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1. Introduction

This study attempts to explore whether and to what extent occupational gender segregation affects average earning difference between male and female informal sector workers in India. A decomposition exercise is undertaken in order to examine the contribution of occupational segregation, if any, to the gender earning difference. A decomposition framework has been developed (by reducing weighting bias) to study the relative roles of gender segregation across occupations and within-occupation earning differentials in explaining overall average gender earning gap. Rural-urban differentials are examined explicitly. The interesting point of this study is to isolate the effects of both the occupational segregation and the earning differences within occupations which differ from the findings usually reported in the international literature on gender pay gaps where substantial contribution from segregation was appeared (Petersen and Morgan, 1995; Brick et al, 2023).

Empirical studies are available on pattern of informal/unorganized sector employment in India at the aggregate level (Mitra, 1998; Kundu and Lalitha, 1998; Ghosh, 2001; Sakthivel and Joddar, 2006; Sen and Das, 2016*).* Some studies concentrated on the conditions of informal sector workers and their social security (Jhabvala, 1998; Unni, 2005). Sen and Das, (2013) performed the efficiency analysis of India's unorganized manufacturing sector by using Data Envelopment Analysis (DEA) technique. Some works also highlighted the gender disparity in employment and wage in the overall Indian labour market (Rustagi 2005; Duraisamy and Duraisamy, 1996). In connection with gender segregation in Indian overall labour market, some works may be cited (Swaminathan and Singh, 2006, Chattopadhyay et. al. 2013; Agrawal and Agrawal, 2015; Agrawal, 2016). Most of the studies on occupational gender segregation were in the context of India's overall labour market. Works are mostly performed for rural and urban informal sector workers of India specifically. Moreover, this paper has developed a decomposition scheme as an extension of Kidd and Shannon (1996) methodology (by minimizing weighting bias) in order to examine the relative roles of gender segregation across occupations and within-occupation earning differentials in explaining overall average earning differences. This study puts emphasis on the contribution of both occupational segregation and within-occupation earning difference which differs from the findings of previous studies on gender pay gaps where substantial contribution from gender segregation was appeared (Petersen and Morgan, 1995; Brick et al, 2023).

2. Methodology

Gender segregation occurs when distributions of male and female workers across different occupations are a bit dissimilar. There are several measures to account the degree of gender segregation across occupations in an economy. Most widely used measure of segregation is the Index of Dissimilarity (I_D) (Duncan & Duncan, 1955) which is defined as:

$$I_D = \frac{1}{2} \sum_{1}^{k} \left| \frac{F_j}{F} - \frac{M_j}{M} \right|.$$

F_j and M_j denote the number of female and male workers engaged with the jth occupation respectively, k is the total number of occupations and F & M are total female and male workers respectively. This measure indicates the proportion of male and female workers to be transferred to make the two distributions equal. I_D ranges from 0 (when both distributions are identical) to 1 (when two distributions are perfectly segregated) i.e., $0 \leq I_D \leq 1$.

Karmel and MacLachlan Index or KM Index is a transformation of I_D where respective shares of both males and females in total labour force participation are taken into account (Karmel & MacLachlan, 1988). KM Index is defined as:

$$KM = \frac{1}{T} \sum_1^k \left| \frac{M}{T} F_j - \frac{F}{T} M_j \right|.$$

T, F and M are the female, male and total number of workers respectively. KM Index ranges from 0 (in case of perfect similarity) to $2.\frac{M}{T}.\frac{F}{T}$ (in case of complete dissimilarity). Relationship between KM index and Duncan's Index of Dissimilarity (I_D) can be derived as:

$$KM = 2 \frac{M}{T} . \frac{F}{T} . I_D$$

One important shortcoming of KM Index is that the level of segregation may increase solely because of an increase in female employment. To examine the occupational gender segregation in India's informal sector we have used these two indices for rural and urban areas separately.

2.1 Occupational Segregation and Gender Earning Gap: A Decomposition Exercise

We are interested to analyze more formally whether and to what extent occupational gender segregation explains average earning difference between male and female informal sector workers. Overall gender earning gap may be decomposed into a portion explained by gender differences in the distribution of workers across occupations/activity groups and a portion explained by earning differentials within occupations/activity groups. Quantitative estimates of their relative roles can be accounted for by algebraic decomposition schemes. Since the early 1970s, a majority of the empirical literature on gender wage gap has used Blinder-Oaxaca (BO) decomposition, a formal statistical technique introduced by Oaxaca (1973) and Blinder (1973) that builds on the theory of labour discrimination. Following Kidd and Shannon (1996) decomposition methodology, we have developed a decomposition framework (by taking care of weighting bias) to examine quantitatively the relative roles of gender segregation and earning differentials across and within occupations in explaining average earning gap. A unique scheme is formulated as an alternative to Kid & Shannon (1996) decomposition scheme by minimizing the weighting bias.

Let E_m and E_f are overall average earning for male and female workers at a particular time point. Now overall average earning gap between male and female workers may be defined as

$$E_m - E_f = \sum_j \alpha_{mj} E_{mj} - \sum_j \alpha_{fj} E_{fj} \quad \ldots . (1).$$

α_{mj} and α_{fj} are shares of male and female employment in occupation j. E_{mj} and E_{fj} are average earnings within occupation j.

Now gender earning gap (average) can be written as

$$E_m - E_f = \sum_j E_{mj} (\alpha_{mj} - \alpha_{fj}) + \sum_j \alpha_{fj} (E_{mj} - E_{fj}) \quad \ldots . (2)$$

$$\text{or } 100 = \frac{\sum_j E_{mj} (\alpha_{mj} - \alpha_{fj})}{E_m - E_f} .100 + \frac{\sum_j \alpha_{fj} (E_{mj} - E_{fj})}{E_m - E_f} . 100 \quad \ldots . (3)$$

Alternatively, equation (1) can also be written as

$$E_m - E_f = \sum_j E_{fi} (\alpha_{mj} - \alpha_{fj}) + \sum_j \alpha_{mj} (E_{mj} - E_{fj}) \quad \ldots . (4)$$

$$\text{or} \quad 100 = \frac{\sum_j E_{fj}(\alpha_{mj} - \alpha_{fj})}{E_m - E_f}.100 + \frac{\sum_j \alpha_{mj}(E_{mj} - E_{fj})}{E_m - E_f}.100 \quad \ldots . (5).$$

Decomposition schemes (2) & (4) are not same. In scheme (2), $(\alpha_{mj} - \alpha_{fj})$ is weighted by the male earning/wage within the occupation j i.e., E_{mj} while $(E_{mj} - E_{fj})$ is weighted by female employment in occupation j i.e., α_{fj} . Scheme (4) attaches weight just in the opposite way. In fact, the unique scheme does not exist. Results hence differ. This is clearly due to bias in weights. So in order to minimize such bias, an alternative scheme may be formulated by combining (2) & (4) as

$$2(E_m - E_f) = \sum_j E_{mj}(\alpha_{mj} - \alpha_{fj}) + \sum_j \alpha_{fj}(E_{mj} - E_{fj}) + \sum_j E_{fj}(\alpha_{mj} - \alpha_{fj}) + \sum_j \alpha_{mj}(E_{mj} - E_{fj})$$

$$(E_m - E_f) = \sum_j \frac{(E_{mj} + E_{fj})}{2}.(\alpha_{mj} - \alpha_{fj}) + \sum_j \frac{(\alpha_{mj} + \alpha_{fj})}{2}.(E_{mj} - E_{fj}) \quad \ldots\ldots\ldots (6)$$

$$100 = \frac{\sum_j \frac{(E_{mj} + E_{fj})}{2}.(\alpha_{mj} - \alpha_{fj})}{(E_m - E_f)}.100 + \frac{\sum_j \frac{(\alpha_{mj} + \alpha_{fj})}{2}.(E_{mj} - E_{fj})}{(E_m - E_f)}.100 \quad \ldots\ldots\ldots (7).$$

In (7), weights are in average form i.e., earning and employment levels for male and female workforce are averaged. Bias is hence reduced. Thus using the above decomposition scheme one can easily determine the percentage contributions of gender segregation across occupations and wage differentials within occupations to the gender earning difference.

First part of equation (7) is the percentage of overall average earning gap (gender) explained by differences in employment distribution across occupations may be termed as 'Gender Segregation Effect (GSE)'. Second part captures the percentage contribution of earning differences between male and female workers within the occupation. This may be termed as 'Earning Differential Effect (EDE)'. Average overall earning difference is hence be attributed either to the Gender Segregation Effect (GSE) or to the Earning Differential Effect (EDE). GSE as well as EDE may be positive or negative or may be zero. EDE may be more pronounced in explaining the average gender earning difference or the reverse may happen. Two effects may also be identical. Thus, overall earning difference between male and female workforce depends on relative contribution of these two effects. This scheme is analogous to Oaxaca (1973) decomposition.

3. Results and Discussion

Data are collected from the National Sample Survey Organization (NSSO) Reports on Informal Sector and Conditions of Employment based on 61st Round Survey (2004-05) and 66th Round Survey (2009-10). Survey with large samples was carried out by the Field Operations Division of National Sample Survey Organization (NSSO), India. Number of sample workers (male and female) engaged in different occupations/activity groups was 72152 and 66467 respectively for rural and urban areas at the 61st Round survey. The corresponding figures were 56117 and 55986 at the 66th Round Survey. In their comprehensive survey for informal sector employment, NSSO has covered all unincorporated enterprises in the non-agricultural sector with ownership as proprietary or partnership. Workforce refer to the workers in the usual status (Principal Status + Subsidiary Status) engaged in non-agricultural sector as well as in the agricultural sector excluding growing of crops, market gardening, horticulture and growing of crops combined with farming of animals (AGEGC). Individuals are engaged in AGEGC sector and in different

occupations/industrial activity groups as Mining and Quarrying, Manufacturing, Electricity-Gas-Water Supply, Construction, Wholesale and Retail Trade, Hotel and Restaurant, Transport and Communication, Financial Intermediation, Real Estate and Business Activities, Public Administration and Defense, Education & Health and Other Community & Social Service Activities. These 13 occupations/activity groups are considered in our analysis. Sample sizes for each category of occupations was as per the number of estimated workers belong to that occupational activity group. The sample size ranges from 402 for Electricity gas and water supply to 12527 for Construction sector in the rural area and 527 for Electricity gas and water supply to 14479 for wholesale and retail trade sector in the urban area (66^{th} Round Survey).

3.1 Employment Shares and Average Wages across Occupations/Activity Groups

Table I & Table II depict the employment shares and the average wages for male and female informal sector workers over time and across broad occupation groups for rural and urban areas respectively. Percentage of informal sector workers to the total non-farm workforce in India has declined irrespective of rural and urban areas. Male employment level appears as more pronounced in the urban sector. Percentage of rural female workers has declined significantly (nearly 12 percentage points during the period).

Table I. Employment Shares (Percentage) and Average Wages (Rupees) across Occupations/ Activity Groups: Rural India

Occupations/ Activity Groups	Employment Shares (%)				Average Wages (Rupees)			
	2004-05		2009-10		2004-05		2009-10	
	Male	Female	Male	Female	Male	Female	Male	Female
A	10.5	52	7.9	42.5	56	45	110	69
B	1.5	0.9	1.8	0.7	74	47	147	90
C	23.3	28.5	19.6	30.3	72	39	119	72
D	0.1	0.1	0.1	0.1	146	55	392	330
E	18.7	3.9	26.4	8.3	72	51	122	90
F	23.7	7.3	22.1	9.4	65	48	104	73
G	2.8	1.6	3	1.9	71	49	109	52
H	10.8	0.4	11.6	0.7	83	51	136	97
I	0.3	0.1	0.3	0.4	123	60	296	115
J	1.2	0.1	1.2	0.2	81	49	154	86
K	1.5	1.8	1.3	2.1	127	72	240	164
L	0.9	0.6	0.6	0.5	74	63	235	149
M	4.7	2.8	4.1	3	70	37	110	53
All	100 (79.2)	100 (86.4)	100 (74.2)	100 (74.4)	74	48	127	91

Source: Computed from NSSO data; (..) Informal sector employment (Percentage) in Indian economy; A: AGEGC (Agricultural sector excluding growing of crops, market gardening, horticulture and growing of crops combined with farming of animals.); B: Mining & Quarrying ; C: Manufacturing ; D:Electricity-Gas-Water Supply ; E:Construction ; F: Wholesale & Retail Trade ; G: Hotel & Restaurant ; H: Transport & Communication ; I: Financial Intermediation ; J:Real Estate & Business Activities ; K: Education ; L:Health & Social work ; M: Other Community & Social Service Activities.

Table I depicts that Manufacturing, Wholesale & Retail Trade and Construction sector altogether share almost 66 percent of total rural male informal sector employment. Migration

of unskilled rural male workers of the agricultural sector to the construction sector is reflected by the increasing employment share of Construction sector from 13 percent to 22 percent during the period. More than 50 percent of the total female workforce was associated with AGEGC activities in 2004-05 and it has declined over time. A concentration of female informal sector workers towards AGEGC and manufacturing sector is clearly observed.

In the urban area, about 70% of male informal sector workers are employed in Manufacturing, Wholesale & Retail trade and Construction sector (Table II). Urban female workers are mainly employed in urban manufacturing sector. An increase in the participation of female workers in the Education sector is observed. Male workers show more diversification in respect of their employment across different informal sector activities.

Table II. Employment Shares (Percentage) and Average Wages (Rupees) across Occupations/Activity Group: Urban India

Occupations / Activity Groups	Employment Shares (%)				Average Wages (Rupees)			
	2004-05		2009-10		2004-05		2009-10	
	Male	Female	Male	Female	Male	Female	Male	Female
A	1.5	8.7	1.5	6.5	110	69	136	66
B	0.3	0.1	0.3	0.2	147	90	185	159
C	26.1	44.8	25.2	44.0	119	72	179	88
D	0.1	0	0.2	0	392	-	310	-
E	11.4	5.8	12.6	5.6	122	90	147	103
F	33.4	15.8	33.4	16.7	104	73	154	135
G	4.5	4.2	4.2	3.6	109	52	167	158
H	11.2	1.1	11.1	1.1	136	97	198	243
I	0.9	0.5	1.0	0.9	296	115	385	267
J	4.1	1.9	4.3	1.9	154	86	327	293
K	1.6	8.5	1.6	8.2	240	164	266	182
L	1.1	2.7	1.1	3.4	235	149	231	171
M	3.8	5.9	3.5	7.9	110	53	153	64
All	100	100	100	100	127	91	181	132
	(73.9)	(64.4)	(68.5)	(61.6)				

Source: Computed from NSSO data; (..) Informal sector employment (Percentage) in Indian economy; Occupations/Activity Groups Codes A to M are same as Table I

Table III depicts the degree of occupational gender segregation for India's informal sector workers. High degree of segregation (measured by I_D and KM Indices) is observed in the rural informal sector though it has declined slightly during the period. Segregation level is relatively more prominent in the rural areas in comparison to that of the urban areas.

It may be due to fact that rural female workers are mostly engaged in off-farm activities (AGEGC activities) and manufacturing works whereas male workers are associated with manufacturing, trade and construction sector works. Gender segregation has slightly increased in the urban regions though the rural regions show a bit decline (Table III). Male and female workers are highly segregated in case of self employed group of workers irrespective of rural and urban areas. Degree of segregation is relatively less for regular wage/salaried employed and casual labourers. Wage/salaried employed and casual workers together in the rural regions exhibit a decline in gender segregation level although opposite is observed in case of the urban regions. Urban casual labourers show an increase in gender segregation (Table III). Decline in gender segregation for Wage/salaried employed and casual workers may be due to rural transformation i.e., shifting of both male and female workers to

the manufacturing and construction sector over time. Construction, manufacturing and education sectors are the prime drivers for the increase in segregation level for urban casual workers.

Table III. Occupational Gender Segregation in India's Informal Sector

Workers	I_D		KM Index	
	2004-05	2009-10	2004-05	2009-10
Rural				
All Workers	0.4710	0.4602	0.2143	0.1770
Self Employed	0.4845	0.4995	0.2375	0.2242
Regular Wage/Salaried Employed and Casual Labourers	0.3127	0.1984	0.0797	0.0506
Casual Labourers	0.2707	0.1309	0.0799	0.0333
Urban				
All Workers	0.3652	0.3711	0.1077	0.0998
Self Employed	0.4475	0.4405	0.1535	0.1356
Regular Wage/Salaried Employed and Casual Labourers	0.3151	0.3531	0.0689	0.0724
Casual Labourers	0.1839	0.3229	0.0474	0.0789

Source: Authors' Calculations based on NSSO data.
Index of Dissimilarity (I_D) ; KM Index :Karmel and MacLachlan Index

3.2 Occupational Segregation and Gender Earning Difference

We are interested to examine whether and to what extent occupational gender segregation explains average earning difference between male and female informal sector workers. The decomposition scheme discussed in the methodology section, has been used to examine the extent to which gender segregation across occupations and earning differences within occupations explain average earning difference between male and female informal sector workers in India. Table IV depicts the results of decomposition exercise for wage/salaried employed & casual labourers in the rural and in the urban informal sectors.

Table IV. Decomposition of Gender Earning Difference: Regular Wage/Salaried Employed and Casual Labourers

Gender Earning Difference by GSE & EDE	Rural		Urban	
	2004-05	2009-10	2004-05	2009-10
Overall Average Earning Difference (Rupees)	26.2	35.6	27.1	51.18
Contribution (%) of Gender Segregation Effect (GSE)	-15.42	-25.73	-38.37	-21.04
Contribution (%) of Earning Differential Effect (EDE)	115.42	125.73	138.37	121.04

Source: Authors' Calculation Based on NSSO data

Average absolute earning difference (nominal terms) between male and female workers is relatively higher in the urban informal sector and it has increased both in rural and in urban India. The result aligns with NSSO Reports and other studies on India's gender wage/earning gap such as Chakraborty and Mukherjee (2014), Deshpande et al. (2018), Sengupta & Puri (2022) etc.. Earning differentials within occupation explain the larger proportion of average earning gap irrespective of rural and urban areas. Earning differences within occupation for wage/salaried employed and casual labourers explain more than 100 percent of average

earning gap in both the rural and the urban areas. The contribution of the segregation effect is negative, which implies that the overall gender pay gap would be even greater than it is today if there was no occupational gender segregation. In this case earning differential within occupation explains more than 100% of average earning gap. EDE has increased over time in the rural area although the urban area shows an opposite direction (Table IV).

Decomposition results specific for casual labourers in India's informal sector (rural and urban regions) are shown in Table V. An increase in average earning difference (absolute and in nominal terms) between male and female casual labourers is observed irrespective of rural and urban areas. In case of casual labourers, impact of gender segregation work in favor of earning gap although the contribution is relatively smaller. EDE explain almost hundred percent of average earning difference of male and female rural casual workers in 2009-10. The corresponding figure is about 80 percent for urban casual workers. Importance of gender segregation component in case of urban casual informal sector workers has risen over time. Increase in earning differences (gender) is mostly due to earning differentials within occupations, however, effect of gender segregation has increased during the period 2004-05 to 2009-10 (Table V). Hence, average gender earning difference is completely explained by within-occupation earning differentials irrespective of rural and urban informal sector in India. In case of urban casual workers only, positive role of gender segregation is observed.

Table V. Decomposition of Gender Earning Difference: Casual Labourers

Gender Earning Difference by GSE & EDE	Rural		Urban	
	2004-05	2009-10	2004-05	2009-10
Overall Average Earning Difference (Rupees)	24.3	33.1	28.8	54.9
Contribution (%) of Gender Segregation Effect (GSE)	8.63	-0.30	4.84	19.16
Contribution (%) of Earning Differential Effect (EDE)	91.37	100.30	95.16	80.84

Source: Authors' Calculation Based on NSSO data

4. Concluding Remarks

This study has examined the state of occupational gender segregation and its impact on average earning difference between male and female informal sector workers in India. Earning difference within occupations explains a large proportion of average earning gap irrespective of rural and urban informal sector of India. The results are interesting because they differ from the findings usually reported in the international literature on gender pay gaps, in which a substantial contribution is generally found of segregation. The results also have serious policy implications in the context of informal sector employment in Indian states. In order to reduce gender discrimination in average earning, within-occupation earning differences must be taken care of. Equal pay for equal work for male and female workers may be ensured from the part of the Government to reduce earning inequality within occupations. Government should undertake appropriate pay regulatory measure along with reforms in the informal sector in order to improve the condition of the workers specially the women. Equal pay principle will work a bit more when gender segregation would be addressed properly. Attention should be paid to the reorientation of women employment through initiating proper education and training and also to the reduction of intra-occupation earning inequality.

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