Pathway from nutrition intake to wage among elementary workers in India

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Abstract

Despite the consistent effort to reduce hunger and poverty, a sizeable proportion of the population in India is living below the poverty line (22% 2011-12) and 36% women and 34% men were underweight. Malnutrition and poverty form a vicious circle of poverty which needs to be removed through government intervention. In the context, using data from national representative "employment and unemployment" (and 61st round 2004-05 and 68th round 2011-12) of the National Sample Survey Organisation (NSSO) we have tried to establish the association between nutrition status and wage in India. In order to take into account the heterogeneous effect of the calorie intake across the income distribution and endogeneity of the calorie consumption, we have applied instrumental variable quantile regression. Regression result confirms the heterogeneous impact of per-capita calorie intake across household income distribution. Result shows that the marginal effect of per consumer unit calorie intake on wage decrease with the increase in wage. Calorie intake elasticity of wage gain increases from 0.76 at the lowest 10th quantile to the 1.11 at the highest 90th quantile of the wage distribution in 2004-05. In 2011-12 calorie-wage elasticity decreased to 0.42 and 0.79 respectively at the 10th and 90th quantile of the wage distribution. Study clearly shows the urgent need of public nutritional supplementation at the low of the wage distribution for the maximization of wage gain from the marginal public nutritional expenditure.

Keywords: *wage, elementary worker, calorie, two-stage least square, quantile regression, India*

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Introduction

Health is the input of human capital formation and means and ends of the economic growth. At the policy level, human capital development was adopted in the eighth five year plan for 1992-97; since then it has strategic importance. By definition, human capital represents the aggregation of education, health, on-the-job training, and migration that enhance the individual's productivity in the labour market (Kiker, 1966; Laroche et al., 1999; Schultz, 1994; Jorgenson and Fraumeni, 1989). As per WHO (1946) constitution "health a state of complete physical, mental and social well-being and merely absence of disease and infirmity". Better physical health increase the employability in India where majority of the labour force is employed in labour intensive elementary work. According to the latest WHOSAGE-India survey one-third (35%) prime working age population of age 18-49 years were underweight (Shukla et al., 2014). In this context, considering nutrition status in terms of calorie intake as a measure of health in the study we have established the causation between per consumer unit calorie intake and wage among elementary workers in India.

Previous studies

Many studies have established wage as a function of education and health in the market and nonmarket economy. Health, measured in terms of nutrition, morbidity and mortality, with other forms of human capital like education, experience, and migration health determine the labour productivity and wage (Bose, 1997; Bloom and Canning, 2008; Bloom and Canning, 2005; Mincer, 1974; Mincer, 1988; Schultz, 2003). Improved health influences individual productivity and earning through the labour market participation, investment in human capital, saving, low fertility and population age structure (Dasgupta, 1997; Bloom et al., 2009; Bloom et al., 2003; Bloom et al., 2007; Jayachandran and Lleras-Muney, 2009; Palloni and Rafalimanana, 1999; Angeles, 2010). In the early stage of economic growth, increased availability calorie has significant positive effect on nutrition status thereby productivity led per capita income growth (Fogel, 2004; Fogel, 1994; Thomas and Frankenberg, 2002).

At the micro level, it has also been found that better health measured in terms of calorie intake, height, or BMI increase the labour productivity per time unit worked and labour supply per adult hence wage (Strauss and Thomas, 1998; Swaminathan et al., 2013; Thomas and Frankenberg, 2002; Thomas and Strauss, 1997; Strauss, 1986; Hoddinott et al., 2008). Aziz (1995) has proved that increased calorie intake improves productivity and wage of the female agriculture worker in India. Similarly, Deolalikar (1988) has established the strong positive effect of weight-for-height on market wage rate and firm output in the rural South India. Effect of calorie intake on wage or income depends on demand for labour for *e.g.* high wage-calorie elasticity in peak agriculture season (Behrman et al., 1997b; Swamy, 1997).

The intensity of association between calorie intake and labour productivity depends on three factors. *First,* at the low level of health and economic equilibrium, majority of the labour force are employed in primary sectors' manual work, requiring high endurance to work for long (Alleyne and Cohen, 2002). Employment nature at the low level of income demands more physical labour, which could be achieved by higher calorie intake (Becker, 1965). *Second*, on the leisure-wage tradeoff curve, leisure preference becomes stronger with the increase of calorie intake; and calorie-wage association becomes weaker at the high level of economic equilibrium (Fogel, 1994; Strauss and Thomas, 1998). *Third,* calorie has a positive effect on wage on the malnourished whereas, protein intakes has a positive effect on wage at the higher level of nutrient intake. At the low level of income and nutrition distribution, increased calorie intake leads to the higher labour productivity and wage but at a decreasing rate (Deolalikar, 1988; Strauss and Thomas, 1998; Dasgupta, 1997). Better nutritional status increase individual efficiency to work more hours, and reduces the absenteeism from work due to illness (Bloom and Canning, 2000). Specifically in the context of developing countries characterized by higher prevalence of malnutrition and infectious diseases marginal productivity of health is higher than the developed countries (Strauss and Thomas, 1998). In this context, the present study aims to study the intensity of effect of calorie intake on wage among the elementary workers.

Measurement of health

In terms of nutrition, health is the physical capacity to work *i.e.* maximum work per unit of time someone is capable of doing (Stanton, 1990; Dasgupta, 1997; Jamison, 1985). According to World Health Organisation (WHO, 1946) health is 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. Individual health is multidimensional concepts hence associated health measurement error may be related with the health outcome and wage (Jamison, 1985). At the micro level disability, adjusted life expectancy (DALY), activities of daily living (ADL), instrumental activities of daily living (IADL), self-reported health status, and morbidity are the widely used measures of health outcome. But, all these measures suffer from reporting bias hence the association between health status and labour productivity or wages will be biased upward/downward (Iburg et al., 2001; Sen, 2002; Murray and Chen, 1992). Studies have established the long term effect of calorie intake among the nutritional deficient population increases the height during infancy and income among adults (Strauss, 1986; Fuentes et al., 2001). Taking calorie, protein, iron, and micronutrients intake as a health input, micro level studies have established the positive effect of improved health on labour productivity and wages (Deolalikar, 1988; Fogel, 1994; Strauss and Thomas, 1998; Weinberger, 2004; Bhargava, 2001). Following these micro studies, we have measured the health or nutrition in terms of per consumer unit calorie intake.

Data

The study is based on the two rounds of representative employment and unemployment sample survey data collected by the national sample survey organisation (NSSO) during July-2004 to June-2005 (61st round) and July-2011 to June-2012 (68th round). This data records the socio-economic, demographic, consumption expenditure and economic activity from each sampled households' member. All employed members of the household have been listed by their industry[2] and occupation[3] of employment. For the current day activity status total wage received in last seven days by the employed members is also collected. Each household's actual

[2] Employment status in an industry of a person's haven classified as per National Industrial Classification (NIC)-1998 in 2004-05 and NIC-2008 in 2011-12.

[3] Occupation of the employment has been classified as per National Classification of Occupation (NCO)-1968 in 2004-05 and NCO-2004 in 2011-12.

economic status has been measured in terms of monthly and/or yearly consumer expenditure on twelve food items, consumer durables, medical, education and services.

Using multi-stage stratified sampling design a total of 602833 (398025 rural and 204808 urban) individuals in 2004-05 and 456999 (280763 rural and 176236 urban) individuals in 2011-12 have been enumerated from 28 states and 7 union territories of India. Studies have found that effect of calorie intake on wage is highest in the peak agriculture season (Swamy, 1997; Behrman et al., 1997b). Hence, in order capture, the seasonal variation in rural employment, food grains availability and price fluctuation total sampled villages/urban block were equally divided into four parts, and these were enumerated in four different agriculture seasons. For the detail sampling design, concepts and definition followed in the survey see (NSSO, 2006; NSSO, 2014).

From each sampled household consumption expenditure in last 30 days on 12 food items cereals, pulses, milk, milk products, edible oil, vegetables, fruits & nuts, egg, fish & meat, sugar, salt & spices, beverages & prepared foods and pan tobacco & intoxicants has been collected. Following the concept of poverty estimation method by PlanningCommission (2009) we have theoretically calculated the total calorie intake from expenditure by the household on these 12 food items. Assuming that, irrespective of the economic status total calorie gained by the household from the expenditure on each food items varies only by state, districts, rural-urban and agriculture seasons. Using contemporary consumer expenditure survey[4] we calculated the mean calorie price[5] of each 12 food items in each districts by rural-urban and agriculture seasons. We merged the mean calorie price of 12 food items, by districts, rural-urban and four agriculture seasons, with contemporary employment-unemployment. Total household calorie intake is the sum of calorie each food items, which is equal to the multiplication of calorie price of food item with the corresponding food expenditure. According to Singh and Kumar (2004) for the given amount of labour per capita calorie requirement varies by age and sex. Hence,

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[4] Using same sampling frame up to the first-stage unit or ultimate stage-units NSSO simultaneously conducts the quinquennial rounds of Employment and Unemployment and Consumer Expenditure survey.

[5] Calorie price is the calorie obtained from one rupee on food items.

considering age and sex structure of the household members we have calculated the per consumer unit calorie intake.

According to the International standard classification of occupation (ISCO-2008) elementary occupation is the tasks are of a simple and routine nature; mainly entail the use of hand-held tools, some physical effort, little or no previous experience and understanding of the work and limited initiative or judgment (ILO). Elementary occupation includes: 1) cleaners, helpers, food preparation, Street and related sales and service workers, refuse workers and other elementary workers; 2) agricultural, fishery, and related labourers; 3) labourers in mining, construction, manufacturing, and transport (ILO).

We have classified the elementary work as per the usual principal activity status and wage has been collected for current day activity in last seven day of the survey. There might be chance that some of the elementary workers would have been employed as per usual principal activity status but would have not been employed as per current day activity status. One of the strategies could have been to study only the elementary workers who were employed as per current day activity status, but it does not take account the agriculture seasons, business cycle and long term determinants employment status. Therefore, we have analyzed the

Appendix figure 2 shows the similar pattern of the non-parametric distribution of wage earnings of three major groups of elementary occupation. Therefore, theoretically these elementary occupation groups can be clubbed together for the analysis. Wage earning of elementary workers engaged in agriculture sector is the highest followed by manufacturing and service sector. Though, there is not significant wage differential among the elementary works across the economic sectors.

Analysis plan

Empirical test of the pathways from per capita nutrition intake to wage depends on two factors: *First,* heterogeneous effect of nutrition intake on wage and productivity; *Second,* reverse causation of wage on nutrition intake and measurement error in health of nutritional status. *First, Heterogeneous effect of nutrition intake on wage and productivity:* Measures of nutrition as determinants of health and thereby wage and labour productivity. Individual nutritional status is the function of dietary, calorie, micronutrient intake, and individual nutrition status portend the health outcomes such as anthropometries, self-reported health, morbidity, physical capacity and functioning (Singh-Manoux et al., 2007; Miilunpalo et al., 1997; Strauss, 1986; Amare et al., 2012). Thus, among other health inputs calorie intake determines the both present and future health outcome. Taking nutrition intake as a health input, micro level studies have established the efficiency-wage hypothesis (Strauss, 1985; Weinberger, 2004; Strauss, 1986; Dasgupta, 1997; Basta et al., 1979; Bhargava, 1997; Behrman et al., 1988). In the long run, high calorie intake among the nutritional deficient population increases the height during infancy and cognition, therefore income/wage among adults (Fuentes et al., 2001; Strauss, 1986; Basta et al., 1979; Behrman, 1993). Using panel data from the rural south India Deolalikar (1988) found significant positive effect of weight-for-height on market wage and firm output. Similarly, Weinberger (2004) found that wage will increase by 5-17% if household achieve the recommended level of iron intake. Thus, high calorie intake immediately improves productivity and wage through energy availabilities and in the long-rung through better health and cognition development (Behrman and Deolalikar, 1989).

Empirically, wage (*W*) is defined as a function of per consumer unit calorie intake (*K*), socio-demographic status (*D*), economic environment (*E*), demand for labor or business cycle (*L*) and level of development or technological advancement (*T*) and unobserved error term (ε):

(1) $$W = f(K, D, E, L, Y, \varepsilon)$$

Here, *W* is the natural log of wage, *K* is the natural log of per consumer unit calorie intake; socio-demographic status (*D*) has been measured in terms of age, sex, general education, technical education, caste, religion and land holding; economic environment (*E*) is measured in terms of rural-urban residence and India state region; demand for labour or business cycle (*L*) is proxied by agriculture seasons; year of survey accounts for the level of development or technological advancement. Specific model will be as:-

(2) $$W = \alpha K + \beta_1 D + \beta_2 E + \beta_3 L + \beta_4 Y + \varepsilon$$

Increased calorie intake has significant positive effect on labour productivity and wage but at a decreasing rate (Strauss, 1986; Behrman et al., 1997b; Deolalikar, 1988). The effect of calorie intake on wage depends not only on the wealth status of the farmers but also on the stages of production and agriculture season (Behrman et al., 1997a; Swamy, 1997). Therefore, wage elasticity of calorie intake depends on the wage distribution, and such heterogeneity should be taken into account while estimating the calories-wage association. Now, the quantile regression takes into account for the heterogeneous effect of calorie intake on the wage distribution for given value of socio-demographic, residence, economic environment and level of development (Koenker and Bassett, 1978; Koenker and Hallock, 2001). If θ indicates the proportion of the population having the wage below the quantile at θ, quantile equation model can be written as:

(3) $$W = \alpha_\theta K + \beta_{1\theta} D + \beta_{2\theta} E + \beta_{3\theta} L + \beta_{4\theta} Y + \varepsilon_\theta$$

Second, reverse causation of wage on nutrition intake and measurement error in health of nutritional status: Empirical wage-calorie association depends on the causation between nutrition status and wage or productivity. Dietary intake determines the nutrition status (Amare et al., 2012) and nutrition status has an effect on health outcome such as morbidity and mortality in a population (Shankar, 2000; Ulijaszek, 1996; Caulfield et al., 2004; Katona and Katona-Apte, 2008; Black et al., 2008); and individual health determine the labour efficiency, wage and productivity (Sachs, 2001; Alleyne and Cohen, 2002; Behrman, 1993; Deolalikar, 1988; Behrman et al., 1988). Hence there is causation between nutrition status and labour productivity or wage (Nuwaha et al., 2011; McNamara et al., 2012; Basta et al., 1979; Deolalikar, 1988). However, nutritional measure such as calorie, protein, and iron intake being the input of health production function do not have reverse causation with the health of individual (Strauss, 1986; Amare et al., 2012; Dalgaard and Strulik, 2011; Wang et al., 2014).

None the less outcome of the study wage depends on individual nutrition status measured by calorie intake, which in turn depends on the wage or income (Jha et al., 2009; Thomas and Strauss, 1997). At the low level of economic development increased income improves the calorie intake and nutrition status simultaneously calorie intake has a positive effect on wage and productivity (Behrman, 1993; Behrman et al., 1988). On the other side (Dasgupta, 1997) argued that there is no one-to-one reverse causation between wage and calorie intake as labourers spend no more than 15-20% of their wage on energy requirement. However, per capita calorie intake may be endogenous, hence correlated with unobserved error term. Thomas and Frankenberg (2002) have shown that the effect of nutrition status on economic productivity is confounded by early childhood nutrition and family socio-economic background, genetic factor and ethnicity. Thus, in order to take into account the potential endogeneity of calorie intake we have instrumented it by per capita household monthly expenditure and household head education (Strauss, 1986; Amare et al., 2012; Strauss, 1985; Weinberger, 2004). Then combination of instrumental variable and quantile regression is estimated as two-stage quantile regression (Chernozhukov and Hansen, 2008; Calderon, 2007).

Two-stage quantile regression model can be specified as:

$$(4) \qquad Q(W_\theta | K, D, E, L, Y) = \alpha_\theta K + \beta_{1\theta} D + \beta_{2\theta} E + \beta_{3\theta} L + \beta_{4\theta} Y + \beta_{5\theta} Z + \varepsilon_\theta$$

This specified model follows the following assumptions:

i. Left hand side of the equation is strictly increasing in θ for almost every value of endogenous and exogenous predictors,

ii. $\varepsilon | D, E, L, Y, Z \sim \varepsilon(0, 1)$, and

iii. θ is independent of exogenous predictors (*D, E, L* and *Y*)and instruments (*Z*) that do not enter into the structural equation.

Now instrumenting the per consumer unit calorie intake:

(5) $K = g(D, E, L, Y, Z, \omega)$, where ω is statistical dependent on ε,

- W is the wage,
- K is the potential endogenous variable with random coefficient $\alpha_{(\theta)}$,
- D, E, L and Y are the exogenous predictors with random coefficient $\beta_{i(\theta)}$,
- ω is a vector of unobserved disturbances determining K and correlated with ε,
- Z is a vector of instrumental variables that are excluded from structural equation and independent of the disturbance ω but correlated with K as given in equation (5).

As per definition, unemployed elementary workers were not getting wage, and employee would have received higher wage. Therefore, analysis of calorie-wage association based on selected sample will give the upward biased result. Employment as elementary worker depends on the socio-economic and demographic status of the individual and family, which indirectly determines wage earning. In order to take into account the selection bias due to employment status we have applied the Heckman's sample selection model, which incorporates the omitted variables in the complete model (Vella, 1998; Heckman, 1979). Sample selection equation of being employed as elementary worker can be specified as:

(6) $M = \lambda_1 S + \lambda_2 D + \eta$

Where S is the socio-economic status of the elementary worker's family and D is the demographic condition of them. Incorporating equation (6) with equation (4) and (5) we will get the Heckman's sample selection model, which follows the following assumptions:-

- $(\omega, \eta) \sim N(0, 0, \sigma_\omega, \sigma_\eta, \rho_{\omega\eta})$ both error terms are normally distributed with mean 0, variances and correlation coefficient between error terms is $\rho_{\omega u}$.
- $(\omega, \eta)$is uncorrelated with the explanatory variables in equation (5) and (6).

Now sample selection problem implies that employment as elementary worker depends only on *S* and *D* as mentioned in equation (6) not upon *K, E, L, Y* and *Z* from equation (4) and (5). Combined regression (4) and (5) model wage on calorie intake and other variables does not include the unemployed elementary workers. Following the Heckman (1979) method sample selection biases wage of an elementary worker can be specified as:

(7) $$E(W_\theta|M=1,K,D,E,L,Y,Z)=\alpha_\theta K+\beta_{1\theta}D+\beta_{2\theta}E+\beta_{3\theta}L+\beta_{4\theta}Y+\beta_{5\theta}Z+E\{\omega_\theta|\eta>-(\lambda_1 S+\lambda_2 D)\}$$

The last term $\{\omega_\theta|\eta>-(\lambda_1 S+\lambda_2 D)\}$of equation (7) is the omitted variable which is specified as:

(8) $$E\{\omega_\theta|\eta>-(\lambda_1 S+\lambda_2 D)\}=\rho_{\omega\eta}\sigma_\omega\gamma(\lambda_1 S+\lambda_2 D)$$

where $\gamma(\lambda_1 S+\lambda_2 D)$ is the inverse Mill's ratio (Heckman, 1979)and $\rho_{\omega\eta}\sigma_\omega$is unknown parameter. Thus, equation (7) is the Heckman sample selection instrumental variable quantile regression.

We have separate and pooled analysis for survey year 2004-05 and 2011-12. Separate analysis is aimed to test the change in calorie-wage elasticity over the period of time and pooled analysis gives the combined calorie- wage association among elementary workers in India. Non-parametric distribution (Kernel density) of wage in 2004-05 and 2011-12 shows the similar pattern therefore we can do pooled analysis.

Result

Table 1 shows the percentage of the labour force employed as elementary worker it reduced from 31% in 2004-05 to 28% in 2011-12. The share of elementary workers has declined during 2004-05 to 2011-12. However, decline in the share of elementary workers is more prominent among the poor socio-economic group than better off. For an *e.g*. 49% of the poorest labourers were engaged in elementary occupation in 2004-05 which reduced 43% in 2011-12 compared with only 1% share decline amongst the richest labour during the same period. Table 1 shows that 28% male and 37% female labourers were employed in elementary occupation in 2004-05 which declined to 26% male and 34% female share in 2011-12. By education, at both the time period more than 40% of the illiterate labour forces were employed in elementary occupation than only 5% of the higher secondary and above completed labourers. Technical education has a significant impact on the occupation of labour force. At both the time periods, one-thirds rural labourers were engaged in elementary occupation compared with less than one-fifths in the urban area. Almost half of the ST/SC labour forces were constituted of elementary workers in both periods.

Mean per consumer unit calorie intake by background characteristics of the elementary workers is shown in the second panel of table1. Mean calorie intake among the elementary workers was 2323 kcal in 2004-05 and 2553 kcal in 2011-12. Socio-economic and demographic background show the positive gradient with the mean calorie intake. Mean calorie intake among the elementary workers of age up to 19 years was 2257 kcal in 2004-05 and 2412 kcal in 2011-12 which increases to 2863 kcal and 3062 kcal for the 60+ aged elementary workers. Mean calorie income in the rural area was 2357 kcal in 2004-05 and 2596 kcal in 2011-12 compared with 2139 kcal and 2320 kcal in the urban area. Richest elementary workers were taking 1.6 and 1.7 times more calorie than poorest one in 2004-05 and 2011-12 respectively. Similarly, elementary workers belonging to the highest calorie quintile group were taking 2.5 and 2.8 time more calorie than the lowest calorie group in 2004-05 and 2011-12 respectively.

Table 2 shows the percentage of elementary worker belonging to the highest wage quintile, theirs' mean wage and overall mean wage of the elementary workers. Distribution of the elementary workers shows that only 7% were belonging to the highest wage quintile in 2004-05 which declined to 4% in 2011-12. Average wage of the elementary workers was ₹43 and ₹76 respectively in 2004-05 and 2011-12. Percentage of elementary workers belonging to the highest and theirs' wage quintile increases with age. Mean wage of the workers age less than 19 years was ₹140 in 2004-05 and ₹196 in 2011-12 whereas for age group 50-59 year wage was

₹205 and ₹290 in the same period. Only 6% and 5% of the male elementary workers were belonging to the highest wage quintile compared with 2% and 1% female in 2004-05 and 2011-12 respectively. There is no sex differential in mean wage in the highest wage quintile whereas average was ₹50 of male and ₹29 of female in 2004-05 and ₹84 of male and ₹55 of female in 2011-12. Mean wage and percentage of the elementary workers belonging to the highest wage quintile increases with the increase in education level. One-fourths (25%/26%) elementary workers with higher secondary and above education or technical belonged to the highest wage quintile in 2004-05 which reduced to one-eights (13%) in 2011-12. Average wage of the illiterate elementary workers was ₹35 and of higher secondary and above educated was ₹86 in 2004-05. Only 2 % of the elementary workers in rural area were in the highest wage quintile compared with 19% and 11% in the urban area respectively in 2004-05 and 2011-12. Similarly mean wage of the elementary workers in 2004-05 and 2011-12 respectively in the rural area was ₹38 and ₹72 compared with the urban area of ₹74 and ₹100. At both the time periods less than one percent of the elementary workers from the poorest expenditure quintile belonged to the to the highest wage quintile. On the other hand, more than one fourths of the elementary workers form richest wealth quantile belonged to the highest wealth quintile in 2004-05 and 15% in 2011-12. Mean wage of elementary workers increases with calorie quintile from 40 to 48 in 2004-05 and ₹73 to ₹77 in 2011-12. At both the periods 4% elementary workers from the lowest calorie quintile belonged to the highest wage quintile with their mean income of ₹163 in 2004-05 and ₹232 in 2011-12. Whereas, 7% and 4% elementary workers in 2004-05 and 2011-12 respectively from the highest calorie quintile belonged to the highest wage quintile with mean wage of ₹196 and ₹280.

Table 3 shows the Heckman's sample selection Instrumental variable mean and quantile regression for 2004-05 (panel A) and 2011-12 (panel B) respectively. Test statistics of the instrumental variable regression shows that null hypothesis is rejected for under identification test (Anderson LM stat-10000, χ^2 p-0.00), weak identification test (Wald F stat-2402), over identification of all instrument (Sargan stata-61, χ^2 p-0.00) and endogeneity test (C stat-3119, χ^2 p-0.00). Hence instrumental variable regression model is correctly specified. In Panel A, mean regression coefficient for the year 2004-05 is 0.99 implies that calorie-wage elasticity at the mean is 0.99. In numerical terms 0.10 point (232kcal/day) increase in calorie intake will lead to 10% (₹4.3/day) wage increase among the elementary workers in India. At the low 10% and 25% of the wage distribution there is not one-to-one calorie-wage association. Calorie-wage elasticity at the low 10^{th} quantile of wage is 0.76 and at 25^{th} quantile elasticity is 0.85. In other word we can say that 0.10 point increase in calorie intake at the low 10% of the wage distribution will lead to 7.6% wage increase to them. Similarly, 0.01 increases in calorie intake would lead to 8.5% wage increase of the elementary workers with the lower quarter of the wage distribution. At the median of the wage distribution calorie-wage elasticity is 0.95 which is almost one-to-one association. Here, it should be noted that there is not much difference in regression coefficient at mean and median wage. Calorie-wage elasticity at the upper 75% and 90% quantile of the wage distribution is more than unity 1.05 and 1.11 respectively. That means, 0.01 point increase in calorie intake will lead to 1.05 and 1.11 times wage increase at 75% and 90% of the wage distribution.

Table 3 Panel B shows the regression coefficient of natural log of wage on natural log of per consumer unit calorie intake and other controlled variables for the year 2011-12. Test statistics of the instrumental variable regression shows that null hypothesis is rejected for under identification test (Anderson LM stat-6217, χ^2 p-0.00), weak identification test (Wald F stat-1389), over identification of all instrument (Sargan stata-48, χ^2 p-0.00) and endogeneity test (C stat-815, χ^2 p-0.00). Hence instrumental variable regression model is correctly specified. Mean regression coefficient of calorie intake is 0.57, which implies on average that 10% increase in calorie intake will lead to 5.7% wage increase of the elementary workers. In real terms 255 kcal/day increase in calorie intake will lead to ₹7.6 additional wage gain to the elementary workers. Quantile regression result shows the calorie-wage elasticity increases with the increase in wage distribution. Calorie wage association up to median wage distribution is almost same. At the 10%, 255 and 50% of the wage distribution calorie-wage is 0.42, 0.47 and 0.48 respectively. In other words 0.01 points increase in calorie intake will lead to 4.2%, 4.7% and 4.8% wage increase at the 10%, 25% and 50% wage distribution of the elementary worker.

Calorie-wage elasticity at the upper 75% and 90% of the wage distribution is 0.57 and 0.79 respectively. In real term 10% increase in calorie intake will lead to 5.7% and 7.9% wage increase at the 75% and 90% wage distribution of the elementary workers.

Table 4 shows the pooled regression coefficient of 2004-05 and 2011-12. Test statistics of the instrumental variable regression shows that null hypothesis is rejected for under identification test (Anderson LM stat-17000, χ^2 p-0.00), weak identification test (Wald F stat-3845), over identification of all instrument (Sargan stata-81, χ^2 p-0.00) and endogeneity test (C stat-4162, χ^2 p-0.00). Hence, Heckman's sample section instrumental variable regression and two stage quantile regression is correctly specified. Heckman sample selection instrumental variable mean regression coefficient is 0.86, implies that calorie-wage elasticity is less than unity. In numerical term 243 kcal/day increase in calorie intake of the elementary workers will lead to ₹6 wage increase. Quantile regression result shows that calorie-wage elasticity increases from with the wage distribution of the elementary workers. At the low 10% and 25% of the wage distribution 10% point increase in per day calorie intake will lead to 6.5% and 7% wage increase of the elementary workers. Regression coefficient at the median wage distribution is 0.77 means 10% increase in per day calorie intake will lead to 7.7% wage increase.

Non-parametric distribution of the per-capita household income in Figure 3 shows the frequency if of the sampled household income by calorie quantile. Frequency of the elementary occupation based household decreases with the increase in calorie quantile. The bottom of the lowest calorie quantile household is less flattened at relatively lower income, whereas the bottom of the highest income quantile household more flattened at the higher income. This shows the positive and linear association between calorie intake and income at the different level of distribution of the per-capita household income. Calorie-wage elasticity at the third quarter of the wage distribution is 0.92 and at the 90% of the wage distribution elasticity is more than unity.

Conclusion and policy recommendation:

Result shows the instrumental variable regression estimated at the mean of the income distribution and the corresponding predictors confounds the heterogeneity in the association between income and its determinants. The coefficient of instrumental variable median regression is two times more than the coefficient of the mean regression. This implies that a small fraction of the elementary occupation based household's income was very high as shown in Figure 1 and Figure 2. The positively skewed distribution of the per capita household income underestimates the effect of per consumer unit calorie intake on household income. Instrumental variable quantile regression shows that the marginal effect of per consumer unit calorie intake on income decreases with the increase in income. Studies have found that at the low income setting such as elementary occupation based household increase in nutrition status in terms of calorie intake has positive effect on income but at decreasing rate (Deolalikar, 1988; Strauss, 1986; Strauss and Thomas, 1998).

At the lowest 10^{th} and 25^{th} quantile calorie intake elasticity of the household income is 2, which implies that the effect of the calorie supplementing food subsidy at the lowest quarter will two times more effect than the targeting at the median population. In the context of the contemporary food security bill the study establishes that the positive discrimination in the favor of the poorest of the poor will gain maximum income and social welfare from the limited economic resources. However, consistent decline in per capita calorie intake in last three decades makes the universal food security as the best initiative in India.

Limitations

Total calorie requirement for the households varies by the physical activity, age and sex of each household member. But, we have only considered the age and sex structure of the household members in terms of consumer unit. In the study we have established the effect of calorie intake on wage among elementary workers doing strenuous task, which is not sole nutrients they need, but adequate diet also involves vitamins and minerals.

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Table 1: Percentage of the labour force employed in elementary occupation and per consumer unit calorie intake in theirs household by background characteristics, India, 2005-05 & 2011-12

		Percentage of the labour force employed in elementary occupation			***Calorie intake /consumer unit/day (kcal) among elementary workers***		
		Year 2004-05	***Year 2011-12***	***Pooled 2004 & 2011***	***Year 2004-05***	***Year 2011-12***	***Pooled 2004 & 2011***
Age	Up to 19 years	35.2	33.2	34.4	2257	2412	2316
	20-29 years	29.8	26.7	28.2	2336	2567	2444
	30-39 years	32.8	28.2	30.4	2213	2426	2315
	40-49 years	31.3	28.3	29.7	2296	2496	2398
	50-59 years	28.2	26.2	27.2	2469	2710	2594
	60 years and above	21.1	24.8	23.1	2863	3062	2980
Sex	Male	28.4	25.9	27.1	2316	2521	2420
	Female	36.6	33.5	35.2	2338	2637	2468
Education level	Illiterate	44.4	42.4	43.5	2337	2586	2444
	Below primary	37.6	37.5	37.5	2288	2559	2424
	Primary completed	30.3	32.5	31.4	2290	2472	2384
	Middle education	24.2	24.5	24.4	2319	2528	2430
	Secondary education	13.7	16.7	15.4	2320	2532	2455
	Higher sec. and above	4.6	5.4	5.1	2473	2609	2559
Tech. education	No	31.5	28.5	30	2323	2552	2434
	Yes	2.9	1.6	2.2	2453	2729	2562
Sector	Rural	34.0	32.4	33.2	2357	2596	2472
	Urban	19.9	15.5	17.5	2139	2320	2228
Religion	Hindu	31.4	28.5	29.9	2328	2569	2444
	Islam	26.8	24.7	25.7	2252	2452	2357
	Other religion	25.9	20.4	23.2	2375	2457	2410
Caste	ST/SC	47.6	42.1	44.8	2306	2532	2413
	OBC	27.5	25.8	26.6	2338	2565	2453
	Other caste	17.6	15.1	16.4	2338	2578	2449
Land	Less than one acre	41.1	35.1	37.9	2307	2530	2418
	1-3 acre	22.8	18.6	20.8	2379	2715	2520
	More than three acres	7.5	6.4	7.0	2418	2588	2490
Per capita monthly consumer expenditure quintile	Poorest 20%	49.4	42.7	46.0	1911	2031	1966
	Poorer	39.6	36.3	38.0	2236	2382	2306
	Middle	32.0	29.8	30.8	2469	2687	2577
	Richer	23.2	22.3	22.7	2692	3003	2848
	Richest 20%	11.9	10.8	11.4	2994	3461	3226
Per consumer unit calorie intake quintile	Lowest 20%	42.6	36.7	39.6	1523	1520	1521
	Second Lowest	35.7	31.7	33.7	2030	2111	2069
	Middle	31.3	26.5	28.9	2376	2509	2438
	Second Highest	25.7	23.5	24.6	2777	2999	2885
	Highest 20%	19.5	20.9	20.2	3740	4308	4044
	Total	30.7	27.6	29.1	2323	2553	2434
P value of Chi2/F-statistics		***p<0.00***	***p<0.00***	***p<0.00***	***p<0.00***	***p<0.00***	***p<0.00***

Table 2: Percentage of the elementary workers belonging to the highest wage quintile, theirs' mean wage and overall mean wage (Indian Rupees ₹) of the elementary workers, *India, 2005-05 & 2011-12*

		Survey year 2004-05			*Survey year 2011-12*			*Pooled 2004 & 2011*		
		Highest 20% wage quintile		*Total*	*Highest 20% wage quintile*		*Total*	*Highest 20% wage quintile*		*Total*
		Percent	*Mean wage*	*Mean wage*	*Percent*	*Mean wage**	*Mean wage**	*Percent*	*Mean wage**	*Mean wage**
Age	Up to 19 years	0.7	140	34	1.2	196	65	0.9	170	46
	20-29 years	3.2	148	41	3.4	232	77	3.3	191	59
	30-39 years	4.7	170	43	3.6	242	77	4.2	201	60
	40-49 years	7.4	190	48	4.6	252	80	5.9	216	65
	50-59 years	8.4	205	49	5.7	290	79	7.0	242	65
	60 years and above	1.7	144	34	1.6	203	66	1.6	180	53
Sex	Male	6.2	179	50	4.7	249	84	5.4	211	68
	Female	1.6	173	29	1.1	247	55	1.4	201	41
Education level	Illiterate	1.5	164	35	1.7	228	67	1.6	195	50
	Below primary	4.0	164	43	3.5	234	76	3.7	198	60
	Primary completed	6.5	174	48	3.3	232	77	4.8	195	64
	Middle education	10.0	181	55	5.5	236	83	7.6	202	70
	Secondary education	16.7	191	69	9.1	266	97	11.8	229	87
	Higher sec. and above	25.0	209	86	13.1	318	110	17.1	264	102
Tech. education	No	4.6	178	43	3.7	249	76	4.2	210	60
	Yes	26.1	207	86	12.8	312	100	20.6	234	91
Sector	Rural	2.3	168	38	2.4	231	72	2.4	200	55
	Urban	19.3	187	74	11.2	272	102	15.1	220	88
Religion	Hindu	4.5	181	42	3.3	256	75	3.9	213	59
	Islam	5.0	160	45	5.9	218	82	5.5	195	66
	Other religion	6.3	178	51	6.5	251	93	6.4	210	69
Caste	ST/SC	3.6	177	41	3.0	244	73	3.3	207	57
	OBC	4.0	175	41	3.7	249	77	3.9	213	60
	Other caste	9.0	184	52	5.9	258	84	7.5	211	67
Land	Less than one acre	5.0	179	44	3.9	246	77	4.4	209	61
	1-3 acre	2.6	181	36	2.1	258	67	2.4	211	50
	More than three acres	4.4	176	40	4.4	319	78	4.4	238	57
Per capita monthly consumer expenditure quintile	Poorest 20%	0.6	161	32	0.9	246	62	0.7	209	46
	Poorer	1.6	158	37	1.6	227	72	1.6	193	55
	Middle	3.0	162	41	2.9	233	78	3.0	199	60
	Richer	8.4	171	52	6.5	255	86	7.4	210	70
	Richest 20%	27.1	194	90	15.4	260	111	21.0	219	101
Per consumer unit calorie intake quintile	Lowest 20%	3.9	163	40	3.5	232	73	3.7	195	56
	Second Lowest	4.3	183	43	3.4	239	76	3.9	207	59
	Middle	4.1	169	42	3.3	255	76	3.7	206	59
	Second Highest	5.0	183	45	4.5	247	80	4.7	213	63
	Highest 20%	7.2	196	48	4.3	280	77	5.5	232	64
Total		7.2	179	43	3.7	249	76	4.2	210	60
P value of Chi2/F-statistics		*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*	*p<0.00*

**Mean wage for the 2011-12 and pooled 2004-05 & 2011-12 has been calculated at the constant price of 2004-05*

Table 3: Heckman's sample selection instrumental variable quantile regression coefficient of natural log of wage of the elementary workers, India

		Mean regression	*Quantile10*	*Quantile25*	*Median*	*Quantile75*	*Quantile90*
Panel A: Year 2004-05							
log of per consumer unit calorie intake		0.99*(0.02)	0.76*(0.03)	0.85*(0.02)	0.95*(0.02)	1.05*(0.02)	1.11*(0.03)
Age	***Up to 19 years®***						
	20-29 years	0.07*(0.01)	0.13*(0.02)	0.09*(0.01)	0.06*(0.01)	0.04*(0.01)	0.06*(0.02)
	30-39 years	0.21*(0.01)	0.21*(0.02)	0.17*(0.01)	0.14*(0.01)	0.14*(0.01)	0.18*(0.02)
	40-49 years	0.27*(0.01)	0.21*(0.02)	0.18*(0.01)	0.18*(0.01)	0.22*(0.01)	0.32*(0.02)
	50-59 years	0.23*(0.02)	0.11*(0.03)	0.13*(0.02)	0.15*(0.01)	0.23*(0.02)	0.40*(0.02)
	60 years and above	-0.11*(0.02)	-0.05(0.03)	-0.09*(0.02)	-0.08*(0.02)	-0.04(0.02)	0.04(0.03)
Sex	***Male®***						
	Female	-0.45*(0.01)	-0.53*(0.01)	-0.51*(0.01)	-0.45*(0.01)	-0.39*(0.01)	-0.34*(0.01)
Education level	***Illiterate ®***						
	Below primary	0.22*(0.01)	0.16*(0.02)	0.19*(0.01)	0.21*(0.01)	0.25*(0.01)	0.29*(0.02)
	Primary completed	0.21*(0.01)	0.11*(0.02)	0.14*(0.01)	0.19*(0.01)	0.25*(0.01)	0.33*(0.01)
	Middle education	0.37*(0.01)	0.24*(0.02)	0.27*(0.01)	0.35*(0.01)	0.43*(0.01)	0.53*(0.02)
	Secondary education	0.48*(0.02)	0.32*(0.03)	0.37*(0.02)	0.45*(0.02)	0.57*(0.02)	0.65*(0.02)
	Higher sec. and above	0.32*(0.02)	0.16*(0.04)	0.19*(0.03)	0.3*(0.02)	0.41*(0.03)	0.52*(0.03)
Technical education	***No®***						
	Yes	0.22*(0.06)	0.06(0.1)	0.17*(0.06)	0.15*(0.05)	0.31*(0.06)	0.27*(0.08)
Sector	***Rural ®***						
	Urban	0.47*(0.01)	0.40*(0.01)	0.41*(0.01)	0.43*(0.01)	0.5*(0.01)	0.52*(0.01)
Panel B: Year 2011-12							
log of per consumer unit calorie intake		0.57*(0.02)	0.42*(0.04)	0.47*(0.02)	0.48*(0.02)	0.57*(0.02)	0.79*(0.03)
Age	***Up to 19 years®***						
	20-29 years	0.05*(0.02)	0.11*(0.03)	0.10*(0.02)	0.08*(0.01)	0.05*(0.02)	0.03(0.02)
	30-39 years	0.15*(0.02)	0.16*(0.03)	0.16*(0.02)	0.13*(0.01)	0.11*(0.02)	0.10*(0.02)
	40-49 years	0.16*(0.02)	0.12*(0.03)	0.15*(0.02)	0.12*(0.02)	0.11*(0.02)	0.17*(0.03)
	50-59 years	0.12*(0.02)	0.05(0.04)	0.08*(0.02)	0.07*(0.02)	0.10*(0.02)	0.21*(0.03)
	60 years and above	-0.16*(0.02)	-0.18*(0.04)	-0.15*(0.03)	-0.11*(0.02)	-0.08*(0.02)	-0.09*(0.03)
Sex	***Male®***						
	Female	-0.50*(0.01)	-0.62*(0.02)	-0.54*(0.01)	-0.47*(0.01)	-0.45*(0.01)	-0.43*(0.01)
Education level	***Illiterate ®***						
	Below primary	0.08*(0.01)	0.04*(0.02)	0.06*(0.01)	0.06*(0.01)	0.09*(0.01)	0.12*(0.02)
	Primary completed	0.09*(0.01)	0.05*(0.02)	0.08*(0.01)	0.08*(0.01)	0.09*(0.01)	0.15*(0.02)
	Middle education	0.13*(0.01)	0.06*(0.02)	0.09*(0.01)	0.09*(0.01)	0.13*(0.01)	0.20*(0.02)
	Secondary education	0.21*(0.01)	0.12*(0.03)	0.13*(0.02)	0.15*(0.01)	0.21*(0.01)	0.33*(0.02)
	Higher sec. and above	0.21*(0.02)	0.11*(0.03)	0.11*(0.02)	0.14*(0.02)	0.19*(0.02)	0.36*(0.03)
Technical education	***No®***						
	Yes	-0.05(0.07)	-0.17(0.13)	-0.21*(0.08)	-0.11(0.06)	0.19*(0.07)	0.05(0.1)
Sector	***Rural ®***						
	Urban	0.24*(0.01)	0.16*(0.02)	0.17*(0.01)	0.19*(0.01)	0.24*(0.01)	0.35*(0.01)

Note:- ** p≤0.05; Standard Error in parenthesis; Regression result is adjusted for caste, religion, state region, land holding, agriculture seasons*

Test statistics of instrumental variable regression:

Panel A 2004-05*: Under identification test (Anderson canon. corr. LM statistic): 10000 ($\chi^2(6)$ P =0.00); Weak identification test (Cragg-Donald Wald F statistic): 2402; Sargan statistic (over identification test of all instruments): 61 ($\chi^2(5)$ P =0.00); Endogeneity test of endogenous regressors: 3119 ($\chi^2(1)$ P =0.00).*

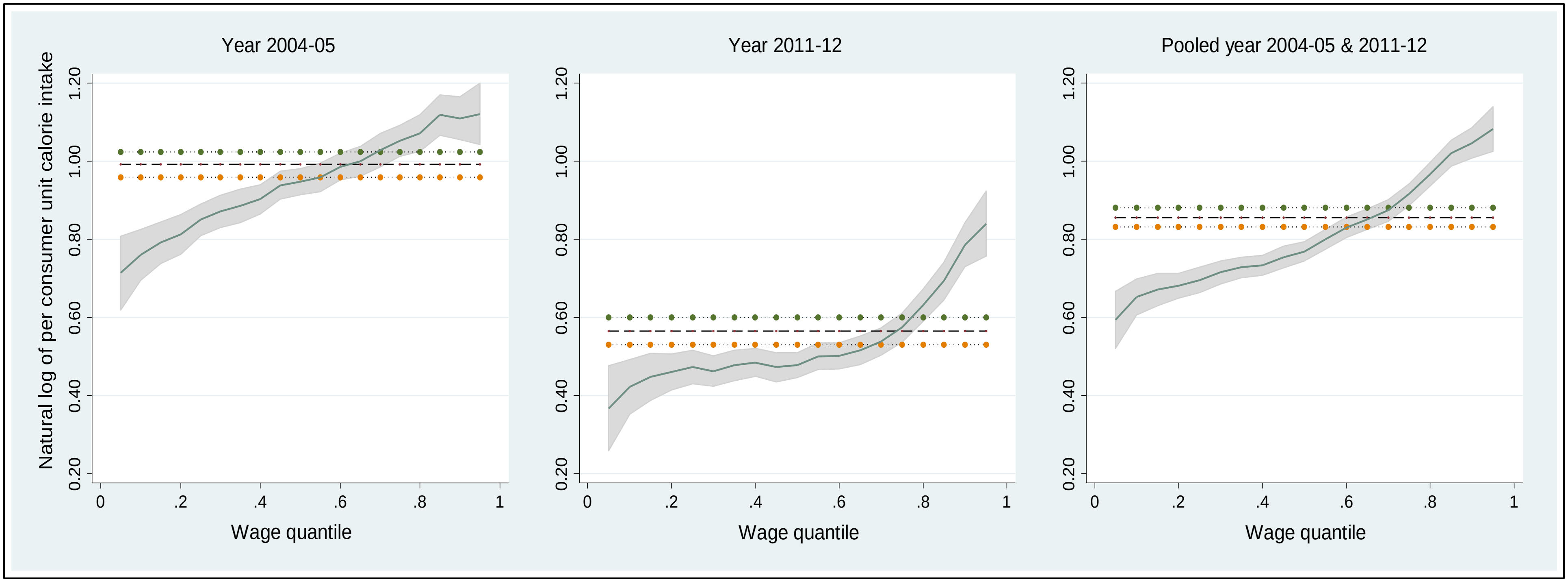
Panel A 2011-12*: Under identification test (Anderson canon. corr. LM statistic): 6217($\chi^2(6)$ P =0.00); Weak identification test (Cragg-Donald Wald F statistic): 1389; Sargan statistic (over identification test of all instruments): 48 ($\chi^2(5)$ P =0.00); Endogeneity test of endogenous regressors: 815 ($\chi^2(1)$ P =0.00).*

Table 4: Heckman's sample selection instrumental variable quantile regression coefficient of natural log of wage of the elementary workers, Pooled, 2004 & 2011

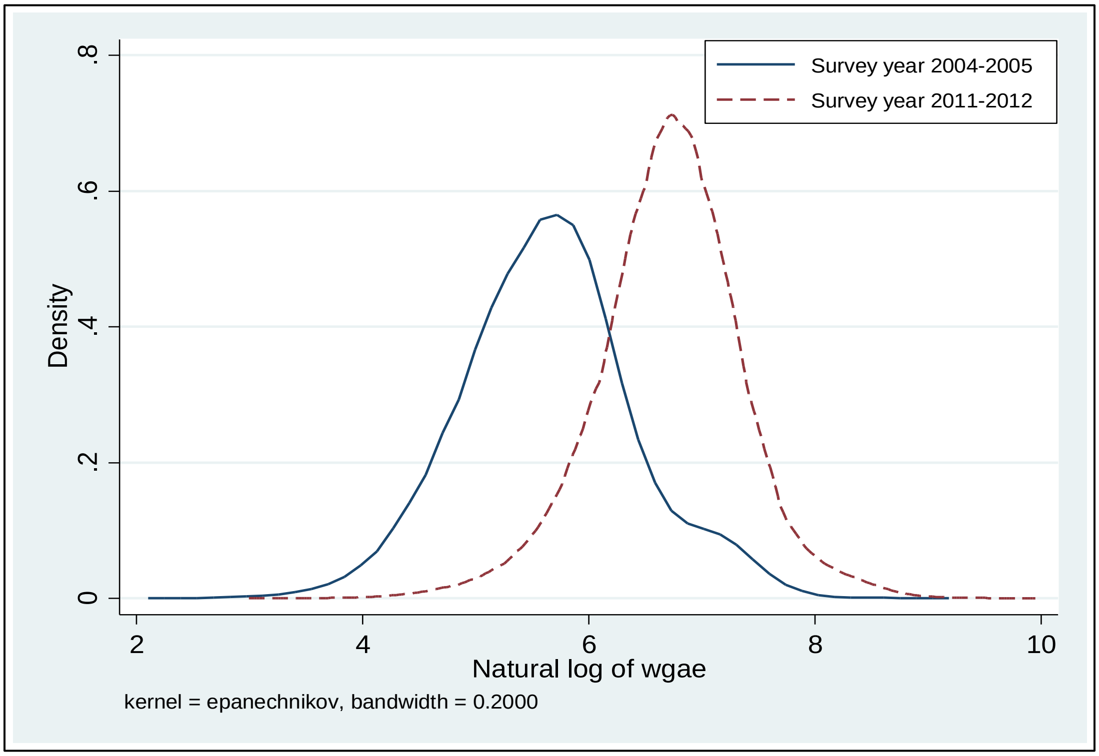
		Mean regression	*Quantile10*	*Quantile25*	*Median*	*Quantile75*	*Quantile90*
log of per consumer unit calorie intake		0.86*(0.01)	0.65*(0.02)	0.70*(0.02)	0.77*(0.01)	0.92*(0.01)	1.05*(0.02)
Age	***Up to 19 years®***						
	20-29 years	0.06*(0.01)	0.14*(0.02)	0.09*(0.01)	0.08*(0.01)	0.05*(0.01)	0.06*(0.01)
	30-39 years	0.18*(0.01)	0.21*(0.02)	0.17*(0.01)	0.15*(0.01)	0.14*(0.01)	0.16*(0.01)
	40-49 years	0.23*(0.01)	0.2*(0.02)	0.16*(0.01)	0.16*(0.01)	0.18*(0.01)	0.27*(0.02)
	50-59 years	0.19*(0.01)	0.11*(0.02)	0.11*(0.02)	0.12*(0.01)	0.18*(0.01)	0.34*(0.02)
	60 years and above	-0.12*(0.02)	-0.06*(0.03)	-0.11*(0.02)	-0.08*(0.01)	-0.05*(0.01)	-0.01(0.02)
Sex	***Male®***						
	Female	-0.48*(0.01)	-0.57*(0.01)	-0.54*(0.01)	-0.47*(0.01)	-0.42*(0.01)	-0.38*(0.01)
Education level	***Illiterate ®***						
	Below primary	0.18*(0.01)	0.12*(0.01)	0.14*(0.01)	0.16*(0.01)	0.19*(0.01)	0.23*(0.01)
	Primary completed	0.18*(0.01)	0.1*(0.01)	0.12*(0.01)	0.15*(0.01)	0.19*(0.01)	0.27*(0.01)
	Middle education	0.28*(0.01)	0.18*(0.01)	0.2*(0.01)	0.24*(0.01)	0.31*(0.01)	0.42*(0.01)
	Secondary education	0.36*(0.01)	0.22*(0.02)	0.26*(0.01)	0.3*(0.01)	0.41*(0.01)	0.51*(0.02)
	Higher sec. and above	0.29*(0.02)	0.15*(0.03)	0.15*(0.02)	0.22*(0.01)	0.33*(0.02)	0.48*(0.02)
Technical education	***No®***						
	Yes	0.13*(0.05)	0.03(0.08)	0.07(0.05)	0.11*(0.04)	0.26*(0.04)	0.22*(0.06)
Sector	***Rural ®***						
	Urban	0.39*(0.01)	0.31*(0.01)	0.31*(0.01)	0.34*(0.01)	0.41*(0.01)	0.47*(0.01)

Note:- ** p≤0.05; Standard Error in parenthesis*
Regression result is adjusted for caste, religion, state region, land holding, agriculture seasons
Test statistics of instrumental variable regression*: Under identification test (Anderson canon. corr. LM statistic): 17000 ($\chi^2(6)$ P =0.00); Weak identification test (Cragg-Donald Wald F statistic): 3845; Sargan statistic (over identification test of all instruments): 81 ($\chi^2(5)$ P =0.00); Endogeneity test of endogenous regressors: 4162 ($\chi^2(1)$ P =0.00).*

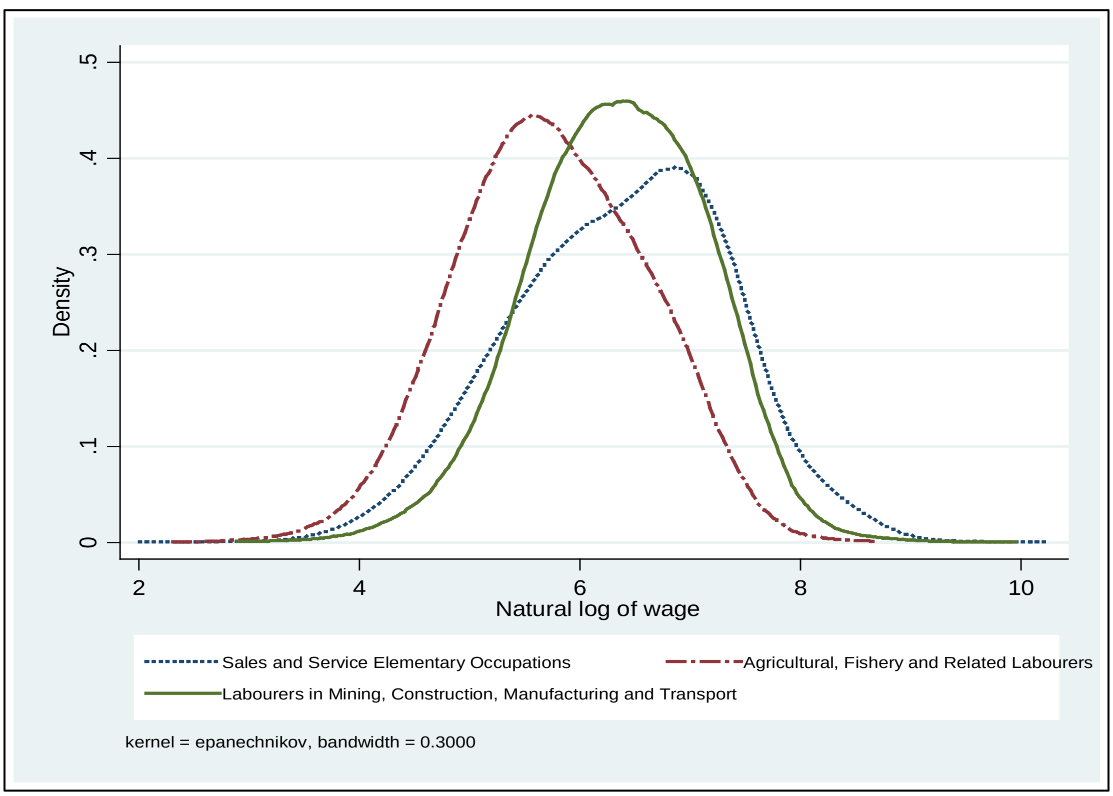
Figure 1: Heckamn sample selection regression coefficient of two stage ordinary least square and two stage quantile regression, India, 2004-50, 2011-12 and pooled 2004-05 & 2011-12



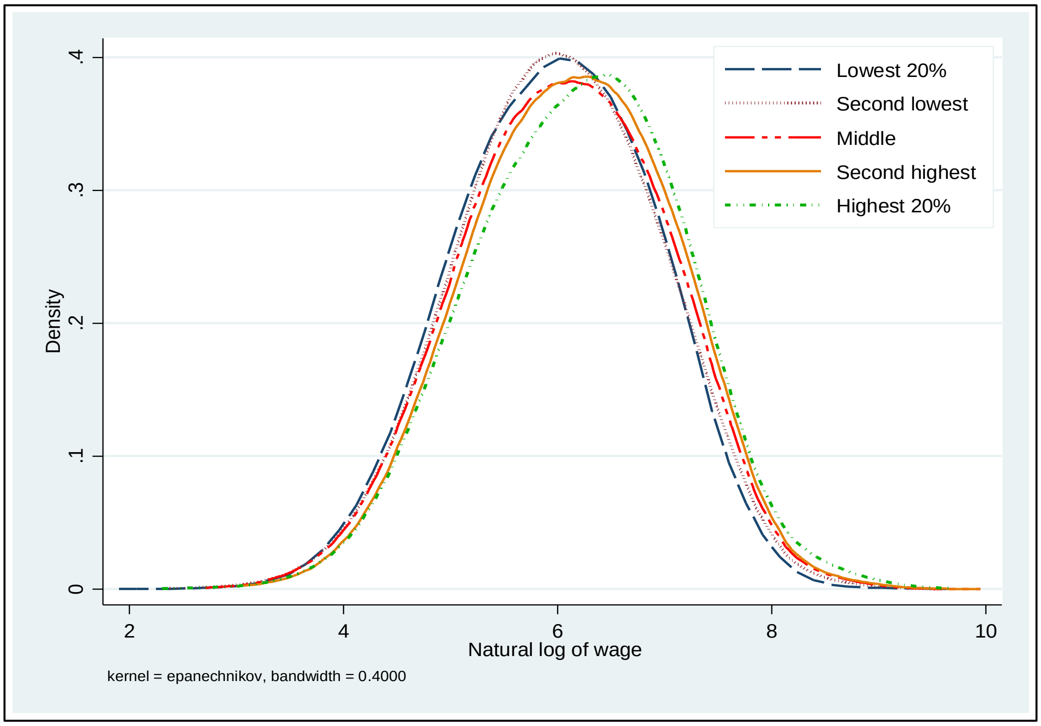
Appendix figure 1: Kernel density of the natural log of wage earning in last 7 days of the elementary workers, India, 2004-05 and 2011-12



Appendix figure 2: Kernel density of the natural log of wage earning in last 7 days of the elementary workers engaged in different occupations, India, pooled 2004-05 & 2011-12



Appendix figure 3: Kernel density of the natural log of wage earning in last 7 days of the elementary workers by per consumer unit calorie quintile, India, 2004-05 & 2011-12



Appendix table: Heckman sample selection instrumental variable quantile regression coefficient of log of per consumer unit calorie intake of the elementary workers, India

	Mean regression	*Quantile10*	*Quantile25*	*Quantile50*	*Quantile75*	*Quantile90*
Year 2004-05 Rural						
log of per consumer unit calorie intake	0.81*(0.02)	0.57*(0.04)	0.65*(0.03)	0.72*(0.02)	0.85*(0.02)	0.98*(0.03)
Year 2004-05 Urban						
log of per consumer unit calorie intake	1.41*(0.05)	1.26*(0.07)	1.37*(0.05)	1.47*(0.05)	1.52*(0.05)	1.44*(0.06)
Year 2011-12 Rural						
log of per consumer unit calorie intake	0.41*(0.02)	0.33*(0.05)	0.38*(0.03)	0.37*(0.02)	0.42*(0.02)	0.57*(0.04)
Year 2011-12 Urban						
log of per consumer unit calorie intake	0.88*(0.04)	0.61*(0.08)	0.69*(0.05)	0.76*(0.04)	0.9*(0.05)	1.13*(0.07)
Pooled 2004-05 & 2011-12 Rural						
log of per consumer unit calorie intake	0.68*(0.02)	0.5*(0.03)	0.55*(0.02)	0.59*(0.02)	0.71*(0.02)	0.91*(0.02)
Pooled 2004-05 & 2011-12 Urban						
log of per consumer unit calorie intake	1.22*(0.03)	1*(0.05)	1.05*(0.04)	1.2*(0.03)	1.34*(0.03)	1.35*(0.04)

*Note:- * p≤0.05; Standard Error in parenthesis*

Regression result is adjusted for age, sex, education level, technical education, caste, religion, land holding, state region, per capita consumer expenditure quintile, per consumer unit calorie intake quintile and agriculture seasons