EMPLOYMENT ESTIMATION WITH LIMITED INFORMATION ABOUT BUILDING AND UPGRADING: AN ILLUSTRATION FROM PERU

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The only complete way to measure the labor needed for building any dwelling is to have someone at the site counting the hours that others are working. That method is expensive and not helpful if the amount of future employment is already supposed to be one of the justifications for beginning the project. A way has to be found for estimating employment in advance.

The main things known in advance in a building project are location, types of materials, components, and dimensions. Builders and subcontractors will usually be committed to a price as well, and the assumption is that competition — real or potential -- will keep the price down to the level of costs (including reasonable profits). In fact, however, we simply assume that the price bid per square meter and cost per square meter are the same. Without that assumption, one would again need someone at the site and in the builder's office, counting every expenditure.

In making bids, contractors and small builders usually use rules of thumb or past experience in estimating the importance of labor costs. They seldom know how many hours of skilled and unskilled time were actually worked in the past, nor to what extent these apply to the new design. They think of cost, component by component, in a general way. Consequently, information about dimensions and expenditures is more widely available than information about employment.

Knowing dimensions and costs, we can connect the two and specify the cost per square meter of different housing types. In Lima, Peru in 1980 it appeared that in going from minimal to intermediate housing the cost per square meter first rose at an increasing rate, followed by a decreasing rate of increase in going from good to excellent housing. It appears that in the intermediate range, households sought improvements in the quality of materials, finishes, and fixtures; but that, once having attained high quality, they shifted toward buying more space. From minimal to excellent housing, as can be seen in Table 1, value per square meter rises in increments of 25%, 30%, and 7%. Floorspace rises in increments of 67%, 60%, and 67%. Basically, the two elements combined to double the value of the structure from one category to the next. Obviously, these figures reflect demand, as well as supply conditions.

Labor needed to produce these dwelling types (including numerous subcategories) depends on the technique of building and the relative prices of inputs. Sometimes improvements in technique will change employment even though all input prices and wages have remained the same. More often, a disproportionate rise in the cost of one input will lead to its partial replacement by other inputs that have remained cheaper. If the ratio of skilled to unskilled wage rates, p, rises, the ratio of unskilled to skilled employment, q, should rise in response. If (given p) the unskilled wage rate, w_u, rises, enough workers of all types may be displaced by mechanization and the like to keep r, the share of labor costs in the total, unchanged. What the responses to price and wage changes are (the elasticity of substitution) will depend on the physical and organizational alternatives in building. To a great extent, these alternatives are not developed until the builder is actually confronted by new price and wage pressures.

To assess the level of employment for a future case, one must first obtain the levels of p, q, r, and w_u (defined above) for a past case and then decide how much any of them will have changed. Either way, employment, N, will be related to cost, C, in the following manner: (For a derivation,

Table 1 -- Characteristics of Major Housing Types

	Housing Type	H0 Temporary	H1 Substandard	H2 Minimal	H3 Basic	H4 Good	H5 Excellent	Mean of Sample (median)
1.	Wall materials	Many inferior: straw mats, adobe, quincha, refuse.	Some inferior: adobe, wood.	All good materials: fired bricks, reinforced concrete, concrete blocks, dressed stone.				
2.	Roof materials	Same.	Wood, metal or asbestos sheets.	All good materials: reinforced concrete, clay tiles, some asbestos cement sheets.				
3.	Water source	River, well, water wagon, standpipe, neighbor sells.	Public standpipe, tap shared with others.	All have piped water on the premises.				
4.	Sanitary facilities	None or latrine.	Latrine, WC shared with others.	All have flush toilets connected to the sewerage system or modern septic tanks			Two or more bathrooms.	
5.	Rooms, number	1-2	2-3	2-3	3-4	4-5	5 and more	3.5 (3.0)
6.	Typical floor space, m^2	45	37	45	75	120	200	104
7.	Typical value of structure per m^2. 1980 soles, thous.	Below 5	9	16	20	26	28	---
8.	Typical value of structure without the site, 1980 soles, millions.	Below .3	.3	.7	1.5	3.1	5.6	---
9.	Typical area of site, m^2	185	60	75	120	170	Over 200	148
10.	Typical value of the site per m^2, 1980 soles, thousands.	Below 1	2.5	4	5	7	Over 10	---

Table 1 (cont'd) -- Characteristics of Major Housing Types

Housing Type	H0 Temporary	H1 Substandard	H2 Minimal	H3 Basic	H4 Good	H5 Excellent	Mean of Sample (median)
11. Typical site value, 1980 soles, millions	Below .1	.15	.3	.6	1.2	Over 2	---
12. Rental range, 1980 soles, thousands	Below 1	1-2	2-4	4-8	8-16	Over 16	4.8 (2.2)
13. Value range, 1980 million soles.	Below .3	.3-.6	.6-1.2	1.2-2.4	2.4-4.8	Over 4.8	2.8 (1.0)

see the appendix.)

$$N = \frac{r(1 + q)}{(p + q)} \cdot \frac{C}{w_u}$$

The term with the r, p, and q is the "employment generator", Ø. If it applies, not to total cost, but to <u>changes</u> in employment compared with <u>changes</u> in cost, it is the "incremental employment generator," θ

Application to Peru

In the case of Peru, we have made a detailed assessment of cost and employment only for two core dwelling types. The bigger and better one costs US $1,077 more and requires an additional 28.5 workdays. Since the daily wage of unskilled labor, w_u, was US $7.32, the marginal employment generator, θ, was 0.169.

$$\theta = \frac{dNw_u}{dC}$$

$$= \frac{28.5\ (\$7.32)}{\$1077}$$

$$= .194$$

In the absence of additional information we can do not better than to assume that the marginal employment generator applies to the entire housing stock. For each additional US $100 spent on making dwellings bigger or better, 2.3 onsite workdays will be generated...as long as the wage level of $7.32 daily remains unchanged.

$$N = \frac{.194\ (\$100)}{\$7.32}$$

$$= 2.65$$

The less dwellings are like core housing, the less accurate such estimates are likely to be. For example, it will be better for any other single-story dwelling than for luxury highrise apartments. If the normal body temperature of a child has been measured as 37 degrees, it is safer to apply that to an adult human than to a gorilla or a wha: Note that as long as r, the share of labor in costs, is around .25, the employment generator is not likely to be below 0.14 or above 0.24. Thi statement can be verified by trying hypothetical combinations of p and (See Table 3.) Employment changes per sol or dollar are mainly due tc a rise in the wage level, w_u.

With this procedure, Table 2 shows how onsite workdays per dwel] rise from 101.5 for the smallest core unit to 1,105 for a 200 m^2 luxury residence. If the indirect labor content of materials is added, accorc to the findings of Rufino Cebrecos Revilla, employment goes from 152 tc 1,602 workdays. On a per square meter basis, employment falls from 4.(workdays to 3.6 and then rises back to 5.5. It rises the most at the intermediate level where quality rises faster than space. This pattern is best observed by looking at incremental employment generation, as fc

The change from the smallest core to that of 34.4 m^2 and to the minimal 45 m^2 unit is mainly one of additional space. Since the cost o plumbing can be distributed over more square meters, the cost per squar meter actually falls. The initial unit requires 4.0 workdays per squar meter, but the marginal increments only take 3 workdays per square mete After that the marginal changes cost 5.0 and 5.7 workdays per extra squ meter, followed by a leveling off. Gradually the average employment generator, $\emptyset$, falls to the level of the incremental generator, Θ, or fr .31 to .205.

Table 2

Employment Generation in Different
Housing Types, Lima, Peru, 1980

Category	$24.9m^2$ Core	$34.4m^2$ Core	$45m^2$ Minimal	$75m^2$ Basic	$120m^2$ Good	200m Excelle
1. Difference in floorspace compared with the next smaller type, m^2.	-	9.5	10.6	30.0	55.0	80.
2. Percentage change in value per m^2 of floorspace. Compared with next smaller type, %.	-	-2.9	-1.4	25.0	30.0	7.7
3. Onsite workdays per m^2 of floorspace.	4.0	3.8	3.6	4.2	5.2	5.
4. Ratio: Change in onsite workdays to change in m^2 of floorspace.	-	3.0	3.0	5.0	5.7	6.
5. Onsite workdays per dwelling.	101.5	130	162	312	625	1105
6. Onsite employment generator, Ø.	.314	.250	.239	.222	.213	.2
7. Incremental employment generator, θ.	-	.194	.194	.194	.194	.1
8. Ratio, indirect materials employment to onsite employment.	.40	.40	.40	.40	.45	.4
9. Ratio change in materials employment to change in m^2 of floorspace.	-	1.2	1.2	2.0	2.8	2.7
10. Indirect employment, in materials, workdays.	40.6	52	65	125	281	497
11. Sum, onsite and indirect materials employment, workdays.	152	182	227	437	906	1,602

Source: Floorspace and values of the different housing types (without the site) were observed in June and July 1980. Workdays per square meter were analyz in detail for the two core housing types. It is assumed that the extra worl days for additional square meters rise in proportion to the marginal square meter cost. The ratios of materials to onsite labor come from Rufino Cebre Revilla, Construcción de Vivienda y Empleo (Lima: Publicaciones CISEPA, Pontificia Universidad Catolica, Documento de Trabajo 35, April 1978), p. 3 These estimates can vary by plus or minus 25 percent in accordance with the volume and techniques by particular enterprises.

Table 3

HYPOTHETICAL VALUES OF THE EMPLOYMENT GENERATOR, Ø, WITH ALTERNATIVE LEVELS OF THE SKILL RATIO, q, AND THE WAGE RATIO, p

Case	p	q	Ø
1. Typical Set	2.00	3.00	.200
	1.63	1.50	.200
	1.50	1.00	.200
	1.38	.50	.200
	1.20	0	.200
2. Relatively Low	2.00	2.00	.1875
Unskilled	1.67	1.00	.1875
Ratio	1.50	.50	.1875
	1.33	0	.1875
3. Relatively Low	1.500	3.00	.2222
Wage Ratio	1.312	1.50	.2222
	1.250	1.00	.2222
	1.188	.50	.2222
	1.125	0	.2222
4. Extreme Combinations			
Low Ø	2.500	1.00	.1429
High Ø	1.200	3.00	.2381

NOTE: r is assumed to be .25.

Employment in Expansion or Upgrading

Even harder to observe than formal construction employment on new dwellings is that in expansion or upgrading. Such employment may proceed piecemeal over a long period of time and be partly carried out by the household. The value of such improvements is not what they mean to the household, but rather what they mean to society, the extent to which they increase the market value of the house. If the change in value, dC, is known or can be estimated, then the incremental employment generator can be applied to that, as above:

$$dN = \frac{\theta dC}{w_u}$$

More days than that may have been worked by the household, but the difference should not be counted as the equivalent of real employment. It is time spent on learning or leisure.

If the value of an improvement or expansion is not known, one can assess employment generated by using the additional floor space that has been produced. If the house is at the minimal level, extra floorspace generates 2 workdays per extra square meter. If it is at the "good" level, it generates 4 workdays per extra square meter. If one only knows the number of rooms that have been added, one has to assume that they are of average size for that quality range unless there is information to the contrary. Note that at the "good" and "excellent" level, materials are somewhat more labor-intensive than at lower levels. (Table 2, line 8).

None of these ways of measuring employment are suggested as having a high degree of precision. But their accuracy is likely to be within 25 percent. The estimates are better than ignoring employment effects altogether or than making exaggerated claims that arouse skepticism. Moreover, any plausible errors in p, q, and r -- the basic elements of this method -- are not likely to change the relative ranking of different dwelling types as employment producers.

APPENDIX

I. GUIDELINES FOR ESTIMATION

Derivation

With the assumption of separability, we shall now derive the employment generator, Ø, using the three ratios:

$r = W/C$,	the wage bill, W, in total costs, C.
$p = w_s/w_u$,	the ratio of skilled to unskilled wages.
$q = N_u/N_s$,	the number of unskilled workers employed for every skilled worker.

The wage bill, W, is equal to the daily wage rate, including fringes, w, times the number of workdays, N, of each type of worker--skilled, s, and unskilled, u.

$$W = w_s N_s + w_u N_u \qquad (2)$$

Using the second two ratios above, we can simplify matters by expressing everything in terms of the wages of unskilled workers, w_u, and the number of skilled workers, N_s, since $w_s = w_u p$ and $N_u = N_s q$.

$$W = w_u N_s (p + q) \qquad (3)$$

We now have the employment of skilled workers for a given wage bill.

$$N_s = \frac{W}{w_u(p + q)} \qquad (4)$$

Using the ratio, r, or $W = rC$, skilled employment can be related to the cost of the project,

$$N_s = \frac{rC}{w_u(p + q)} \qquad (5)$$

Since the number of unskilled workers is equal to qN_s, total employment, $N = N_s(1 + q)$, or

$$N = \frac{r(1 + q)}{(p + q)} \cdot \frac{1}{w_u} \cdot C \text{ and } \qquad \emptyset = \frac{r(1 + q)}{(p + q)} \qquad (6)$$

$$N = \emptyset \cdot \frac{1}{w_u} \cdot C \qquad (7)$$

The first term of (6) relates the three ratios to one another and is the generator, $\emptyset$. The second term is the reciprocal of the unskilled wage rate. Together these two constitute a multiplier that relates the total cost of a project, C, to the employment, N, that is generated. Because of the possibility of inflation, the term with the ratios, $\emptyset$, is likely to be more stable than the other two. But r and q may vary with the type of project, i, and should actually be expressed as r_i and q_i.