Female Labor Force Participation and Labor Saving Gadgets

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I show under what conditions women would migrate out of the household sector into formal sector jobs, in response to increased ability to use labor saving household gadgets which raise productivity of female labor engaged in household tasks.

JEL Classification : O1, O3.

Keywords : Labor-saving gadgets, migration, female labor force participation.

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1. Introduction

It has been widely documented that rising rates of female labor force participation characterize the process of rapid growth. In particular after a developing economy has crossed a "subsistence threshold" subsequent growth entails greater participation of women in the labor force. For example, Alwyn Young shows that between 1966 and 1990, when the phase of rapid growth took off in the East Asian economies, participation rates rose from 0.38 to 0.49 in Hong Kong, from 0.27 to 0.51 in Singapore, from 0.27 to 0.36 in South Korea and from 0.28 to 0.37 in Taiwan, and that nearly all of this was due to increased participation of women in the labor force. Kristin Mammen and Christina Paxson show that Thailand and India experienced a U shaped relationship between female labor force participation and development with the rising segment of the U coming into force when these economies grew out of relative stagnation.

Several explanations have been proposed for such findings in the theoretical literature. Galor and Weil (1996) propose that development leads to a rise in capital labor ratios and that this increases the demand for brain power as opposed to muscle power, giving women an advantage and improving their opportunities relative to men's. Mammen and Paxson (2000) suggest that in the initial stages of development, only men's opportunities improve and this results in a pure income effect on women's demand for leisure, or in the amount of time they can afford to devote to household tasks. However later female education and growing acceptability of women working outside the home led to improving female opportunities exerting a substitution effect and inducing women to substitute away from leisure and household tasks towards formal sector jobs. These explanations all emphasize the "pull factor" - a rise in women's wages or opportunities in the formal sector which pulled them out of the household sector. In this paper I focus instead on an alternative mechanism which, while it involves rising wages in the formal sector, originates in a change in the household sector itself - a change in the technology of performing tasks in the household sector, which by raising female labor productivity in the household pushes them out of this sector. Modeling a simple economy with only one labor-intensive manufactured export, and a household sector whose services are not traded internationally, I show how increased ability to import labor saving household gadgets would raise labor productivity in the household sector. As household tasks are mainly the province of women, this is essentially an increase in the productivity of female household labor, enabling women to migrate out of the household sector into the formal sector. I show under what conditions this migration would take place. The crucial assumption here is that household services are not traded internationally : in a

sector whose products are traded, an increase in productivity would cause expansion and not contraction. This does not seem to be an unrealistic assumption given that services as a sector are treated as non tradable in most studies : the logic used there applies with even stronger force to household tasks.

Section 2 presents the model of this simple economy and the main result. Section 3 analyzes to what extent the findings of this paper are compatible with those of others. Section 4 concludes.

2. The Model

Consider a small open economy with three outputs: labor intensive cloth C produced by labor L_c and capital K_c, capital-intensive gadgets G produced by labor L_g and capital K_g, and meals M produced within the household by labor L_m and gadgets G_m. Only cloth and meals enter people's utility functions.

There are fixed endowments of labor and capital, both inelastically supplied, and perfect internal factor mobility between the household sector and the two factory sectors. This ensures that the value of the marginal product of labor in the household is equal to its opportunity cost, the market wage in the factory. Likewise, the marginal product of gadgets in producing meals is equal to their price. Thus the household is thoroughly

penetrated by the market : phenomena like disguised unemployment of labor or other assets are ruled out.

Gadgets are assumed to have a life-span of one period and to die a sudden death thereafter. This is designed to rule out complications due to the durability of household equipment which have nothing to do with the problem we wish to focus on.

The economy exports cloth and imports gadgets at terms of trade t while the price of meals in terms of the numeraire gadgets is p. Suppose the economy is initially in equilibrium with incomplete industrial specialization. Assuming CRS production functions, the terms of trade t will determine factor prices in terms of both industrial outputs independently of factor endowments. Suppose w and r are the prices of capital and labor in terms of gadgets. With development, trading opportunities rise, partly due to a fall in transport, communication and warehousing costs, and I model this as a rise in t as this raises the f.o.b prices that exports could fetch.

If t rises, w rises more than proportionally by the Stolper-Samuelson theorem. Suppose that the unit cost functions for cloth and gadgets are $\theta_c(w,r)$ and $\theta_g(w,r)$. In competitive equilibrium,

$$t = \theta_c(w,r) \text{ and}$$

$$1 = \theta_g(w,r).$$

Differentiating these two equations logarithmically and eliminating the terms in r, we get

$$dw/w=((1-S_{lg})/(S_{lc}-S_{lg}))dt/t \quad (1)$$

where S_{lc} and S_{lg} are the shares of labor in cloth and gadgets output respectively.

Further, as w rises with the price of gadgets fixed at 1, p, the price of meals must rise:

$$dp/p = S_{lm}dw/w \quad (2)$$

where S_{lm} is the share of labor in the cost of meals.

From (1) and (2),

$$dp/p=S_{lm}(((1-S_{lg})/(S_{lc}-S_{lg})))dt/t. \quad (3)$$

Whether meals become expensive relative to cloth depends on whether the coefficient on the right hand side of this equation exceeds unity .

The higher gadget-intensity of meals will reduce labor-requirements per meal. However, more meals may be demanded as income rises due to the improvement in terms of trade; the price effects on the demand for meals are ambiguous. What determines whether aggregate employment in household production rises or falls?

Suppose there is no migration out of the household sector. With household employment constant, meals multiply as the input of household gadgets G_m increases:

$$dM/M = (1 - S_{lm})dG_m/G_m. \quad (4)$$

As wages rise with household labor fixed,

$$dG_m/G_m=\sigma_m dw/w \quad (5)$$

where σ_m is the elasticity of substitution between household labor and gadgets. Therefore, from (4), (5), (2) and (3),

$$dM/M = (1 - S_{lm})\sigma_m dw/w$$

$$=(1/S_{lm} - 1)\ \sigma_m dp/p$$

$$=(1-S_{lm})(((1-S_{lg})/(S_{lc}-S_{lg})))\sigma_m dt/t. \quad (6)$$

The higher the elasticity of substitution of gadgets for labor and the lower the share of labor in household production, the more rapidly will household labor productivity (and no-migration household output) rise.

Meanwhile, balanced trade, the equality of the value of cloth exports with gadget imports, implies

$$(C - C_d)t = G_m - G \quad (7)$$

where C_d is domestic cloth consumption. Differentiating this gives us

$$(C-C_d)dt + (dC - dC_d)t = dG_m - dG. \quad (8)$$

Since labor has been assumed to remain constant in both the household and industrial sectors,

$$dM = M_g\, dG_m \quad (9)$$

where M_g is the marginal product of gadgets in household production. Since the value of the marginal product of gadgets in terms of gadgets is unity, M_{g} p= 1, we deduce that

$$dG_m = pdM. \quad (10)$$

In the industrial sector, with inputs constant, one output can be transformed into another only at the marginal rate of transformation, which in our competitive model is the relative product price:

$$dG = - tdC. \qquad (11)$$

Inserting these values for the changes in demand and production of gadgets, from (8), (10) and (11) we get

$$tdC_d = (C - C_d)dt - pdM. \qquad (12)$$

This can be written as

$$dC_d/C_d = ((C-C_d)/(C_d))dt/t - (pM/tC_d)\, dM/M$$

$$=[((C-C_d)/(C_d))-(pM/tC_d)(1-S_{lm})(((1-S_{lg})/(S_{lc}-S_{lg})))\sigma_m]dt/t. \qquad (13)$$

We now have the supply-side relationship between the growth rates of the two final outputs and of the terms of trade under conditions of no migration. The demand-side relationship can be represented by

$$dp/p - dt/t = \varepsilon_m/\varepsilon_s\, dC_d/C_d - \varepsilon_c/\varepsilon_s\, dM_d/M_d \qquad (14)$$

where ε_m, ε_c are the income-elasticities of demand for meals and cloth respectively and ε_s is the elasticity of substitution in consumption between them, (see appendix) while M_d denotes the demand for meals. Now, substituting the expressions derived above in terms of dt/t for dp/p and dC_d/C_d, we get demand for meals growing at the rate defined by

$$dM_d/M_d =[\varepsilon_m(C-C_d)/\varepsilon_c C_d+\{1-s_{lm}(((1-s_{lg})/(s_{lc}-s_{lg})))\}\varepsilon_s/\varepsilon_c-\sigma_m\{pM\varepsilon_m/tC_d\varepsilon_c\}(1-s_{lm})(((1-s_{lg})/(s_{lc}-s_{lg})))]dt/t. \qquad (15)$$

If we compare this with the growth rate of the supply of meals in a no-migration situation (ie comparing (6) and (15) it is evident that there exists some threshold elasticity of factor substitution in household production σ_m^* such that for $\sigma_m \geq \sigma_m^*$, excess supply of meals will emerge, driving down the price of meals and inducing migration out of the household sector. This value is given by

$$\sigma_m^* = [\{\varepsilon_m(C-C_d)+C_d\varepsilon_s\}t((s_{lc}-s_{lg})/(1-s_{lg}))-\varepsilon_s tC_d s_{lm}] /[(1-s_{lm})(tC_d\varepsilon_c+pM\varepsilon_m)]$$

3. Comparison with other Literature

My model shows under what conditions a rise in the productivity of female household labor through the import of labor saving gadgets would lead to an excess supply of household services (captured by meals in the model) and induce migration of female labor out of the household sector. It is to be noted that as my model involves a rise in wages it is compatible with other theories which focus on the pull exerted by rising wages and therefore rising opportunity costs of female labor in the household sector. However one must consider not only an improvement in women's opportunities in the form of higher wages but also women's increasing ability to take advantage of these opportunities. While this second factor is often assumed to be a product of better education, decreasing social prejudice, etc, it is usually not explicitly modeled. My paper differs in this respect. Also, the mechanism I focus on - an improvement in household technology via labor saving gadgets - directly impacts the household sector, and constitutes a "push" factor.

I also note that as my mechanism of importing labor saving household gadgets can be regarded as an increase in the opportunities available to women (as it frees up female labor otherwise engaged in household tasks) it is not inconsistent with traditional theories of a relative improvement in the position of women leading to a substitution effect away from household labor and into the formal sector.

4. Conclusions and Extensions

Labor saving household gadgets could conceivably have played a role in freeing up female labor engaged in household tasks, inducing migration into the formal sector and the rapid rises in formal sector female participation rates that have been so widely documented. Moreover this process would not be inconsistent with other factors such as a rise in formal sector wages, which indeed is a feature of my model. The crucial assumption is the non tradability of household services.

Empirical evidence shows that in Korea and Taiwan imports of labor saving household gadgets increased with openness at the same time as increases in female labor force participation. The value in thousands of dollars of imports of household gadgets, including household laundry equipment, refrigerators, electrical and electrothermic domestic appliances from the US increased from 393 in 1960 to 32,729 in 1990 for Korea and from 231 in 1960 to 157,004 in 1990 for Taiwan (source : World Trade Database). These numbers represent of course an underestimation of the role of such gadgets in the

Korean and Taiwanese economies because they ignore the substantial expansion in the domestic production of such gadgets and in their sales in their home markets - a factor that I too have ignored in my model for the sake of simplicity. The process was aided by an increase in openness in these economies : openness as measured by the ratio of trade to GDP at constant (1996) prices rose from 16.74 to 82.75 in Taiwan and from 5.05 to 43.01 in Korea during this period (source : Penn World Tables). These variables show a marked upward trend during this period which coincides with the large increases in labor force participation (almost entirely due to female labor) documented by Alwyn Young (from 0.27 to 0.36 for Korea and from 0.28 to 0.37 for Taiwan). This is consistent with my model. Insufficient data is available for assessing the trends in the terms of trade of manufactured exports to gadget imports and the question of whether a causal link between gadget imports and female labor force participation can be established in these or in other developing countries is part of a future research agenda.

A closely related issue concerns the fertility decline that accompanied the rising rates of female labor force participation. Unfortunately it is difficult to establish the direction of causality as while the attraction of working and the rising opportunity cost of mothers' time could have induced lower fertility, it is also possible that improvements in contraceptive technology, or in medical technology which lowered infant mortality and made fewer births necessary to achieve a given family size, freed female labor previously engaged in child rearing and resulted in larger formal sector participation rates among women. If this were so, it could be analyzed using a framework similar to the one I develop in this paper.

APPENDIX

Divide the budget constraint $Y = pM + tC_d$ through by t to transform to new variables in terms of cloth $I = Y/t$ and $q = p/t$:

$I = qM + C_d$.

The indirect utility function $u = u(Y, p, t)$, being homogeneous of degree zero, can be similarly transformed :

$$u(Y, p, t) = v(I, q).$$

The demand for each good can be written as a function of real income v and price q:

$M = f(v, q)$; $C_d = g(v, q)$.

Differentiating these demand functions,

$dM = \partial f/\partial v\, dv + \partial f/\partial q\, dq$

$dC_d = \partial g/\partial v dv + \partial g/\partial q dq$

from which

$\partial f/\partial v\, dC_d - \partial q/\partial v\, dM = (\partial g/\partial q.\partial f/\partial v - \partial f/\partial q.\partial g/\partial v)\, dq$.

Since the price variations in $\partial f/\partial q, \partial g/\partial q$ are with utility constant,

$\partial g/\partial q = -q\partial f/\partial q$.

Thus we have

$$(\partial f/\partial I.dC_d - \partial g/\partial I.dM)/\partial v/\partial I = -(q.\partial f/\partial v + \partial q/\partial v)\partial f/\partial q.dq$$

$$= -\partial I/\partial v.\partial f/\partial q.\ dq$$

or $(\partial f/\partial I.dC_d - \partial g/\partial I.dM) = -\partial f/\partial q.dq.$

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