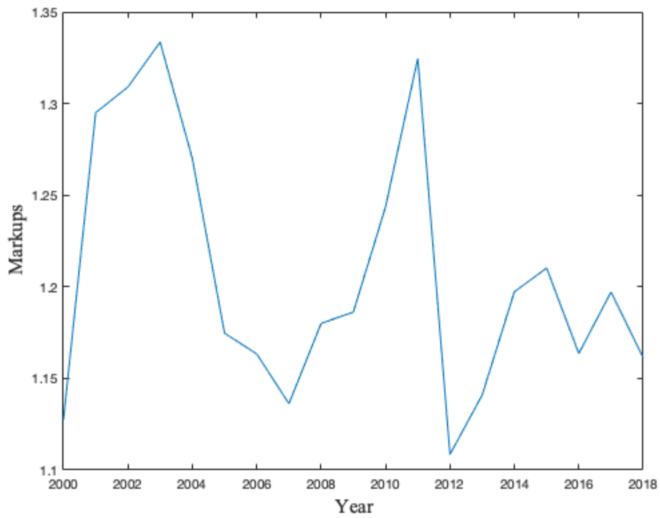


Figure 5: Markups

3 Markup Estimation

In this section, I describe the estimation process used in this paper to compute markup levels in India. I first use the Olley Pakes (OP) Production Function Estimation method to estimate the parameters of a Cobb-Douglas production function. The Olley Pakes (1996) is a two-stage estimation method with the following estimating equation:

$$y_{i,t} = \alpha + \beta_k k_{i,t} + \beta_x x_{i,t} + \omega_{i,t} + \eta_{i,t}$$

where, k_{it} is a dynamic input decided at period $t-1$, $x_{i,t}$ is a static variable input decided at period t. $\omega_{it,}$ is the productivity shock and $\eta_{i,t}$ is the measurement error. Firm-specific productivity shock addresses the endogeneity problem between the output and the inputs. The method assumes that the productivity shock evolves according to the first-order Markov process:

$$\omega_{i,t} = E(\omega_{i,t}|\omega_{i,t-1}) + u_{i,t} = g(\omega_{i,t-1}) + u_{i,t}$$

The OP process assumes that investment in period t is a function of capital in period t and the productivity shock in period t i.e.

$$inv_{i,t} = inv(k_{i,t}, \omega_{i,t})$$

, and that it is invertible

$$\omega_{i,t} = h(inv_{i,t}, k_{i,t})$$

I use the *prodest* function in STATA to get estimates of the variable inputs' parameters. Following Baqaee and Farhi (2020), I use the Gross Sale Value of each firm as the dependent variable $y_{i,t}$, value of Total Capital as the dynamic input $k_{i,t}$, Cost of Production as the static input $x_{i,t}$ and Investment as the instrumental variable. I use the estimate of the static variable parameter to compute markup following Hall(1998) [12] i.e.

$$\mu_i = \frac{\partial log y_i / \partial x_{i,t}}{\Omega_i} = \frac{\beta_x}{\Omega_i}$$

where Ω_i is the firm's expenditure on the cost of production relative to the firm's turnover. Following Baqaee and Farhi (2020), I use a three-year rolling window to estimate the production function

[12] The paper assumes Hicks-Neutral technology.

parameters for any given year, i.e., markup for year t has been estimated using data for periods $t-1$, t, $t+1$.

Markups were at 1.13 at the start of the 2000s and increased to 1.33 before the Great Recession. After the fall in 2006, there is no clear pattern in the levels, and with the most recent data available, the markup in 2018 was 1.16.

4 Model

In this section, I build a standard three sector model and use the data described in section 2 to calibrate crucial parameters such as the elasticity of substitution of labor and capital in the production function. The model is then used to run counterfactual to compare the contribution of the decline in the relative price of investment goods and the increase in markups to the decline in the aggregate labor share of income. The three sectors in the model are Agriculture, Manufacturing and Services.[13] Each sector has an intermediate goods producer and a final goods producer. The manufacturing sector has two final goods producers - Final Manufacturing Goods Producer and Investment Goods Producer. The Investment Goods Producer linearly transforms manufacturing goods into investment goods. All the Services final goods producers take inputs from the intermediate goods producers - z_m, z_a, z_o, and use CES technology to produce Y_m, Y_a, Y_o, respectively. Intermediate goods producers, on the other hand, use labor and capital as inputs. They use CES technology to produce, which differs in capital shares and elasticities of substitution between capital and labor for the three sectors.

I add mark-ups in the model following Karabarbounis and Neiman (2013), i.e., the intermediate goods producers face monopolistic competition within the sector, while the final goods producers are perfectly competitive. In this model, markups are determined by the demand sensitivity of the intermediate goods by the final goods producer. Therefore, any change in mark-ups in a sector comes from a change in the elasticity of substitution between inputs in the final goods production function.[14]

The households in this environment own and supply capital and labor to the intermediate goods producers. They are also the firms' owners and earn profits from the intermediate goods firms.

4.1 Manufacturing Sector

The manufacturing sector comprises of the final manufacturing goods producer, the investment goods producer, and the manufacturing intermediate goods producer. The intermediate goods producer uses labor and capital to produce the output used as inputs by the final goods produce. The final goods produce aggregates the inputs into final output. The final output is sold to households as manufacturing consumption goods and to the investment goods producer as input to produce investment goods. A detailed set up of the three producers in the manufacturing sector is as follows.

Final Goods Producer The final goods producer in the manufacturing sector combines a continuum of intermediate inputs $z_m \in [0,1]$ and produces the final food Y_m. The final good is either sold to households for consumption or used by the investment goods producer as input. Manufacturing good is produced using the following technology:

$$Y_{m,t} = \Big(\int_0^1 y_t(z_m)^{\frac{\epsilon_m - 1}{\epsilon_m}} dz_m \Big)^{\frac{\epsilon_m}{\epsilon_m - 1}}$$

[13] Herrendorf, Herrington, and Valentinyi (2015) have three broad sectors - Agriculture, Manufacturing and Services. In the data, they treat Construction and Mining as a part of the Manufacturing sector, while currently, these industries are included in the Services Sector in my classification.

[14] An alternate source of changes in average mark-ups in an industry is a change in the distribution of mark-ups amongst firms within the industry. Symmetry in intermediate goods and in their treatment in the production function of the final goods sector implies that the model abstracts from these causes of change in average mark-ups.

where $y_t(z_m)$ is the quantity of input z_m used in the production of the manufacturing good, and ϵ_m is the elasticity of substitution between inputs. Manufacturing goods producers buy the inputs at price $p_t(z_m)$ from the intermediate goods producers and sell their output at price $P_{m,t}$ which is normalized to 1. Under perfect competition, firms equate marginal cost to price, and we get the following:

$$P_{m,t} = \Big(\int_0^1 p_t(z_m)^{1-\epsilon_m} dz_m \Big)^{\frac{1}{1-\epsilon_m}} = 1$$

First order condition from cost-minimization implies the following input demand function:

$$y_t(z_m) = (p_t(z_m)/P_{m,t})^{-\epsilon_m} Y_{m,t}$$

Investment Goods Producer The investment goods producer linearly transforms some of the manufacturing goods into investment goods using the following technology:

$$X_t = Y^x_{m,t} A_{x,t}$$

where A_x is exogenously given, investment-specific production efficiency. The price of the investment good is q, and from the producer's profit maximization problem, we have

$$q_t = \frac{1}{A_{x,t}}$$

i.e., q is inverse of the production technology. In the paper, the change in the relative price of investment good q is assumed to have come from an exogenous change in this technology.

Intermediate Goods Producer The intermediate goods producers face monopolistic competition and take the demand function from the final goods producers as given $y_t(z_m) = p_t(z_m)^{-\epsilon_m} Y_{m,t}$. The intermediate goods producer chooses how much capital $k_t(z_m)$ and labor $l_t(z_m)$ to hire, how much to produce $y_t(z_m)$ and what price to charge $p_t(z_m)$. Their maximization problem is:

$$\underset{y_t(z_m),p_t(z_m),k_t(z_m),l_t(z_m)}{max} \Pi_t(z_m) = p_t(z_m)y_t(z_m) - R_t k_t(z_m) - W_t l_t(z_m)$$

s.t.

$$y_t(z_m) = p_t(z_m)^{-\epsilon_m} Y_{m,t}$$

&

$$y_t(z_m) = F^m(k_t(z_m), L_t(z_m))$$

where, $F^m(k_t(z_m), L_t(z_m))$ is the production function of the intermediate goods producer. I assume a CES production function wherein $y_t(z_m)$ for intermediate good producer of type z_m has the following production function:

$$F^m(k_t(z_m), L_t(z_m)) = \big(\alpha_m k_t(z_m)^{\frac{\sigma_m - 1}{\sigma_m}} + (1-\alpha_m) L_t(z_m)^{\frac{\sigma_m - 1}{\sigma_m}}\big)^{\frac{\sigma_m}{\sigma_m - 1}}$$

and, the marginal products are:

$$F^m_{k_t(z_m)} = \alpha_m \Big(\frac{y_t(z_m)}{k_t(z_m)}\Big)^{\frac{1}{\sigma_m}}$$

$$F^m_{L_t(z_m)} = (1-\alpha_m) \Big(\frac{y_t(z_m)}{L_t(z_m)}\Big)^{\frac{1}{\sigma_m}}$$

The first-order conditions from the profit maximization problem yield the following prices:

$$p_t(z_m) F^m_{k_t(z_m)} = \mu_m R_t$$

$$p_t(z_m) F^m_{L_t(z_m)} = \mu_m W_t$$

where μ_m is the markup:

$$\mu_m = \frac{\epsilon_m}{\epsilon_m - 1}$$

4.2 Agricultural Sector

The agricultural sector consists of final agricultural goods producers and intermediate agricultural goods producers. The final agricultural goods producer buys the output of the intermediate goods producer and households purchase the final goods.

Final Goods Producer The final goods producer in the agricultural sector combines a continuum of intermediate inputs $z_a \in [0,1]$ and produces the final food Y_a. Agricultural good is produced using the following technology:

$$Y_{a,t} = \Big(\int_0^1 y_t(z_a)^{\frac{\epsilon_a - 1}{\epsilon_a}} dz_a\Big)^{\frac{\epsilon_a}{\epsilon_a - 1}}$$

where $y_t(z_a)$ is the quantity of input z_a used, and ϵ_a is the elasticity of substitution between inputs. Agricultural final goods producers buy the inputs at price $p_t(z_a)$ from the intermediate goods producers and sell their output to households at price $P_{a,t}$. Under perfect competition, firms equate marginal cost to price, and we get the following:

$$P_{a,t} = \Big(\int_0^1 p_t(z_a)^{1-\epsilon_a} dz_a\Big)^{\frac{1}{1-\epsilon_a}}$$

First order condition from cost-minimization implies the following input demand function:

$$y_t(z_a) = (p_t(z_a)/P_{a,t})^{-\epsilon_a} Y_{a,t}$$

Intermediate Goods Producer The intermediate agricultural goods producers use labor and capital as inputs and produce the intermediate goods $z_a \in [0,1]$ using CES production technology. They are monopolistically competitive and set price $p_t(z_a)$ for their output. They take the price of inputs - W_t, R_t, the price of final agricultural goods $P_{a,t}$ and aggregate demand for $Y_{a,t}$ as given. Their profit maximization problem is:

$$\underset{y_t(z_a),p_t(z_a),k_t(z_a),l_t(z_a)}{max} \Pi_t(z_a) = p_t(z_a)y_t(z_a) - R_t k_t(z_a) - W_t l_t(z_a)$$

s.t.

$$y_t(z_a) = \big(p_t(z_a)/P_{a,t}\big)^{-\epsilon_a} Y_{a,t}$$

&

$$y_t(z_a) = F^a(k_t(z_a), L_t(z_a))$$

where, $F^a(k_t(z_a), L_t(z_a)))$ is the production function of intermediate good producer of type z_a. The function takes the following form:

$$F^a(k_t(z_a), L_t(z_a)) = \big(\alpha_a k_t(z_a)^{\frac{\sigma_a - 1}{\sigma_a}} + (1-\alpha_a) L_t(z_a)^{\frac{\sigma_a - 1}{\sigma_a}}\big)^{\frac{\sigma_a}{\sigma_a - 1}}$$

and, the marginal products are:

$$F^a_{k_t(z_a)} = \alpha_a \Big(\frac{y_t(z_a)}{k_t(z_a)}\Big)^{\frac{1}{\sigma_a}}$$

$$F^a_{L_t(z_a)} = (1-\alpha_a) \Big(\frac{y_t(z_a)}{L_t(z_a)}\Big)^{\frac{1}{\sigma_a}}$$

First-order conditions from the intermediate goods producer's maximization problem yield the following prices:

$$p_t(z_a) F^a_{k,t}(z_a) = \mu_a R_t$$

$$p_t(z_a) F^a_{l,t}(z_a) = \mu_a W_t$$

where μ_a is the markup:

$$\mu_a = \frac{\epsilon_a}{\epsilon_a - 1}$$

4.3 Services Sector

Like the agricultural sector, the services sector consists of final goods producers and intermediate goods producers. Households buy the final agricultural goods, and the producer of those buy intermediate goods to produce the final output.

Final Goods Producer The final goods producer buys a continuum of inputs $z_s \in [0,1]$ at price $p_t(z_s)$. The producer assembles the final goods using the following technology:

$$Y_{s,t} = \Big(\int_0^1 y_t(z_s)^{\frac{\epsilon_s - 1}{\epsilon_s}} dz_s \Big)^{\frac{\epsilon_s}{\epsilon_s - 1}}$$

where, $y_t(z_s)$ is the quantity of input z_s used in the production of the final good, and ϵ_s is the elasticity of substitution between inputs. Firms take price $P_{s,t}$ as given. Cost minimization yields the following condition:

$$y_t(z_s) = (p_t(z_s)/P_{s,t})^{-\epsilon_s} Y_{s,t}$$

The final good is competitively produced. This implies that firms choose to produce quantity such that the marginal cost of production is equal to the price i.e.:

$$P_{s,t} = \Big(\int_0^1 p_t(z_s)^{1-\epsilon_s} dz_s \Big)^{\frac{1}{1-\epsilon_s}}$$

Intermediate Goods Producer There are $z_s \in [0,1]$ types of intermediate goods in this sector. Each producer uses capital and labor as inputs using CES production technology. These are monopolistically competitive firms that set price $p_t(z_s)$. They take the price of inputs: wage rate W_t, rental rate R_t, price of final good $P_{s,t}$, and demand final output $Y_{s,t}$ as given. The profit maximization problem for each producer is the following:

$$\underset{y_t(z_s),p_t(z_s),k_t(z_s),l_t(z_s)}{max} \Pi_t(z_s) = p_t(z_s) y_t(z_s) - R_t k_t(z_s) - W_t l_t(z_s)$$

s.t.

$$y_t(z_s) = \big(p_t(z_s)/P_{s,t}\big)^{-\epsilon_s} Y_{s,t}$$

&

$$y_t(z_s) = F(k_t(z_s), L_t(z_s))$$

where, $F(k_t(z_s), L_t(z_s))$ is a CES production function of the intermediate good producer of type z_s. The function takes the following form: and, the marginal products are:

$$F^s(k_t(z_s), L_t(z_s)) = \big(\alpha_s k_t(z_s)^{\frac{\sigma_s - 1}{\sigma_s}} + (1-\alpha_s) L_t(z_s)^{\frac{\sigma_s - 1}{\sigma_s}}\big)^{\frac{\sigma_s}{\sigma_s - 1}}$$

$$F^s_{k_t(z_m)} = \alpha_s \Big(\frac{y_t(z_s)}{k_t(z_s)}\Big)^{\frac{1}{\sigma_s}}$$

$$F^s_{L_t(z_s)} = (1-\alpha_s) \Big(\frac{y_t(z_s)}{L_t(z_s)}\Big)^{\frac{1}{\sigma_s}}$$

First-order conditions from the maximization problem yield the following prices:

$$p_t(z_s) F^s_{k,t}(z_s) = \mu_s R_t$$

$$p_t(z_s) F^s_{l,t}(z_s) = \mu_s W_t$$

where μ_s is the markup:

$$\mu_s = \frac{\epsilon_s}{\epsilon_s - 1}$$

4.4 Household Sector

There is an infinitely lived representative household that buys investment goods for renting out as capital and consumption goods (C_m, C_a, C_s) from the three sectors in the economy. The household owns the firms in the economy and also supplies labor to the intermediate goods producers. It, therefore, has three sources of income - (i) labor income, (ii) rental income, and (iii) profit. Households derive utility from the consumption goods and discount the future at the rate of β. In the specification, households have a non-homothetic utility function in order to capture change in expenditure shares as the household becomes richer. Household's maximization problem is defined in the following:

$$\max_{C_{m,t}, C_{a,t}, C_{s,t}, K_{t+1}, L_t} \sum_{t=0}^{\infty} \beta^t u(C_{m,t}, C_{a,t}, C_{s,t})$$

subject to the budget constraint

$$C_{m,t} + P_{a,t}C_{a,t} + P_{s,t}C_{s,t} + q_t X_t \leq R_t K_t + w_t L_t + \sum_{i=m,a,s} \pi_{i,t}$$

The law of motion of aggregate capital is given by:

$$X_t = K_{t+1} - (1-\delta)K_t$$

where the initial level of capital in period 0: K_0 is given. Capital can move across the sectors over time. Household is assumed to have the following utility function:

$$U(C_a, C_m, C_s) = \sum_t \beta^t (C_{a,t} - \bar{a})^{\gamma_a} C_{m,t}^{1-\gamma_a-\gamma_s} C_{s,t}^{\gamma_s}$$

where households consume minimum subsistence level of consumption of agricultural goods $\bar{a}$. Solving the household's problem we get the following expenditure shares:

$$\frac{p_{a,t}C_{a,t}}{m_t} = \frac{p_{a,t}\bar{a}}{m_t} + \gamma_a \frac{m_t - p_{a,t}\bar{a}}{m_t}$$

$$\frac{C_{m,t}}{m_t} = (1-\gamma_a-\gamma_s)\frac{m_t - p_{a,t}\bar{a}}{m_t}$$

$$\frac{p_s C_{s,t}}{m_t} = \gamma_s \frac{m - p_{a,t}\bar{a}}{m_t}$$

where m_t is the total income of the household in period t. This functional form assumption allows for variation in consumption expenditure shares with varying income. This change in demand creates structural transformation in the model over time. From the household's problem, we also get the Euler equation:

$$R_{t+1} = \frac{q_t}{\beta} \frac{\frac{\partial U_{t,m}}{\partial C_m}}{\frac{\partial U_{t+1,m}}{\partial C_m}} - q_{t+1}(1-\delta)$$

4.5 Equilibrium

Steady-state equilibrium in the economy is described by quantities $\{ Y_m, Y_a, Y_s, Y_m^x, y(z_m), y(z_a), y(z_s), K, K_m, K_a, K_s, L_m, L_a, L_o, C_m, C_a, C_o\}$ and prices $\{P_m, P_a, P_s, p_m, p_a, p_s, w, R\}$ such that they satisfy the maximization problems in sections 3.1 - 3.4 and the following market clearing conditions:

1. Labor Market

$$L_m + L_a + L_s = 1$$

2. Capital Market
$$K_m + K_a + K_s = K$$
where, $K_m = \int_0^1 k(z_m)dz_m$, $K_a = \int_0^1 k(z_a)dz_a$, and $K_s = \int_0^1 k(z_s)dz_s$
3. Manufacturing Goods Market:
$$Y_m = C_m + Y_m^x$$
4. Agricultural Goods Market
$$Y_a = C_a$$
5. Services Goods Market
$$Y_s = C_s$$

4.6 Labor Share of Income

The total income generated in a sector is the sum of the labor share of income, capital share and profit share across all the intermediate goods producers. Following Karabarbounis and Neiman (2013), I assume intermediate goods producers in each sector are symmetric. The three shares of income in sector i at time t are:

$$s_{i,L,t} = \frac{1}{\mu_{i,t}} \frac{w_t L_{i,t}}{R_t K_{i,t} + w_t L_{i,t}}$$

$$s_{i,k,t} = \frac{1}{\mu_{i,t}} \frac{R_t K_{i,t}}{R_t K_{i,t} + w_t L_{i,t}}$$

$$\begin{aligned} s_{i,\pi,t} &= 1 - s_{i,L,t} - s_{i,K,t} \\ &= \frac{1}{\mu_{i,t}} \end{aligned}$$

Using the first-order conditions from the intermediate goods producer's problem, we can get the following expression for labor share of income:

$$s_{i,L,t} = \frac{1}{\mu_{i,t}} \big[1 - \alpha_i^{\sigma_i} \big(\frac{p_{i,t}}{\mu_{i,t} R_t}\big)^{\sigma_i - 1}\big]$$

From the equation above, the labor share of income is negatively related to the level of mark-ups regardless of elasticity of substitution ($\frac{\partial s_{i,L,t}}{\partial \mu i,t} < 0$). Increasing mark-ups increases profit share and reduces both labor and capital share of income.

However, the effect of change in the relative price of investment q depends on the substitutability or complementarity of labor and capital in production. From the Euler equation at steady state, rental rate R is increasing in q. If the two are substitutes ($\sigma > 1$), the labor share of income falls with a decline in the relative price of an investment, other things constant. In the case of complementarity ($\sigma < 1$), the labor share of income goes up with the decline in the relative price of investment goods. The decline in the relative price of investment increases the wage rate. Firms' demand for capital goes up with the decline in the rental rate, but with the complementarity in the production function, they have to buy the more expensive input, labor, as well. This leads to an increase in the labor share of income. This is contrary to the case with $\sigma > 1$, wherein a firm can substitute the now more expensive input labor for cheaper capital. This mechanism is the same as in Karabarbounis and Neiman (2013).

5 Quantitative Results

In this section, I investigate the relative contribution of two factors in the decline of the labor share of income - (i) a decline in the relative price of investment goods, (ii) a rise in profit shares. The decline of the relative price of investment goods is generated through improvement in technology in investment goods production, i.e., an exogenous increase in A_x. From section 4.1, we have that the relative price of investment goods q and production technology A_x are related by $q = 1/A_x$ in the model. Therefore, an improvement in the production technology A_x leads to a decrease in RPI in the model. For increasing market share in the model, I exogenously increase the mark-ups μ_i in each sector.

I consider multiple alternative calibrations - (i) with change in RPI only, (ii) with change in both RPI and mark-ups. Section 2 documents that markups have been stable at around 20% after 2000. However, due to a lack of data before 2000, there is uncertainty as to whether markups have increased substantially since 1980. For the model with a change in RPI and markups, I consider two extreme scenarios to cover the set of possibilities with respect to markups. In the first case, I use the average markup levels in the period 2003-07, i.e., $\mu_i = 1.22\ \forall i$ and assume that there has been no change in markups since the period 1980-84, i.e., $\mu_i = 1.22\ \forall i$ in the 1980-84 period as well. In the second case, I assume markups have changed since 1980-84 from an extreme value of no markups, i.e., $\mu_i = 1\ \forall i$.[15]

5.1 Decline in RPI

In the first exercise, I allow for a change in RPI only, keeping the values of markups constant for all sectors. I compare two steady states - the first one as 1980-84 and the second as the 5-year period before the Great Recession, i.e., 2003-07. With the calibrated model, I compute the aggregate labor share of income in the two steady states and decompose the change as described in section 2. I find that the model with no change in markups and only change in RPI matches the decomposition well i.e. gives the same contribution of the covariance term as observed in the data.

5.1.1 Calibration

I calibrate the discount factor to match the average value of the capital-output ratio for India of 2.8 in the period 1980-2007. The values for the α_i in each sector have been calibrated to match the average labor share of income in the 1980-84 period for each sector. The household sector's utility function is a non-homothetic utility function, with subsistence consumption of agricultural goods. Therefore, as the household income rises, the share of agricultural goods in the household expenditure tends to γ_a. I take the US economy as the benchmark with the highest per-capita income and set the value of $\gamma_a = 0.016$ as the average share of the agriculture sector in the US in that period was 1.6%. I calibrate the subsistence consumption $\bar{a}$ to target the value-added share of agriculture in 1980-84 in India ($\sim$ 36%). The manufacturing sector has two final goods - manufacturing consumption goods and investment goods. I use the depreciation rate to target the manufacturing sector's value-added share in 1980-84 ($\sim$ 14%). γ_s has been calibrated to match the value-added share of the Services sector in 1980-84.

Assuming that the change in labor share is coming entirely from a decline in the relative price of an investment, I calibrate the elasticity of substitution σ_i in each sector to match the change in the labor share of that sector from 1980-84 to 2003-07. The table below gives all the values of the parameters and the targets.

[15] De Loecker and Eeckhout (2018) compute a markup value of 1 for India in 1980 using linear extrapolation from their estimated series of markups. I am currently working on computing markups from 1980 - 2007 for the whole economy using production function estimation on data from KLEMS. See Appendix A.3.

Parameter	Value	Target
δ	.54	Average share of Manufacturing in 1980-84
β	.93	Average capital-output ratio in India
$\bar{a}$	.5	Average share of Agriculture in 1980-84
γ_a	.016	Average share of Agriculture in US $\sim$ 1.6%
γ_s	.93	Average share of Services in 1980-84
α_m	.34	Average LS in Manufacturing in 1980-84
α_a	.32	Average LS in Agriculture in 1980-84
α_o	.27	Average LS in Services in 1980-84
σ_m	1.4	Change in LS in Manufacturing from 1980-84 to 2003-07
σ_a	1.05	Change in LS Agriculture from 1980-84 to 2003-07
σ_s	1.3	Change in LS Services from 1980-84 to 2003-07

Table 5: Calibration: Change in RPI

5.1.2 Results

The elasticity values I get show that labor and capital are substitutes in all three sectors. However, the Manufacturing and the Services sectors have much higher elasticities of substitution, and the elasticity of substitution in the Agriculture sector is close to 1. As the relative price of investment decreases, labor becomes more expensive. Firms substitute labor for cheaper capital, and the labor share of income falls. A higher elasticity value in manufacturing 1.4 is needed to justify within the model the larger decline in the labor share of income in the sector, i.e., by ten percentage points. Whereas, the labor share of income falls by seven percentage points in the Services sector, giving an elasticity of substitution value of 1.3. The table below gives the labor share and value-added share of the three sectors in the two steady states, both as I get in the model and as observed in the data.

	Model		**Data**	
	1980-84	2003-07	1980-84	2003-07
q	1.16	0.62	1.16	0.62
μ_i	1.22	1.22	-	1.22
LS_m	.46	.36	.46	.34
LS_a	.55	.54	.55	.54
LS_s	.56	.49	.56	.49
VA_m	.14	.18	.14	.16
VA_a	.36	.21	.36	.18
VA_s	.50	.61	.50	.66
LS	.542	.476	.544	.476
LS change	**-.066**		**-.068**	

Table 6: Results from Change in RPI

The labor share of income in the data falls by 6.8 percentage points, while in the model, it falls by 6.6 percentage points. The aggregate labor share of income is computed as the weighted average of the labor share of income in the three sectors. While the change in within-sector labor share is targeted, the value-added shares are non-targeted.

The 47% decline in the relative price of investment goods increases the equilibrium stock of capital. With more capital, the economy's aggregate output and income increase, which changes the relative demand of the three consumption goods by households due to non-homotheticity. As the income increases, the household sector's consumption expenditure on agricultural consumption goods falls. As a result, the value-added share of agricultural goods falls from 36% to 21%. Households demand more Services goods than manufacturing goods, and hence, the value-added share of the Services sector goes up by 11 percentage points, and the value-added share of manufacturing goes up by only four percentage points, most of which comes from an increase in the production of investment goods.

With a lower RPI and higher capital stock, the wage rate goes up. As the three sectors have different elasticities of substitution, intermediate goods producers in the three sectors change their input mix differently. The capital-labor ratio goes up the most in the manufacturing sector, followed by the Services sector and least in the agriculture sector in the model. In the data, the capital-labor input ratio goes up the most in manufacturing and the least in Services.

Table 7 shows the distribution of the two factors - capital and labor, across the three sectors as computed in the model and as observed in KLEMS data.[16] Both in the data and the model, the ratio of workers employed in Agriculture goes down by 13 percentage points and up by 12 percentage points in the Services sector.

	Model		**Data**	
	1980-84	2003-07	1980-84	2003-07
L_m	.12	.13	.10	.11
L_a	.37	.24	.69	.56
L_s	.51	.63	.21	.33
K_m/K	.19	.24	.16	.26
K_a/K	.35	.18	.21	.12
K_s/K	.46	.59	.63	.62

Table 7: Labor and Capital share movements

While the capital stock increases, total labor is assumed to be the same, i.e., $L = 1$ in the two steady states. In the data, the value of capital increases by $\sim$ 300% and in the model, it goes up by $\sim$ 400%. The model does not do as well in matching the movement of the ratio of capital across sectors. In the model, I find that the ratio of total capital employed moves from Agriculture towards the Manufacturing and Services sector. While the ratio of capital goes down by 18 percentage points in the Agriculture sector, the ratio goes up by 5 percentage points in the Manufacturing sector and by 13 percentage points in the Services sector. In the data, ratio of capital in Agriculture sector goes down by 9 percentage points, and up by 10 percentage points in the Manufacturing sector.

Table 8 below compares the within-sector labor share changes v/s changes in value-added shares in the data with the model. As in the data, 80% of the change in the aggregate labor share comes from changes in the within-sector labor shares. The covariance terms in both are close to 16%, i.e., sectors with declining labor share of income were increasing in relative size in the economy. However, the change in value-added shares alone does not significantly contribute to the decline in the aggregate labor share of income.

[16] Labor in the data is measured in terms of number of persons, and capital stock is expressed in dollars.

	Model	Data
	(%)	(%)
VA Effect	4	0
LS Effect	80	84
Covariance Term	16	16
Total Decline	.07	.07

Table 8: Within-sector / VA share effects

5.2 The decline in RPI and Rise in Mark-ups

In the next exercise, I make the same change in RPI as in previous case. In addition to that, I add the extreme case of increase in markup i.e. zero markup in all sectors in the 1980-84 period to an average of 22% in the 2003-07. Following the calibration strategy as used before - I target the labor shares of income in the two steady states, the value added shares in the first steady state and compute the change in aggregate labor share of income in the second steady state. I find that the model in this case does not generate a big enough covariance term in the decomposition of the change in aggregate share of income, i.e., does not produce the contribution of the structural change in the decline of the labor share of income in India. Moreover, the resultant structural change in this scenario has the opposite impact on the aggregate labor share of income, i.e. prevents the labor share from falling even further.

In addition to this, I also do a counterfactual exercise to compare the contribution of RPI and markup in the decline of the aggregate labor share of income in India. I find that the calibrated values of elasticities of substitution changes significantly in this case which reverses the effect of the decline in RPI i.e. the decline in RPI prevents the aggregate from falling more than it did.[17]

5.2.1 Calibration

I follow the same calibration strategy as before. The discount rate β is calibrated to target the average capital-output ratio from 1980 - 2007. The household utility function parameters γ_a and γ_s target the average share of Agriculture and Services sectors, respectively, in during 1980-84. The subsistence level of agriculture consumption in the utility function $\bar{a}$ is set at 0.016 as the share of Agriculture in the same period in US GDP (1.6%). Since the demand for manufacturing goods comes from both consumption and investment goods, I use the depreciation rate to target the share of the manufacturing sector in the economy. A 4% depreciation rate targets the manufacturing sector's 14% average share in the first steady state. The capital share parameter in the production function is calibrated to target the labor shares in the respective sectors.

I calibrate the elasticities of substitution by matching the post-change labor share values computed in the model to the average labor share values in the respective sector post-2000. Labor share is now affected by both the relative price of investment goods (relative wage rate) and markups. From section 3.8, the labor share of income is a function of -

$$s_{i,L,t} = \frac{1}{\mu_{i,t}}\big[1 - \alpha_i^{\sigma_i}\big(\frac{p_{i,t}A_{i,t}}{\mu_{i,t}R_t}\big)^{\sigma_i - 1}\big]$$

[17]This result departs from Karabarbounis and Neiman (2013) in that their estimate of elasticity of substitution stays the same with or without markups that leads them to maintain their conclusion that decline in RPI explains half of the decline in the global average of labor share of income. The difference arises due to the degree of change in the markups. In Appendix A.2 I document results from varying levels of markup and varying degrees of changes in markup. I find that the level of markup does not matter but the degree of change in markup does.

Parameter	Value	Target
δ	.04	Average share of Manufacturing in 1980-84
β	.92	Average capital-output ratio in India
$\bar{a}$	1.4	Average share of Agriculture in 1980-84
γ_a	.016	Average share of Agriculture in US $\sim$ 1.6%
γ_o	.98	Average share of Services in 1980-84
α_m	.44	Average LS in Manufacturing in 1980-84
α_a	.79	Average LS in Agriculture in 1980-84
α_o	.53	Average LS in Services in 1980-84
σ_m	1.2	Change in LS in Manufacturing from 1980-84 to 2003-07
σ_a	.59	Change in LS in Agriculture from 1980-84 to 2003-07
σ_s	.85	Change in LS in Services from 1980-84 to 2003-07

Table 9: Calibration: Change in RPI and Markups

5.2.2 Results

The model generates a 5.8% decline in the aggregate labor share of income. The labor share of income in the Manufacturing sector falls from 46% to 34%. This fall can be accounted for by both the decrease in the relative price of investment goods through the substitution effect and by the increase in markups by 22%. With an elasticity of substitution value of 1.2, labor and capital are substitutes, and the decrease in the relative price of investment goods increases the wage rate, and firms substitute labor for capital. This decreases the labor share of income in the Manufacturing sector. In both Agriculture and Services sectors, however, labor and capital are complements with the elasticity of substitution values as 0.59 and 0.85, respectively. The labor share of income falls by only 2 percentage points in the agriculture sector and 7 percentage points in the Services sector. While the increase in markups puts downward pressure on the labor share of income, the decrease in the relative price of investment goods compensates for the fall. As the price of capital gets cheaper, firms hire both more capital and labor as they are complements in the production function. This compensates for the decline of labor share because of the increase in markups. As the decline of labor share is higher in the services sector than agriculture, the degree of complementarity is less in the services sector ($\sigma_s = 0.85$), than in agriculture ($\sigma_a = 0.59$).

	Model		Data	
	1980-84	2003-07	1980-84	2003-07
q	1.16	0.62	1.16	0.62
μ_i	1.0	1.22	1.0	1.22
LS_m	.46	.34	.46	.34
LS_a	.55	.53	.55	.54
LS_s	.56	.49	.56	.49
VA_m	.15	.11	.14	.16
VA_a	.36	.27	.36	.18
VA_s	.50	.63	.50	.66
LS	.543	.484	.544	.476
LS change	**-.058**		**-.068**	

Table 10: Results from changes in RPI and Markups

Table 10 compares the pre- and post-change periods in the model with the data. The value-added shares in the three sectors in the second column of the model are non-targeted. The calibration exercise leads to a four percentage point decline in the value-added share of the manufacturing sector compared with a two percentage point increase in the data. The fall in the value-added share of agriculture is less than as observed in the data. For the Services sector, the increase in its value-added share is less than in the data. The increase in markups suppresses output and the change in value-added shares via changes in household consumption demand is not as much as in the case when there is no change in markups. Manufacturing's value-added share goes up because the demand for investment goods goes up with a lower RPI. In the scenario of a decline in RPI and an extreme increase in markups by 22%, the model does not match the value-added shares with the data as well as the scenario where the markups do not change.

The input mix in the three sectors changes differently. As in the case of no change in markups, the capital to labor input ratio increases the most in the manufacturing sector, and the least in the agriculture sector. The model overstates the growth of capital in Services and does not show growth in the share of capital in the manufacturing sector. The model with a huge increase in markups also does not match the changes in the distribution of labor across the three sectors. It shows a decline in the share of labor in Manufacturing by 5 percentage points, in Agriculture by 7 percentage points and an increase in Services by 12 percentage points. These changes do not match the changes observed in the data. Table 11 shows changes in the shares of input across sectors.

	Model		Data	
	1980-84	2003-07	1980-84	2003-07
L_m	.12	.08	.11	.11
L_a	.36	.29	.69	.56
L_s	.52	.63	.21	.33
K_m/K	.17	.16	.16	.25
K_a/K	.35	.23	.21	.12
K_s/K	.48	.61	.63	.62

Table 11: Labor and Capital movements

Table 12 below compares the contribution of changes in the within-sector labor shares and the contribution of changes in value-added shares in the data with the model results. All of the decline in the aggregate labor share of income in the model comes from changes in the within-sector labor shares. The structural change in the economy in the absence of changes in the labor shares of income would have led to an increase in the aggregate labor share of income as the Services sector, the sector with the highest initial share of labor income increases in its value-added share in the GDP, and manufacturing goes down in size. The covariance term, however, pushes the aggregate labor share of income down.

With a 20% increase in markups, all of the labor share decline is attributed to within-sector changes and there is no contribution of structural change. On the contrary to data, a very high increase in markups reduces the within sector labor shares by so much that the aggregate labor share would have fallen by even more had there been no structural change.

	Model	Data
	(%)	(%)
VA Effect	-9	0
LS Effect	104	84
Covariance Term	5	16
Total Decline	.06	.07

Table 12: Within-sector / VA share effects

Counterfactual

In the counterfactual exercise, I use the calibrated model here to compute the impact of the decline in RPI and increase in markups separately. The first column in Table 13 is the values of the labor share and the value-added shares of the three sectors during the first steady state (1980-84). In the second column are results from the experiment where RPI goes down by 47% from an average of 1.16 to 0.62 while keeping the markup at 1. From these results, had markups not risen in the Indian Economy, access to cheaper investment goods would have increased the labor share of income to 60%. This is owing to the elasticity of substitution between labor and capital is less than one in both Agriculture and Services. With cheaper capital, firms in the two sectors hire both more capital and more workers (at a higher relative wage rate). This increases labor share in the agriculture sector from 55% to 69%, and in the Services sector from 56% to 64%. Moreover, with higher capital in the economy, aggregate income in the economy goes up, and with the non-homothetic utility function, demand for consumption goods from the three sectors changes differently. While the value-added share of the agriculture sector goes down from 36% to 23%, the value-added share of the Services sector goes up from 50% to 64%. On the other hand, the labor share in the manufacturing sector falls as the elasticity of substitution between labor and capital is > 1, and the value-added share of the manufacturing sector declines from 15% to 13%. These changes result in an overall increase in the labor share of income in the economy.

q	1.16	0.62	1.16	0.62
μ_i	1.0	1.0	1.22	1.22
LS_m	.46	.39	.39	.34
LS_a	.55	.69	.41	.53
LS_s	.56	.62	.45	.49
VA_m	.15	.13	.13	.11
VA_a	.36	.23	.42	.27
VA_s	.50	.64	.46	.63
LS	.54	.60	.43	.48

Table 13: Results from Counterfactuals

The results change when we allow markups to increase and keep the relative price of investment goods at the 1980-84 level. The markup increase leads to a decline in labor share in all three sectors (column 3 above). The increase in markups suppresses demand and income in the economy. With lower income, households consume less of all three goods. However, due to the non-homothetic utility function with a subsistence level of agriculture goods consumption and high weight on services goods consumption ($\gamma_s = 0.93$), the share of income spent on agriculture goes up, and the share of income spent on manufacturing goods and services sector goes down. With lower income, investment also goes down, which suppresses the value-added share of the manufacturing sector even further. As a result, the value-added share of the agriculture sector goes up from 36% to 42%. The share of the manufacturing sector goes down to 13% and of the services sector to 46%. The overall effect is a fall in aggregate labor share of income from 54% to 43% due to an increase in markups.

The last column of the table above is the result of both changes in the RPI and changes in markups for comparison. From the counterfactual exercise, I find that the decline in RPI mitigates the effect of the increase in markups on the labor share of income and prevents it from falling even further when both changes in RPI and markups are incorporated into the model. Had there been no increase in markups, the decline in the relative price of investment goods would have increased the aggregate income. At the same time, the aggregate labor share of income would have gone up by six percentage points instead of the six percentage points decline.

5.3 Comparison: RPI v/s Markups

From the exercise above, the scenario in which the relative price of investment goods falls by 47% and India had a constant level of markups at 1.22 matches some of the variables in the data better than the scenario in which there is a huge increase in markups. In the first scenario, the model generates 96% of the decline as observed in the data, while the decline in RPI with a large increase in markups can generate 84% of the decline. While the within-sector labor shares are targeted, the value-added shares post-exogenous changes are not. When there is no increase in markups, the value-added shares generated in the model match the shares as observed in the data. The changes in the within-sector labor shares, along with the changes in the value-added shares, give a value of 16% to the covariance term in the decomposition of the total decline. Table 14 below compares the decomposition of the aggregate labor share of income in the two scenarios along with the data.

	Only RPI (1)	RPI and Markup (2)	3 sector Data
LS Effect	81	104	84
VA Effect	4	-9	0
Covariance Term	16	5	16

Table 14: Decomposition of total decline
(in %)

Scenario 1 also matches the shifts in the labor employment shares across sectors. While in both scenarios, a higher share of workers are in Services than in the data (see table 15), the scenario with no increase in markups generates the same percentage change as in the data (Table 16). Moreover, in the first scenario, the share of capital employed in Manufacturing, relative to the other sectors, increases over time, while in the second scenario, it decreases. The decline in RPI increases demand for investment goods produced in the manufacturing sector. A huge increase in markups reduces aggregate demand and output in the economy and, hence, reduces demand for capital. The total stock of capital increases in both scenarios, though the first case overestimates the increase in capital stock (by $\sim 400\%$), and in the second scenario, it grows by $\sim 120\%$. In the data, capital grew by 260% during the period 1980 - 2007.

Overall, a decline in the relative price of investment goods along with no or very small increase in markups explains the decline in the aggregate labor share of income better than the extreme case of an increase in markups from no markup to 22%. The former is more consistent with the sectoral changes observed in the data, along with some other input-mix related variables.

	(1)	(2)	3 sector Data
Manufacturing	12	12	10
Agriculture	37	36	69
Services	51	52	21

Table 15: Initial share of Labor employment (in percentage)

	(1)	(2)	3 sector Data
Manufacturing	1	-5	1
Agriculture	-13	-7	-13
Services	12	12	12

Table 16: Change in share of Labor employment (in percentage points)

	(1)	(2)	3 sector Data
Manufacturing	19	17	16
Agriculture	35	36	21
Services	46	52	63

Table 17: Initial share of capital employment (in percentage)

	(1)	(2)	3 sector Data
Manufacturing	5	-2	9
Agriculture	-18	-12	-9
Services	13	14	-1

Table 18: Change in share of capital employment (in percentage points)

6 Conclusion

This paper is a quantitative exercise to determine the factors contributing to the decline in aggregate labor share of income in India from 1980 to 2007. In an empirical exercise, the paper finds that only changes in labor shares of income within different industries in India explain only half of the decline in the aggregate labor share of income. Structural changes that occurred during the three decades contributed to the other half of the decline. Industries with declining labor share of income were also the ones that were growing in size. This covariance term contributed to 31% of the total decline using the 27 industry disaggregated data provided in KLEMS.

Holding this decomposition as the benchmark, the paper uses a three-sector model to generate a decline in the aggregate labor share of income in India through two mainstream causes of the decline - a decline in the relative price of investment goods and an increase in markups. As detailed firm-level data to estimate markups is unavailable for the period before 2000, the paper considers two extreme scenarios - no change in markups and a change in markup from a value of 1 to 1.22, which is estimated in the paper. I find that the model better explains the decline in labor share of income when there is a decline in RPI and no change in markups than in the scenario where markups go up by 22 percentage points. In the first case, the value-added shares computed by the model and the decomposition of the decline in the aggregate labor share of income closely match the three sector aggregated data. The decline in the relative price of investment goods leads to a decrease in the labor share in the Services sector by seven percentage points, which grows in size by 11 percentage points and a decrease in the labor share of income in the Manufacturing sector by ten percentage points, which grows in size by four percentage points. The sectors with large drop in labor share of income are increasing in size. At the same time, the labor share of income in agriculture goes down by only 1 percentage point, whereas the value-added share of the agriculture sector goes down by 15 percentage points. This leads to the aggregate labor share of income falling by 6.5 percentage points where the covariance term contributes to 16% of the decline as in the three sector aggregated data. Moreover, in a counterfactual exercise, the paper finds that an extreme change in the markups can reverse the impact of the RPI.

The paper highlights the importance of structural changes in explaining the decline in the labor share of income in India. Having a multi-sector model allows for varying elasticities of substitution between labor and capital in different sectors. A decline in the relative price of investment goods, thus, generates varying responses in different sectors. Moreover, with changes in aggregate output and income, the model generates changes in the value-added shares of the three sectors. The model, therefore, creates co-movements in labor shares of income and value-added shares of income. The calibration strategy used in the paper generates the changes in value-added shares of three sectors that explain the contribution of structural changes in the decline of the aggregate labor share of India. The paper, therefore, argues that while RPI stimulated a change in the input mix used in firms, thereby changing the labor share in various sectors, the understanding of the economy's aggregate labor share of income is incomplete without the sectoral decomposition of the economy. While this paper covers a three-sector model, this exercise could be potentially done to more than three sectors in the economy that might get closer to the covariance term in the disaggregated data. This exercise could also be done for other countries to compare the results.

The paper also estimates markups for the Indian economy. It finds annual markups for the manufacturing sector in India post-2000s, with an average value of 1.22 in the period 2003-07. This exercise can be further pursued to study the markup distribution of manufacturing firms in India, the distribution shift amongst the firms over time, and other related questions.

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A Appendix

A.1 Matching Algorithm

The data in ASI is collected annually. For each year, the data is collected in several blocks (A-I). Each firm is assigned a unique DSL number for the year, which is maintained across the blocks. I use this DSL variable to merge the data from different blocks into one file for each year. To maintain anonymity, these DSL values are not maintained across time. Therefore, to create a true panel, I use time-consistent variables available for each year and match some of those to create firm IDs across time. These time-consistent variables were available from 1998 onwards; hence, a panel can be created only post that period.

Along with the variables of interest mentioned in 2.2 in the section, I keep the following variables:

1. NIC 5 digit industry code
2. Year of initial Production
3. State Code
4. Rural/Urban location dummy
5. Type of Organization

and year opening and closing values of -

6. Outstanding loan
7. Assets
8. Subtotal Capital

I first clean the data, removing negative values of Gross Sale Value, Investment, Capital, Wages, and Cost of production. With the possibility of inconsistent data collection, I also removed all firms with initial years of production before 1947, when India gained independence. With this data set, I first group firms with the same values: NIC 5-digit code, Year of initial production, State code, Rural/Urban status and Type of Organization. Within each group, I assign a matching value of 1 for each loan, asset, and capital if the opening and closing values of the variables rounded to 10^6 are equal. I assign the same firm ID if the observations belong to the same group value and have a matching value of 1 for at least one of the three variables. I drop a firm if I have multiple entries with the same year and the same assigned firm ID.

A.2 Alternate changes in markup

In order to understand the role of markups in the model, I perform a series of calibrations and make a comparison similar to Karabarbounis and Neiman (2013) for India. Karabarbounis and Neiman (2013) find that the fall in the relative price of investment goods contributes to half of the fall in the global labor share of income. They find no significant change in their estimates of elasticities of substitution when they add a 5% increase in markups starting with no markups. The paper, therefore, concludes that a decline in RPI caused half of the decline in the labor share of income globally. In this section, I test the effect of varying initial levels of markup and varying degrees of changes in markups on the labor share of income and the estimates of the elasticity of substitution between capital and labor. Additionally, I compare the decomposition of the decline in the aggregate labor share of income in the different scenarios.

The time periods I use in this exercise are 1980 values for the first steady state and 2011 values for the second steady state. The calibration strategy is the same as before. I calibrated the discount factor to match the average capital-output ratio in that period for India. Parameters α_i are calibrated to match the labor shares of income in sector i in 1980, and the elasticity of substitution values are calibrated to target the labor share values in 2011. Depreciation rate δ is calibrated to target the value-added share of the manufacturing sector in 1980. γ_a is set to 0.016 to match the share of the agriculture sector in the US, and $\bar{a}$ is calibrated to target the value-added share of the agriculture sector in India.

Table 19 below shows the values of the elasticity of substitution for the different calibrations. The first column is the case when there are no markups in the economy; the second column is when markups increase by 5% point, starting with no markups in the first steady state. Column 3 has calibrated values when there is a 5% point increase in the markups but with a higher starting level of 30%. I calibrate the model in the last column with a markup change from 30% to 60%. The markup increase from 1.3 to 1.6 is taken from De Loecker et al. (2020), which is their estimate of markups for the US from 1980-2016. The table also compares the decomposition of the decline in the aggregate labor share.

	no markup	$1 \to 1.05$	$1.3 \to 1.35$	$1.3 \to 1.6$	3 sector Data
σ_m	1.26	1.25	1.43	1.26	-
σ_a	1.005	0.96	0.95	0.36	-
σ_o	1.16	1.12	1.25	0.65	-
LS Effect	81%	86%	86%	104%	81%
VA Effect	-7%	-6%	$\sim$ 0%	-6%	-3%
Covariance Term	26%	20%	14%	1%	22%

Table 19: Result Comparison

The elasticities of substitution do not change much if there are no or small changes in markups. However, a large markup increase puts a large downward pressure on the labor share. The decline in the relative 'price of investment goods has to compensate for this downward pressure. As a result, we get complementarity between labor and capital. The decline in the relative price of investment goods and the complementarity between labor and capital increases the labor share of income as firms cannot substitute labor for capital.

No or 5% change in markups gives a decomposition of the aggregate labor share changes that are similar to the data. The LS Effect in the first three columns is close to the 81% change as in the data. A higher percentage change in markups increases the effect of changes in within-sector labor share on the change in the aggregate labor share of income, as a higher profit share in a sector directly reduces the labor share of income in that sector. Additionally, the higher percentage change in markup reduces the positive impact of cheaper investment goods on output. As a result, the value-added shares of the three sectors do not change such that we get a big enough covariance term.

While the markup level does not seem to matter, a big increase in markup reduces the contribution of structural change on changes in the aggregate share of income. Moreover, a large enough increase in markups changes the calibrated values of elasticities of substitution by a lot. From the counterfactual exercise (as in section 5.2.2), a large increase in markup also reverses the impact of the decline in RPI on the aggregate labor share of income in the model.

A.3 Markups: 1980 - 2007

In the paper, all results are based on markup levels estimated using the Annual Survey of Industry data, which covers data for manufacturing firms and post-2000s only. In this section, I attempt to get estimates of markups for the entire economy from 1980 - 2007. I use the industry-level data provided by KLEMS to create the panel data necessary for the estimation process. The estimating equation is the same as before, i.e.

$$y_{i,t} = \alpha + \beta_k k_{i,t} + \beta_x x_{i,t} + \omega_{i,t} + \eta_{i,t}$$

where, $y_{i,t}$ is the value of the gross output of industry i at time t. As before, the dynamic input decided in period $t-1$ is $k_{i,t}$ i.e. the capital stock owned by an industry i, $\omega_{i,t}$ is the productivity shock (following first-order Markov process) and $\eta_{i,t}$ is the measurement error. As regards to the static variable, $x_{i,t}$ I estimate using two different variables available in the data - Labor Employment (LABEMP) and Intermediate inputs (II). For lack of data on investment in KLEMS, I use alternate variables as Intermediate Energy Income (IIE) and Intermediate Material Income (IIM) following Petrin et al. (2004) as proxy variables to learn about the productivity shock $\omega_{i,t}$.

I use the *prodest* function in STATA to get estimates of the variable inputs' parameters. A difference here than before in section 3 is that I use the Levinsohn Petrin (LP)[18] method in the *prodest* function instead of Olley Pakes (OP). I use the Gross Output in each industry as the dependent variable $y_{i,t}$, the value of the capital stock as the state variable $k_{i,t}$, LABEMP or II as free variables $x_{i,t}$ and IIM or IIE as the instrumental variable. I use the estimate of the free variable parameter to compute markup following Hall(1998), i.e.,

$$\mu_i = \frac{\partial log y_i / \partial x_{i,t}}{\Omega_i}$$

where Ω_i is the industry's expenditure on labor relative to the firm's turnover in cases where labor is used as the free variable and the industry's expenditure on intermediate inputs when the intermediate inputs are used as the free variable.

Free	Proxy	1980-84	2003-07
LABEMP	IIM	1.32	1
LABEMP	IIE	1.46	1.1

Table 20: Result Comparison

The results vary depending on the combination of inputs used in the estimation process[19], however, my early estimates do not support a huge increase in markups, further strengthening the paper's conclusion that . In the future, I can refine the process for Indian data and get better markup estimates. I plan to use aggregate economy-level markups for the calibration.

[18] Petrin et al. (2004)

[19] Raval (2023) argues that markups using labor and materials do not give the same markup distribution, contrary to what is assumed in the production approach to markup estimation.