TECHNOLOGICAL CHANGE AND WOMEN'S LABOUR FORCE PARTICIPATION IN LESS DEVELOPED COUNTRIES

by

LESLIRAE BASU

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Department of Commerce and Business Administration

The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

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ABSTRACT

This study attempts to examine the effects of technological change on women's labour force participation in less developed countries. Regression analysis in the context of a simultaneous equation model, using cross sectional data for thirteen Indian manufacturing industries during the latter half of the 1960's was used. The literature survey outlines how technological progress may have either positive or negative effect upon the proportion of women workers in individual sectors. However the overall effect of technological progress on an agriculturally-based economy is to cause a change in the structure of the economy and a rise in the relative importance of urban based industries. This leads to a separation of women from production, and a decline in the overall participation rate of women.

The results of this study show that technological change can have a positive impact on the proportion of women in individual industries; that foreign business and increasing capital/labour ratio also have positive impacts on women's participation. In addition, it is found that technology transfer from foreign business was positively and significantly linked to technical progress in Indian Manufacturing in the late 1960s.

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INTRODUCTION

Participation of women in the labour force has received a lot of attention in recent years in developed countries. It is commonly believed that the percentage of economically active women is higher in developed countries than in less developed ones.

The questions which sparked initial interest in undertaking this study were:

Is the higher female labour force participation in developed countries a consequence of industrialization or of different cultural traditions?

How important is technology relative to culture and how do these interact?

The last twenty years has seen a very substantial increase in women's labour force participation in the West. Yet in 1976, the participation rate of Canadian women 15-24 years of age was about 57% while in 1961, 20-24 year old rural Indian women had a participation rate of 49%.

In the early sixties, it appears that 'Crude Labour Force Participation Rates for Females' did not differ substantially between the Third World and the more developed countries. At that time, in Nepal this female participation rate was 36.5%, for the USA, 30.2%, for India 27.9%, for

South Korea 23.4% and for Canada 22.3%.* The main differences lie in the type of economic activities in which women are engaged. Of the agricultural workforce in Nepal in 1960-61, 41.8% were women, in India 35.6%, in Malaysia 34%. In 1971-72, in the United States a comparable figure was 17.4% and for Canada, 13.7%.** In the United States and Canada, most of the economically active women in that decade were employees (93.9% in Canada and 93.8% in the United States), whereas only 57.6% were employees in Malaysia, 27.8% in South Korea, and 25.1% in India. This difference between North and South in occupations is accentuated when it is realized that the economically active figures do not include cultivators in purely subsistence agriculture.

The question then arises whether technological change and industrialization have any effect on women's participation and status, or rather on the type of economic activities in which women are engaged. It is reasonable to expect that a larger percentage of the working women will be engaged in agricultural activities in less developed countries which have agriculturally based economies than in the more developed countries. In that case, it is important to assess whether technological change has a different impact on women than on men as agriculture declines in importance and a relatively smaller proportion of both men and women

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* Elise Boulding, Handbook of International Data on Women pp. 27 - 28.
**Ibid, pp. 53-54.

are employed in it.

In spite of having access to one of the best Asian libraries in North America, the Wason collection at Cornell, it was very difficult to collect data for an empirical study. A year after beginning to collect data, four countries had been closely examined and had yielded only one complete data set consisting of just thirteen observations.

The first attempt to find data with which to examine some of these questions, began with Malaysia. This was an LDC with a still substantial reliance on its agricultural sector and not highly industrialized. There was a large amount of detailed data available on women's labour force participation, work histories, wages, migration, family life, fertility, etc., from a Family Life Survey by RAND. Unfortunately, the classification was by occupation rather than by industry, so this could not be combined with other data sources such as official statistics.

An attempt was then made to collect the data from Malaysian Industry Surveys, Censuses and other secondary sources but data concerning several important variables had only recently begun to be collected. As a result, in order to get a minimal number of observations, technological change had to be measured over two year intervals. This was inappropriate as capacity utilization and other factors included in the 'residual' measure of technological change,

loomed too large in comparison with the actual technological change. Consequently, the regression results had no significance.

The next country atempted was Korea. It was believed that Korea was not so highly developed as to be non-representative of LDCs, yet was likely to have a comparatively good statistical base. In addition, it had experienced quite high growth and so it was likely that substantial technological progress had occurred over the past 20 years.

Korea did have well organized data on most of the important variables stretching back a good number of years. However, while there was substantial data on foreign aid, nothing in English regarding foreign ownership or investment by industry could be uncovered either in the Wason collection or in the Library of Congress.

Taiwan was the next choice, as there was some resemblence to the Korean case but at a higher level of development. As there is a positive correlation between the level of development, and the quality and quantity of published statistics, it was worth a try! Exactly the same problem regarding foreign ownership and investment by industry emerged however.

Two possible explanations for this very noticeable gap in otherwise very good data sources suggest themselves. The first is that the prevailing development theories and concepts in these two countries had not yet incorporated foreign investment and ownership as important to their national economies. But given the reliance of both countries on foreign aid and investment, and the levels of aid and investment which had taken place in the past, it is difficult to believe this was not considered important enough to collect data about. The more radical interpretation might be that because the role of foreign investment and ownership was so significant, vested interests preferred that it not be too closely investigated. In Canada, for example, revelation of the extent of foreign ownership of industry has produced considerable popular concern and even resentment (though this has resulted in little action).

The final choice was India. There is known to be a large amount of statistics collected by various agencies in India and a less receptive, or at least, a government less fortunate in being able to attract large (per capita) levels of foreign investment and aid. It was not likely India would be bashful about publishing such data.

Indian data was certainly not without its problems. A large volume of data exists, largely unco-ordinated, generally not

consistent over time and prone to using classifications not comparable from one source to the next. However, it was finally possible to construct a small cross-sectional data set for manufacturing industries in the late sixties. An economy-wide time series data set did not prove feasible. The empirical component of this study is therefore based on (and limited by) this small Indian data set.

CHAPTER ONE LITERATURE SURVEY

1.1 Technology's Power and Potential

Technological change is an important factor in the development of LDCs. However, its impact is complex. It is obvious that it can contribute to increased productivity. But not only can it create wealth, it can alter relative positions and make changes in society itself. Total employment opportunities may be increased or decreased by a particular innovation. The effect on any particular group though, may not be correlated with the overall effect. Entire sets of people who have traditionally handled particular tasks may be displaced by a different group. Relative economic opportunities, employment and even political power can be redistributed by the introduction of technological change.

An often overlooked factor is the effect of technological change upon society's values. As Denis Goulet points out, technology is not value-free. Embedded in Western technology are such values as:

1) A reductionist approach to rationality (as opposed to a synthetic approach to truth).
2) Equation of productivity with efficiency, ignoring externalities. An example is the repetitiveness and narrowness that modern technology imposes upon many jobs.

This has been associated with alienation. Western technology's increases in material productivity have often been gained at the expense of creative forces of workers and the satisfaction and identification with their labour.

3) An attitude of conquering nature rather than harmonizing with it. Technology, in bestowing freedom, has largely displaced nature in its power over human life in industrial societies. Consequently, '... homage (is paid) to technology instead of nature'*.

   If too high a value is placed upon technology, it creates a drive to achieve whatever is within reach regardless of the ultimate consequences.

4) Encouragement of achievement orientation. In contrast with many Western societies, the values of many cultures in the developing world were partially shaped by the fact that resources were limited and could not be significantly increased in a generation. In order that society would not degenerate into a 'zero sum game', it was necessary to curb the acquisitive spirit. The impact of technological change with its embedded antithical values tends '... to shatter the fragile web which binds all the values of premodern communities into a meaningful whole'.**

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* Denis Goulet, The Uncertain Promise ,p 32.
**Ibid, p. 20.

The question of values and equity are also linked. It is easier to raise aspirations than to increase resources and even with increased resources, the surviving social institutions and normative structures may not be able to limit the extent to which the increases are appropriated by the few at the expense of the rest.

In summary, technology is a tool for raising productivity, it is a tool which can be used by its owners to exercise various forms of social control, it can decisively affect modes of decision-making and it is linked to alienation characteristic of affluent societies.

Technology, being a powerful tool, must be properly controlled if it is to yield net total benefits instead of social damage. The essense of that control lies in a society critically determining its values and goals and selecting the appropriate technology which takes fully into account all externalities, not just production efficiencies.

1.2 Technology Transfer and the Multinationals' Role

The term Technology Transfer is usually used in the context of transplantation of technology from developed countries to less developed countries, and this is how the term will be used in the context of this paper. However, it can as easily refer to movements in the opposite direction, to those between developed countries, between less developed countries, or to those within a single country but between sectors, industries or firms.

Suppliers of transferred technology include foreign firms, foreign research institutes, governmental agencies, universities, voluntary agencies, foundations, labour unions, professional associations, international agencies and academies of science. In actual practice, most frequently and most controversially, this role is filled by Multinational Corporations.

Multinationals are primarily concerned with present and future profits. They try to ensure their future profitability by maintaining their competitive advantage. A multinational may transfer technology in implementing a strategy of spatially differentiated markets. The more control the multinational has over the transferred technology, the better it can protect its competitive position and have freedom to move when an investment no longer appears attractive.

Though the price charged for technology by multinationals may be high, this is not an important source of revenue for them. The more important elements of such a decision are the effects the sale of technology will have upon the firm's strategic marketing position. A firm may desire to keep out competitors, gain a better understanding of local market conditions or diversify a product line in an existing market. The Product Life Cycle Hypothesis provides one reason a firm may need to consider investment abroad to maintain its competitive position. The risks of such actions lie in having the knowledge leak to a competitor or in creating a competitor from a customer of technical knowledge. This last may not be an important consideration in a situation where the knowledge is expected to become obsolete rapidly, or where it will soon become non-proprietory.

The question of whether or how to transfer technology is only an aspect of the broader investment decision. Generally speaking, if it appears attractive to transfer technology or, more broadly, to invest, a firm will prefer to have ownership and control, (and the profit). Where this is not possible, control may be maintained by means such as restrictive clauses in licensing agreements, contracts to manage the local operations, and the simple dependence of the local firm on the expert technological advice of the multinational corporation. These means may not be as effective for this purpose as majority ownership.

However, there are circumstances which may mitigate a desire for total ownership. A joint venture may be preferred to reduce the risk of expropriation, or to gain a partner with expertise in local market conditions. Legal constraints, such as a requirement for a certain amount of local participation, may make a share in a profitable venture look preferable to none. While a partnership is formed for the partners to pursue mutual benefits, there are bound to be some conflicts of interest.

Licensing too, has its own attractions in some circumstances.

1. When a firm assesses the local market as too small or unattractive for investment, licensing provides some revenue without any direct investment.
2. Alternatively, in situations when a firm wishes to familiarize itself with the local market more thoroughly before deciding whether to invest there itself, licensing provides this opportunity.
3. A firm may be constrained by a lack of resources or the high costs of obtaining information to assess a market. It may decide to settle for the revenue to be gained through licensing.
4. It may be time consuming for a firm to set up its own direct investment but it may need to act quickly to keep out competition. Licensing may be the fastest way of accomplishing this.

5. The technology a firm has available for transferring is generally a sunk cost. Licensing is a way of generating a return with very little marginal cost, particularly if the firm is experienced in the negotiation of licenses.

Balasubramanyam* suggests that the amount and quality of technology transferred with respect to what might potentially be transferred, varies with the degree of ownership and control by the multinational. He give three reasons for this:

1. A firm may only be able to function effectively in an integrated form. It may be unable to separate the knowledge to be transmitted from the rest of its operation.
2. With ownership there is an incentive to make the venture as profitable as possible. If the receipts from licensing are linked to profits or sales, the multinational will have a greater interest in supplying complete and quality technology than under a fixed fee agreement. However, their interest will still be less than for a direct investment since they don't stand to lose as much in the case of failure.
3. A firm may have a disincentive to reveal all if it regards the arrangement as the first step toward their own direct investment at a later date.

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* V.N. Balasubramanyam, International Transfer of Technology to India.

Just as in surgery or in agriculture, the success of the transplant depends crucially on the receptivity of the new environment, or conversely, on the suitability of the technology transplanted for the new environment*. It is not required, however, that the new and old environments be identical. In discussions of technology transfer, the concept of 'appropriate' has become topical. It is often used narrowly though. Considerations of the appropriateness of technology should extend to the social, economic, geographical, cultural, political, climatic and ecological environment. The technology chosen should be suitable for its host environment - both in order to succeed and for the ethical considerations of its impact upon that environment. The emphasis in this paper will be on the impact of technology transferred upon women's participation in the labour force.

When technological change occurs through technology transfer, the problem of dependence upon foreign sources arises. The greater the dependence, the greater the foreign influence upon the society and the development process, economically, politically, and culturally. This is the root of less developed countries' concern over how much technology is actually transferred to nationals and about the amount of research and development which multinational

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* B.N. Bhattasali, Transfer of Technology Among the Developing Countries.

corporations undertake within the boundaries of the host country. By building up its technical expertise, a country can reduce its dependence upon foreign sources, reduce its brain-drain, and be in a better bargaining position when it must import technology. It has been suggested that the cost to a user firm of purchasing technology is an increasing function of the recepient's relative ignorance. There is a certain threshold of skilled personnel required just to know what useable technology exists, to understand it, to repair and maintain it, to adapt it to the country's special conditions or even to operate it. 'If a country builds up its own scientific and technical capacity, it is in a better position to utilize what exists elsewhere'**. In many subsidiaries, the knowledge may be confined to foreign employees. If the firm leaves, so does the technology. If nationals have the knowledge, it becomes diffused throughout the economy, as employees change jobs.

Since private firms in developed countries provide over 50% of national expenditures on research and development, and multinationals operate in both developed and less developed countries, some less developed countries are beginning to demand that a share of these research funds be spent in less developed countries. Multinationals have been very reluctant to do so, arguing their need for 'availability of

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** Glenn E. Schweitzer, 'Technology Transfer and Development Mythology' in Technology Transfer: Successes and Failures, p. 137.

large aggregates of capital, a pool of skilled researchers, the proximity to primary manufacturing and marketing units which makes R&D responsive to practical constraints and a supportive attitude toward R&D in society at large'*. The small scale of production in many less developed countries is considered too low to amortize risky, high cost research.

A further negative facet to dependence on transferred technology is that it is often accompanied by restrictions. These include restrictions relating to exports by the local firm, to sources of supply for materials and components, and to production procedures. Such restrictions are common both in the case of licensing and in the relations between parent firm and its subsidiary.

Export restrictions vary. There can be a complete ban on exports in general, on exports to certain markets, or a requirement that the local firm first obtain permission. The conflict lies in the multinationals' fear of creating competitors and their desire to protect present and potential markets, while the governments of less developed countries resent the loss of potential foreign exchange earnings. An UNCTAD study** of nine less developed countries shows that the percentage of contracts containing restrictive clauses varied from 28 to 99% in different countries. Of those contracts with restrictive clauses,

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* Denis Goulet, The Uncertain Promise, p. 60.
** UNCTAD, Major Issues Arising from Transfer of Technology

from 38 to 100% dealt with export restrictions. However, Balasubramanyam's study* of twenty Indian firms suggests that even when there are no restrictive clauses, there are usually verbal agreements as to restrictions. That study found export restrictions to be the norm, though few firms seemed to mind them. Undoubtedly, this will vary from country to country, industry to industry, depending upon the stage of development and with the size of the user firm.

Balasubramanyam's study also found that the response to government regulation of royalties and the duration of licensing payments was an increase in export restrictions. The foreign suppliers were even less willing to risk losing other markets if their monetary compensation was smaller.

Concern over restrictions on the supply is due to the possibilities of overpricing by the foreign firm and the detrimental effect this can have on the balance of payments. When technology is purchased as a package which includes the supply of intermediate inputs and equipment, such inputs are usually priced above the going international rates. Much evidence of this is found in the literature and has been termed 'institutional monopoly'. A variation on this theme occurs between subsidiaries and parent multinationals. The transfer price of such intermediate inputs is elevated above

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to Developing Countries.
* V.N. Balasubramanyam, International Transfer of Technology to India.

the market price in an accounting manoever to reduce final profits in the host country.

The price of intermediate inputs is often really an indirect cost of importing the technology. Less developed countries' governments are concerned with obtaining technology at the minimum possible total cost, particularly since much of that cost must be paid in that very scarce resource, foreign exchange. It may also be important to maximize the local resources expended and minimize the foreign component for any given technological improvement to promote internal development and inter-industry linkages.

The most obvious costs of technology are the direct monetary costs such as licensing and royalty payments. Technology is generally costly. Multinationals justify this on the basis that research and development is costly and risky. LDCs counter that the cost has been amortized in home markets. One observer concludes that with the low marginal cost and high fixed cost, the actual price charged 'is established by what the market would bear.'* Part of this cost is hidden in the other payments which are part of the package, or in transfer pricing.

Factors bearing on the bargaining position of a local firm which affect the price paid for technology include:

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* Eric Haydon, Technology Transfer to Eastern Europe, p. 33.

1) Information on alternative sources of supply of knowledge.

2) How much the local firm is willing to pay to get the knowledge.

3) How old the technology is.

4) How much it knows about the technology it is buying.

5) Government regulations regarding the maximum amount a firm is permitted to pay for technology. This may strengthen a local firm's bargaining position or, more directly, lower the cost when the contract is submitted for official approval (assuming that the foreign firm will agree to supply for a lower price).

The local firm's concern that their own personnel be trained to understand the acquired technology so that the firm is not overly dependent on outside suppliers is one instance where their concerns actually do mirror that of the host government.

In other matters such as optimizing use of local materials, reducing outside dependence and lowering costs, the organization (either public or private) which is seeking technology, even when sympathic with such national goals may find its interests in conflict with those espoused by the government on several issues. The main difference is usually that the national point of view incorporates externalities.

There is increasing call for developing countries to exert more control and regulation over technology transfer. Goulet, for example, advocates a 'vital nexus'* in society whereby social value decisions determine the development strategies to be followed, and these determine policy on technology. He indicates that if policy makers do not seize the initiative and exercise such control, the technological choices made may not be compatible with values and development strategy, and the goals for which the technology was applied will not be achieved. In fact, technology may end up shaping society rather than vice versa.

On the other hand, Robock, Simmons and Zwick** point out that the scope for controls by less developed countries can be very small depending upon the attractiveness of their markets and the importance of their resources. The elasticity of foreign investment or technology transfer in response to controls by small, impoverished, resource-poor countries appears to be very large. The question arises as to how high is the opportunity cost of lost foreign investment or technology transfer. It is conventionally assumed that this is great and that many LDCs can not afford too much regulation. Radicals assert the contrary with reference to controversies over how much technology is actually transferred to the host country, how valuable such

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* Denis Goulet, The Uncertain Promise.
** Stefan H. Robock et al, International Business and Multinational Enterprises.

inappropriate technology is, and how much payment is extracted directly and indirectly in the form of fees, royalties, transfer payments, imported materials and the non-monetary costs of dependence. They maintain the host country would be better off to isolate itself and develop on its own. Later in this paper one small aspect of this controversy will be examined - whether foreign investment is actually associated with technological change at all.

1.3 Women's Labour Force Participation and Development Goals

Female labour force participation:

i) Affects the rate of growth of population and composition of families,

ii) Affects total and per capita productivity,

iii) Affects the distribution of income amongst families,

iv) Has repercussions on social justice and sexual equality.

In some LDCs population control may play a critical role in improving living standards of the poor in cases where the social costs of increasing population outweigh any social benefits. The 'new home economics' provides a partial analytic framework for examining the effect of female labour force participation on fertility. This framework is incomplete in that sociological factors and the weight given to preferences of different family members (power) are submerged in the household utility function. In addition it addresses only the labour supply side, not the labour demand side of the question.

Fertility rates of a community, are in general, consistent with private, though not necessarily with social, rationality. For example, in hunting and gathering societies where women are responsible for gathering the major portion of the food supply, completed family size averages about two children. More children would interfere with their mother's mobility and unduly threaten the food

supply.* This also illustrates the point that the costs and benefits of children are not independent of the technology of production.

The new home economics postulates that parents' joint utility functions are an increasing function of the number and 'quality' of children, and of other 'basic commodities'. Goods and services do not directly enter into the household utility function but are part of the household production function which combines market goods and services with time and capital goods to produce those 'basic commodities' which are consumed by the household to yield satisfactions. Children are viewed as both an investment and a consumption good and require direct monetary outlays as well as the opportunity costs of raising them, in return for the satisfactions which they provide. Time is a resource which can be allocated to market production for income, home production or to consumption, (as nearly all things which yield utility require differential amounts of time). A change in the wage rate (opportunity cost of time) thus changes relative commodity 'prices' as some commodities are more time intensive in consumption than others. Non-wage increases in income do not change these relative commodity prices. An increase in a parent's wages, other things being equal, will have both income and substitution effects upon

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* Rae Lesser Blumberg, 'Fairy Tales and Facts: Economy, Family, Fertility and the Female', p. 17.

the number and quality of children demanded. The substitution effect is to reduce the number of children (since children are assumed to be much more time intensive than most other consumpton activities.) An increase in the mother's wage will have a stronger substitution effect than an equal increase in the father's wage assuming that children are more demanding of their mother's time than their father's. However this makes assumptions about the relative weighting of each partner's preferences in the household utility function, a point which will be returned to later. An increase in children's wages, other things being equal will increase the demand for quantity of children since this decreases the net price of children.

Rising opportunities and wage rates for women may increase or decrease the demand for children depending upon whether the substitution effect or income is stronger but will result in fewer children than if the same increase in income resulted from an equal increase in the father's wages or from non-wage income.

It has been hypothesized that the outcome of the interaction between income and substitution effects will not come into effect until a certain poverty 'threshold' has been crossed. Below that threshold, increases in income and education lead to better health practices and care and have a positive effect upon potential fertility. If potential fertility is

below desired fertility, the number of children will rise until the threshold is reached, at which point the income and substitution effects will begin to determine the outcome.

One way women gain access to increased opportunities is through education. Education raises both one's market productivity and one's home productivity. It is here that the labour demand side (and hence technological choice) becomes important. If education raises a household member's market productivity more than their non-market productivity, then there will be more of a substitution effect away from children. If education does not broaden the scope of market opportunities, its effect of increased home productivity will lead to greater demand for children. The husband's education will have a stronger income effect, (leading to an increased demand for children) as he usually evades much of his share of the responsibility in time spent on child-related activities.

Education may also change both tastes for, and relative prices of, child quality versus child quantity. Education of the parents is assumed to lower the price of quality (a substitute for quantity). This may be partly due to the education of the parents 'rubbing off' on the children. Also, higher education is correlated with higher income and tastes for durable goods such as housing, car and travel

which are public goods within the family and complementary with the direct expenditures to produce 'quality' in the children. Education, by making couples more efficient in contraceptive techniques, alters the marginal cost of a child. This is defined to be the direct cost of raising a child in time, goods and services, less the cost of fertility regulation. If the cost of fertility regulation is reduced, the cost of children increases leading to a decreased demand for children.

Role theory from sociology may be brought to bear on this question. It is beleived that employment has a two-fold effect upon fertility.

1) It serves to erode the traditional definition of women's role and broadens women's concerns from those stressed in the traditional socialization process. Employment offers a feasible alternative role and gives women an opportunity to develop personal conceptions of themselves which deviate or conflict with the traditional model. The hypothesis is that labour force participation alters preferences and tastes for children.
2) Premarital employment opportunities may mean that women can afford to not marry or to delay marriage to a later age. The link between later marriages and decreased population growth is fairly well established. For example, China has encouraged late marriages as one way of reducing the birth rate. In the Philippines, in regions which exhibited a decline in fertility in 1973,

between 33 - 55% of the decline was attributed to a later age at marriage since fertility rates for the same age groups remained constant. In regions where there was an increase, 20 - 57% of the increase was attributed to earlier marriage patterns (according to Flieger 1975). However, over the long run these relationships may not be stable if people make life-time decisions of how many children to have and make up for later marriage by having more births in future years. Other things being equal though, this should only mitigate the magnitude and not the direction of the change. And like taxes, in some sense a birth deferred is a birth 'saved'.

Role theory as applied to LDCs is also not unambiguous in its predictions. Some LDC employment may not cause role conflict - there is compatability of women's worker and mother roles. In traditional and unorganized sectors, employment may not alter women's sex role orientation as the employment may provide no alternative satisfactions or identity. The existence of extended families, and for the upper and middle classes, the availability of domestic help may reduce the burden of women's child care services and therefore, the opportunity cost of employment as well.

Motivation and type of employment can also affect fertility patterns. Modern sector employment with its more rigid working hours and its greater demand on specific skills may

result in a greater substitution effect away from children. It is less easily viewed as a simple extension of wife and mother role. Jobs for women in the higher socioeconomic classes are more likely to be characterized by greater psychological rewards than those available to lower class women. Where employment is undertaken purely out of economic necessity and not at all from personal preference, the 'alternative' satisfactions and role may have a much smaller impact. However, even work undertaken for purely financial reasons may be indicative of a strong opportunity cost to the family of the women's lost wages if she were to quit.

Empirical studies are hampered by the lack of a unidirectional causal mechanism between employment and fertility. A perfectly good case can be made for self-selection. Women who are unmarried or who have fewer children may find it easier to remain in the labour force. Marriage at a later age could be due to the correlation between more education and greater probability of employment, as education itself has been found to delay the age of marriage. Similarly, if employed women are more independent, 'career-minded', and have non-traditional perceptions of self, this may not be the effect of employment but the fact that such women are drawn to choose employment. Measurement could equally be clouded by the greater probability that a wife will need to earn the more

the children there are (and the lower the per capita household income is).

Most studies do not control for such possible simultaneity between current labour force participation and accomplished fertility. Those which have addressed the question have found mutual causation exists but that the effect of work plans on fertility was stronger (Waite and Stolzenberg 1976). In one study of the Philippines, education was found to be positively correlated with fertility but at a declining rate among rural mothers with very low levels of education. With high school education, the relationship between education and fertility became negative for the rural group. In the urban sample, rising education had a depressing effect upon fertility at all levels although the relationship did not become significant until the high school level was reached.* Miro and Merten (1968) also found that only beyond primary education is a negative relationship between fertility and mother's education found.

Banskota and Evenson found that the elasticity of the number of children with respect to the mother's wage was -.27 with no difference found whether she worked in agriculture or non-agriculture. The wage of the father also had a negative coefficient but was insignificant. With respect to childrens wages, the elasticity was +.74. The

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*Elizabeth King Quizon, 'Time Allocation and Home Production in the Rural Philippines'.

effect of the mothers' education on the other hand, showed a small positive relationship with fertility with an elasticity of +.09. The mother's wage also had a much stronger positive impact on the expenditures on schooling for the children (ie the 'quality' of children) than did the father's wage.

The higher the mother's wage, the higher the opportunity cost of children. This may explain why lower-income families have more children than upper-class families. Cabanero shows that taking into account the out-of-pocket, the opportunity costs of parental time and the potential market and home production contributions of children, they can become net assets as early as age 9 in low income families in the Phillippines. In higher income families this point does not come until age 15.

One of the critical things left out of economic analysis is the weighting given to individual partners' preferences. One recent study from the Philippines shows that while working and non-working women expressed the same ideal family size, those with premarital work experience ended up with fewer children (closer to the expressed ideal). This may suggest that these women had a greater ability to stick to their preferences. It was also found that women who worked in the modern sector had fewer children than those who did not work or who worked in agriculture or the

informal sector. This may indicate either greater psychological rewards from, and greater committment to modern sector employment or to the higher prestige accorded modern sector labour resulting in higher family status for those women.

Each partner will have their own cost-benefit analysis regarding children. Where these differ, the weight attached to the woman's priorities depends upon her relative power in the household, which comes mainly from the strategic importance of her productive activities to the welfare of the family. The importance is usually connected with either the production or control of the food supply or with the cash rewards for productive labour. 'Productive' economic activity by women then plays a crucial role in determining fertility not only by raising the opportunity cost in both monetary and non-monetary ways to the family and to the woman, of additional children; but in providing women with greater status and power in the household. Greater weight in fertility decisions is thus given to precisely those women who are likely to desire smaller family size.

Other things being equal, an increase in female employment should result in greater total output and increased per capita income among all classes. This should improve the living standards of the masses. But whether it actually results in improved income distribution depends upon for

whom employment is created and whether the technology employed displaces employment opportunities for poorer classes in favour of those who are better off. If, for example, the only change was that highly skilled jobs were created for women in the modern sector, then one would expect that only middle and upper class women would have access to these and the overall income distribution would deteriorate. If broad-based rural agricultural development programs designed with women as well as men in mind were undertaken, one would expect an improvement in poorer families' living standards and an improvement in equity as well as productivity.

Ceterius paribus, rising relative inequality between the sexes combined with rising male incomes might also be thought to increase women's absolute standard of living if family incomes are rising. However, this will not be the case if female-headed households form a substantial portion of the lower income families. In fact, in some countries, up to one third of all households are headed by women.*

Regardless of the effect upon income distribution among socioeconomic classes, female labour force participation should improve the distribution of power and status, as well as consumption and human capital investment, between the sexes within the family. This difference is often noted in

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*Irene Tinker, 'Adverse Impact of Development on Women', p.32.

connection with sons receiving more education and training than daughters in many cultures. Recent studies from the Phillippines indicate however, that parental care, time, and attention are also more concentrated on sons.* Since nutritional intake is significantly below the Recommended Daily Allowances, the fact that after accounting for differential age-sex nutritional needs, girls fared much worse than boys suggests that parental allocation of food is also viewed as a differential investment in the human capital of their children.** Labour force participation has greater strategic importance than home production activities a woman may be engaged in, since such participation is either connected with the production of the food supply, or with cash rewards for labour. Consequently, a shift of women's labour in this direction may well be associated with a rise in women's social status and a rational shift in the allocation of resources toward less unequal investment in human capital in the form of food, attention, and education of girls and boys.

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*T. Cabanero, 'Shadow Price of Children in Laguna Households'

** J. Battad, 'Determinants of Nutritional Status of Preschoolers' and R. Valenzuela, 'A Study on Nutritional Distribution Within the Family and Factors Affecting Nutrient Intake'

In summary, while it is possible under some circumstances for the 'income effect to outweigh the substitution effect', women's employment tends to reduce women's preferences for more children. It also affects tastes and hence, demand for 'quality' or greater investment in the human capital of each child. It increases the opportunity cost of large families, delays age at and probability of marriage, and increases women's status within the family, resulting in greater weight accorded to preferences for small families than would otherwise be the case. Both education and technology have important impact upon women's labour force participation. But it has been found that greater education without greater economic opportunities can lead to increased rather than decreased population growth.

1.4 Effect of Technological Change and the Development Process on Women's Labour Force Participation

There is a tendency for people to assume that higher levels of industrialization and development lead to greater economic independence and participation of women and that the more 'traditional' or 'underdeveloped' a country's economy, the more 'traditional' will be the role that women play.

In the more industrialized countries, women have come to form a substantial proportion of the labour force. In Canada, in 1976, 45% of all women above the age 15 were working women, or 50.7% of women between 15 and 65. The comparable figures for Canadian men were 75.5% and 82%. For women 15-24 years of age, the participation rate was 56.9%, not that far below the male rate of 68.2% for the same age category, a reflection of changing values having greater impact upon the young.* In the U.S., by March 1976, the labour force participation rate of married men had declined to 82%, and that of married women had risen to 45%.

It is surprising to find evidence suggesting that technology transfer from more developed to less developed countries is associated with rising inequality between the sexes and

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* Statistics Canada, Canada Yearbook 1978-79.

declining participation rates for women, at least initially. On the surface, this might be construed to be the result of the 'income effect outweighing the substitution effect'. In other words, the response to the benefits of development has been to take more leisure for the womenfolk rather than intensifying their work effort in the face of greater opportunities. This turns out not to be entirely the case.

Structural Effects:

It seems a U-shaped relationship may be an appropriate hypothesis for explaining the impact of technology transfer upon women's status and participation rates. This is because technology transfer is a means of accelerating growth which is non-neutral in its impact upon different sectors of the economy.

As an illustration of the right limb of the 'U', consider the Canadian case. Occupations are largely sex-segregated and certain sex-specific occupations tend to cluster into certain industries. As a result in the past, women in Canada have made up 40% or more of the total labour force in Teaching, Medicine and Health, Clerical and Service occupations. They have made up less than 10% in Natural Science, Engineering, Construction, Transport and the Primary Industries. Between 1951 and 1971, Community and Personal Service, Public Administration and Trade sectors have grown by 163.5%, 109.1% and 78.6% respectively in

Canada. Primary sectors have either declined, or at least have done worse than the aggregate rate of growth of 62.8% over this period. Agriculture, Forestry, Fishing and Trapping have seen employment fall by 41.8%, 42.8% and 50.5%, while Mining grew by only 31.6%.* It has been suggested that this skewed pattern of growth has resulted in increased job opportunities for women causing wage rates for women to climb and attracting more women into the paid labour force. The increased demand for services and conveniences as a result of more women working, has reinforced the movement of the economy towards a larger emphasis on the tertiary sector and less relative importance for the primary sector.

Similarly in subsistence economies, as development proceeds, the relative importance of agriculture for employment in the economy must at some stage start to decline while the secondary and tertiary sectors gain in importance. The extent of participation of women in subsistence economies is often overlooked however. Women must perform two roles and hence their 'participation rates' in this sector are very high. This may not be revealed statistically since, along with exchange labour, household work, child care, and many of the activities in the informal sector, much of unpaid work in family businesses and agricultural work on family

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*Alice Nakamura, Employment and Earnings of Married Females, pp.27-29.

land that women do, is not counted as work in official statistics. So despite the fact that women, working up to sixteen hours a day in the fields '... perform 60-80% of the agricultural work in rural areas of most African countries...'* the U.S. Department of Labour statistics show that only 5% of the women in Africa work. This is probably a fairly accurate reflection of African women's modern sector labour force particiption.

Women's entry into the modern sector is more limited than men's for the following reasons:

1) Family obligations are traditionally vested primarily on women. This decreases their mobility significantly more than men. As development proceeds past subsistence level, functional specialization increases and the center of production tends to shift away from the home. This reduces the access of women to the means of production. (This may also explain why women take less responsibility for agriculture in societies which had cultures with high functional specialization. Prior to the 1700's and Western interference, Asian civilizations had developed functional specialization and much of their economies were no longer subsistence-based.)

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*Irene Tinker, The Adverse Impact of Development on Women in Women and World Development, p.23.

2) Occupational choice for women is much more narrowly limited by custom.
3) Women are generally provided with less investment in their human capital.
4) Even those women who overcome the above barriers may well face sexual discrimination in the labour market.

As the size of the agricultural sector shrinks in proportion to the rest of the economy, so too will women's overall participation even if the proportion of women is rising in all sectors of the economy including agriculture. In subsistence agriculture, as for example in parts of Africa, men may be attracted away from the farm into the higher wage sector while women take on even greater responsibility for the family plot. This illustrates the left limb of the 'U'.

Effects on Individual Sectors:

Moving from an agriculturally-based subsistence economy to a more diversified one is almost certain to reduce participation of women due to decreased access to productive processes. How severe this will be depends upon the second effect of technological change - its effect on the proportion of women in individual sectors, both agricultural and non-agricultural. Two examples may illustrate this:

A. Period 1: Women compose 50% of the agricultural workforce and 10% of the industrial workforce. Agriculture accounts for 70% of the total employment. Economy-wide female participation rate is:

$$(.5)(.7) + (.1)(.3) = .38$$

Period 2: THe only change is that industry accounts for 50% of total employment. Overall female employment rate is:

$$(.5)(.5) + (.1)(.5) = .30$$

B. Period 1: The same scenario as Period 1 above is in effect.

Period 2: Female employment increases 10% in agriculture and 30% in industry. Overall female participation rate is:

$$(.55)(.5) + (.13)(.5) = .34$$

The adverse effects of the decline in agriculture on women's labour force participation, can be softened by appropriate goals, programs, technology, and policies directing whom to design for, and to whom to convey knowledge and opportunites. This can significantly mitigate the magnitude but is unlikely to alter the overall direction of the reduction of labour force participation for women in the relevant range of development.

Technology at the level of the individual industry <u>can</u> be deployed in such a way as to increase the proportion of women in productive labour in both agriculture and in the modern and growing secondary and tertiary sectors of the economy. It is the action taken on this level, which will determine whether the 'mitigating forces' mentioned above, will be invoked.

There are many documented cases where the effect of structural changes on participation have been worsened by an inbuilt assumption by those transferring technology, as well as home government planners, of the sex of farmers and workers in subsistence economies. As Mme. Jeanne Zongo puts it, 'Rural women do most of the agricultural work... but the modernization programmes are all addressed to men'. In one instance, wages were paid to ensure attendence at a demonstration planting and all the unemployed men attended while the women continued their work in the fields.* In another, in a West African country, 'although extension workers had shown men the correct depth to dig the holes, coffee continued to die because women were doing the planting'.**

Men receive credit, technological explanations, training in use, repair and maintenance, yet it is not realized that it may be women who need this. In some cases in Africa, men will let pump and piping systems fall into disrepair since it is the women who are responsible for getting the water and men who have instruction and responsibility for maintaining the piping system. This bias extends to even methane gas and solar energy for cooking, techniques taught usually to men rather than women. Not only is technology not transferred to women in appropriate instances, (perhaps

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*Ibid, p.26.
** Marilyn Carr, Appropriate Technology for African Women, p. 27.

because of it), it is not designed to be appropriate for them either. In another African instance grinding machines were not designed with traditional concepts of propriety for African women in mind. As a result, the women could not use them for this traditional task though it would have reduced their workload considerably.

In other cases, though the adverse effect on productivity was smaller, the direction and design of the technology have none the less had an adverse impact upon female participation. Scythes have been introduced in some areas of wet rice cultivation since it is more efficient than the small pen knives which women traditionally use to cut each individual stalk. However, women have resisted the use of scythes since they have to carry the greater weight of excess stalk that is left over and when they thrash the crop with their feet they receive nasty cuts from the tough lower stalks. Since men do not do these tasks, with the more efficient tools they have displaced women's harvest employment, though women continue to do the threshing.

With little direct access to credit, improved seeds, other technological knowledge, memberships in co-ops, etc. women are slowly cut off from the more productive sectors of the economy and shunted more and more to the lowest productivity work, personal service and menial tasks within the home. Development is not enhanced by moving women from economic

assets (often symbolically represented by a bride price) to economic liabilities (represented by a dowry). In conjunction with this, women's status in society and in the home diminishes.

This is not to imply that development is an evil and technological change is to be avoided. On the contrary, new technology is urgently needed. In one West African country, the fact that the average life expectancy of women (35 years versus 52 for men) is falling is attributed to the increased strain of cultivating ever larger acreage as the soil becomes depleted. What is needed, to use an ubiquitous catch phrase, is 'appropriate technology', unbiased by stereotyped notions of the role of women which do not correspond with the reality of situations in which they are applied. The impact of biased technology upon the values of subsistence societies is often self-fulfilling. Women are assumed to be only wives and mothers and the technology ensures that their status and productivity are reduced to such.

CHAPTER TWO : THE THEORETICAL MODEL

2.1 Hypotheses

1. The hypothesis regarding the connection between women's labour force participation and technological change must be stated in two parts.

a) It is hypothesized that technological change should have a positive effect on women's labour force participation in modern sector industries - specifically in the manufacturing industries in India in the latter half of the 1960s.

b) Regardless of the effect of technological change in individual industries, technological change is associated with a declining economy-wide rate of female participation due to a structural change and consequent reduced access of women to the means of production. Thus, even when female participation is rising in all sectors including traditional sectors, the decline in the traditional sectors' relative size may have this effect.

2. Technological change is positively related to foreign ownership and investment.

With the present data set, it is possible to test a model with regard to 1a) and 2 for Indian manufacturing industries between 1964 and 1969. For 1b), aggregate national time series data are required and the present data set has only cross sectional data.

2.2 The Model

The theoretical model consists of five simultaneous equations.

EQUATION 1:

Women's Participation in Industry i = f(
1. Technical Level
2. Wages
3. Foreign Ownership
4. Required Skills
5. Industry-specific social acceptability of those jobs for women.
6. General cultural acceptability of women working
7. Physical strength required.)

1. The effect of technological change on women's labour force participation in individual industries has been discussed in the preceding section. It is not clear whether the sign of this variable will be positive or negative. Only if the component of jobs designated by custom to be female was expanding as a result of technological change, could it be inferred that the proportion of employment accounted for by women should rise. Even if technological change itself was completely neutral, as long as there is greater social value placed on allocating incremental jobs to men than to women, one might observe a small negative coefficient provided there was a large pool of unemployed to draw from. It must be recognized that the total effect of technological change on women's labour force participation is not restricted to only the direct effects. Technological change will affect wages in the industry, the type of jobs

and their required skills, as well as the social acceptability of working in that industry. The resulting changes in these variables will feed back and make an additional impact upon the proportion of women in that industry.

2. One would expect rising wages to attract more women into an industry. Rising wages however, should also attract men into the industry and so, unless the industry is composed of sex-specific jobs (which may in fact be a good approximation of reality), participation ratios should not change. Even in a labour surplus economy, typical of many LDCs, rising wages need not draw on the unemployed labour pool directly. This may be important as in most countries the unemployment rate is higher for women than for men. This may be even greater than it appears statistically as women are more likely than men to slide into the hidden unemployment category, 'discouraged worker', counted as 'not in the labour force', since they are more likely to assume household duties and responsibilities while unemployed. It may just be a signal for a change in the allocation of skilled labour <u>between</u> industries. If one assumes higher skill levels (greater human capital investment) on average in men as well as greater mobility for men, one might expect a greater proportion of men in the industry as a result of the higher relative wages. The lower-skill-level jobs vacated by mobile employees from other industries (or

branches of the same industry) might be filled by unemployed women (and men). Even in the absence of discrimination (greater social value placed on providing employment to men), men's greater mobility might give them an edge in filling the lower skill jobs. Only in the case where male labour is in scarce supply, would one expect to see female participation rising in an industry, in response to rising wages. An exception, of course, is where sex-specific female jobs are expanding faster relative to the other tasks in the industry.

3. The impact of foreign ownership upon women's labour force participation will depend on the relative levels of female participation in the industry in the 'host' country versus the 'home' country. If the proportion of women in the industry is currently higher in the host countries one would expect a positive impact on the labour demand side upon female participation as a result of foreign investment.

4. One would expect a negative relation between skill requirements and participation of women in the industry in cultures where there is greater investment in male human capital, except in occupations where men are precluded by custom, such as in nursing.

5. The more socially acceptable such industry specific employment is for women, (for example, nursing and teaching), the higher the female participation in that

industry is likely to be unless it is already exclusively female.

6. The more culturally acceptable employment in general is for women at a particular time and place, the higher the general level of participation of women across all industries is likely to be.

EQUATION 2:

Technological Change = f(1. Externally Induced Technology Transfer
   a) Foreign Investment
   b) Foreign Ownership
   c) Other Foreign sources
2. Internally Induced Technology Transfer
   a) Private Domestic Innovation
   b) Gov't Induced Technological Change
3. Endogeneously Produced Technical Change
   a) Scale of Production
   b) Relative Factor Costs)

1a). Provided that the foreign investment originates from those with a greater technical knowledge of production in the relevant industry, a positive relationship between technical change and foreign investment is expected. This is a reasonable assumption as firms which invest abroad must expect to compete successfully despite the inherent difficulties of operating in an alien environment and under unfamiliar institutions, with attendent risks and diminished legal protection. These must be believed to be offset by some advantages of a financial, marketing, production, or managerial nature over indigenous firms. Of these aspects, at least production and managerial skills may be considered to embody or involve 'technology' or technical ability.

b) If the rate of innovation at the source of foreign investment is at least as great as the domestic level of innovation in the 'host' country industry, or if the foreign investors introduce their 'state of the art' technology gradually to the host country operations, it might be expected that foreign ownership will continue to have a positive impact on technological change.

c) Scientific exchange, bilateral and multilateral aid efforts, international mobility of labour, especially skilled personnel, are a few of the other potential means of technology transfer.

2a). Other things being equal, the higher the level of domestic innovation, the higher the level of technological change.

2b). Government projects and government-sponsered research may produce technological change.

3a). Changes in the choice of technique may occur simply due to a change in the scale of production. To the extent that techniques which are optimal for lower levels of production may be replaced by methods which prevail at higher levels of output, this will appear as 'technological change'. Baranson* and Morley & Smith** both discuss the importance of the role of scale of production in choice of technique by

MNCs in less developed countries.

3b). While one of the foundations of orthodox economic theory rests on the assumption that production isoquants and factor prices are independent, it is increasingly recognized in the development literature that over the long run, development of techniques is influenced by the prevailing relative factor prices. 'In a profit-maximizing perfectly competitive economy one can be more precise about the necessary conditions for successful innovation -viz., given the ruling prices of resources and products, the new technique will generate more than normal profit. In the more real world of market imperfections, and varied motivation among innovators, it is still true that a new innovation in a capitalist economy must fit sufficiently well with resource costs and markets to produce long-run profits. Whether or not a technique is introduced and developed is thus firmly anchored in the historic and economic conditions of the date at which it is introduced.'*** A change in relative factor prices (provided this is in the same direction as the long term trend) may be expected to spur technological change. If the relative factor prices change, existing techniques close to the

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* J. Baranson, 'Transfer of Technical Knowledge by International Corporations to Developing Countries'. AER May 1966. pp. 259-267.
** S.A. Morley & G.W. Smith. 'The Choice of Technology: Multinational Firms in Brazil', Economic Development and Cultural Change, Jan. 1977. pp. 239-264.
*** F. Stewart, Technology and Underdevelopment, pp. 3-4.

margin would no longer generate normal profit. This would create forces of disequilibrium causing some of these techniques (and possibly products) to disappear, others to change form and still others to emerge. Other things being equal, the problem-solving research and activity devoted to invention and innovation is likely to be higher at that time than in periods of 'equilibrium', and so too may be the resulting technological change.

EQUATION 3:

Wages = f(1. Proportion of Women Employed
2. Technical Level
3. Productivity
4. Foreign Ownership
5. Scarcity of Required Skills)

1. Other things being equal, in the presence of either discrimination or lower mobility of women than men, it is expected that industries with a high concentration of women would have lower wages than those with a relatively greater concentration of men.

2. Technical Level is defined to be the output per employee (productivity) not accounted for by the contribution of capital. The higher this level, the higher wages are expected to be, ceterius paribus.

3.This variable is output per employee unadjusted by the capital labour ratio. Productivity (and hence wages) may be high, other things being equal, simply due to large amounts

of capital per employee. In this case, the wage bill is likely to be a smaller component of total costs. Assuming firms have some power in the labour market, if the operating point is at a level of output past the intersection of the average and marginal product curves, the higher this point of operation on the marginal product curve, the higher the average product and the wage.

4. A positive relationship between wages and foreign ownership is expected for three reasons:

a) Habit persistence. If wages are higher in the 'home' country, less managerial attention may be devoted to keeping 'host' country wages to the minimum necessary levels.

b) Buying 'Goodwill' and 'Labour Peace'. Operating in an alien environment, the firm may use the risk averting strategy of attempting to create indigenous groups with a vested interest in keeping the firm there. In order to reduce the chances of attracting undesirable political attention and to reduce reliance on management skill in an unfamiliar labour environment, the firm may be willing to pay premium wages.

c) As discussed above, if the foreign firm does possess a significant advantage, it may have a greater 'ability to pay'.

5. The scarcer necessary skills are, the higher wages are expected to be.

EQUATION 4:

Productivity = f(1.Level of Employment
2.Technical Level
3.Capital Labour Ratio)

1.Provided the firm is producing beyond the intersection of Average Product and Marginal Product Curves, the higher the level of employment, the lower the Average Product (Productivity) will be, due to 'Diminishing Returns', other things being constant.

2. The higher the 'technical level', the higher the productivity is likely to be, other things being equal.

3. An increase in capital per employee is expected to raise labour productivity.

EQUATION 5:

Capital Labour Ratio = f(1. Scale of Output
2. Foreign Ownership
3. Relative Factor Prices)

1. It has been argued by MNCs that large scale operations are necessarily more capital intensive than smaller ones.*

2. Foreign firms are likely to be better acquainted with more capital intensive than labour intensive techniques if they come from an environment of higher relative labour

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*Op. cit., pp.239-264.

costs. In addition, it may reduce risk both in labour and political arenas to be less dependent on labour.

3. The higher wage rates relative to interest rates, the higher the capital labour ratio is likely to be.

CHAPTER THREE: THE DATA

3.1 Description

The data set consists of thirteen observations, twelve of which represent different Indian manufacturing industries and the thirteenth, the Indian Electric and Gas Industry. Each observation is comprised of nine variables, eight of which were obtained by calculating the level in 1964, the level in 1969, and taking the percentage change over the 5 year period using 1964 as the base. The exception is 'Level of Foreign Ownership'. These nine variables are:

'Change in Participation' (Part),
'Technological Change' (TCH),
'Change in Real Wages' (W),
'Change in Productivity' (OE),
'Change in the Level of Real Output' (O),
'Change in the Level of Employment' (E),
'Change in the Capital Labour Ratio' (KE),
'Level of Foreign Ownership' (FRON),
'Foreign Investment' (FI).

3.2 Measurement and Source of Variables

1. PART (Change in Women's Participation) Data for this variable were collected from the table 'Total Average Daily Employment and Women Employment (By Major Industries)' from various issues of the Indian Labour Statistics produced by the Indian Labour Bureau.

2. TCH (Technological Change) Technological Change was calculated using the Solow Measure. This produces an estimate of technological change as a residual. That portion of increased productivity, over a given time period, which can not be attributed to an increased Capital Labour Ratio, is taken to be the measure of technological change.

$$TCH = (O / E) - rk (K / E)$$

O = The percentage change in real output between 1969 and 1964 using the 'Implicit Price Deflator Index of Gross Domestic Product' for Indian Manufacturing Industries from the United Nations Yearbook of National Accounts Statistics. The source for the Nominal Output was 'Value Added by Manufacture' from the table 'Annual Survey of Industries - by Industries' in various issues of the Statistical Abstract India.

E = The percentage change in the 'Number of Persons Employed' from the same table in the Statistical Abstract India.

K = The percentage change in real 'Productive Capital'. Productive Capital was obtained from the above source as well. In order to convert Productive Capital to comparable real dollar terms, the following procedure was used. Industry specific weights were applied to determine what portion of Productive Capital was Fixed Capital and what portion was Working Capital. Fixed Capital was then depreciated. The amount of depreciation, plus the difference in 'Fixed Capital' for two adjacent years (the net nominal amount added), plus the amount of Working Capital was deflated. The deflator used was the 'Implicit Price Deflator Index of Gross Capital Formation' for Manufacturing Industries for India. This index was obtained from the United Nations Yearbook of National Accounts Statistics. Real Productive Capital was calculated as this deflated quantity plus depreciated fixed capital.

rk = (1 - rw), Capital's share in Factor Costs.

rw = average of (W&S/CPI) / VA for the years 1963, 1964, 1968, and 1969 where:

W&S = 'Per Capita Annual Money Earnings of Workers in Manufacturing Industries' in Indian Labour Statistics.

VA = Real Value Added as calculated for producing variable O above.

CPI = 'Consumer Price Index Numbers for Working Class for All India - General Index', in Indian Labour Statistics.

An attempt was made to adjust this measure of technological change for changes in capacity utilization, but adequate data for the appropriate years could not be found.

The assumptions underlying the Solow measure are:

i) Constant Returns to Scale. If, in fact, an industry's production function exhibits increasing or decreasing returns to scale, this will bias the measure of technological change upwards or downwards respectively.

ii) Technological change is neutral in that it increases the productivity of labour and that of capital proportionately.

iii) Relative shares between capital and labour remain constant. This would be a weak assumption if technological change changes the production function itself. For Canada, the aggregate relative factor shares over the past half century have remained almost constant. (The Solow measure was originally developed as an aggregate index for developed countries.) However, when one begins to disaggregate by industry, especially in the context of a developing country, the picture can be quite different. For both Malaysia and India, rather large changes in relative factor shares were observed in individual industries. However, the author's calculations showed that the sensitivity of the overall measure of technological change to apparently large changes in the relative factor shares for the Indian

industries was very small. Presumably the same would have been true for the Malaysian data set but the analysis on this data set was not pursued due to a lack of reliable observations.

3. W (Change in Real Wages). Wages and Salaries were obtained from the table 'Per Capita Annual Money Earnings of Workers in Manufacturing Industries' in various issues of Indian Labour Statistics. These were deflated by the 'Consumer Price Index Number for Working Class for All India - General Index' obtained from Indian Labour Statistics.

4. OE (Change in Productivity). This variable was derived as the O / E term in TCH.

5. O (Change in the Level of Real Output). The O term from TCH is identical to O.

6. E (Change in the Level of Employment). This was derived as the E term from TCH.

7. KE (Change in the Capital Labour Ratio). (K / E) from TCH is identical to KE.

8. FRON (Level of Foreign Ownership) This is calculated by taking 'Direct Investment Capital Component of Outstanding Long Term Foreign Investments in Corporate and Commercial Enterprises' by industry at the beginning of 1964 and expressing this as a percentage of Productive Capital for

the industry. Whether this gives the actual level of Foreign Ownership by industry accurately (for 1964) does not matter, providing it approximates fairly closely a monotonic transformation of this variable in the relevant range.

9. FI (Foreign Investment). The last variable, 'Foreign Investment', (FI) was calculated by determining the 'Level of Foreign Ownership' at the beginning of 1969 by the same procedure as described above and taking the percentage change between 1969 and 1964.

By taking 'percentage changes' instead of 'levels', and by taking a cross section, many of the industry - specific characteristics and determinants of the dependent variables have been held constant.

The 'General Cultural Acceptability of Women Working' is held constant by virtue of reference to a single time period. Industry-specific social acceptability of female employment may be assumed constant if social attitudes towards various industries as places of employment for women changed proportionately to the attitude held in 1964, for all industries, over the period 1964 to 1969.

Domestic innovation has been assumed to have occurred at a constant proportion of each industry's 'Technical Level' in 1964. No Indian manufacturing industry in the latter half of the sixties could be classified as technologically sophisticated in comparison with those in the developed

countries, so it seems safe to assume that the bulk of commercial innovation was at least influenced by ideas from abroad rather than purely domestically generated. Therefore, at best, domestic innovation may be assumed to play a fairly minor role in the technological improvements of this period. 'Scarcity of Required Skills' is assumed to have remained constant during the same period for each industry, or to have changed by the same proportion in all industries. The major shift in the Indian economy involving greater military expenditures at the expense of industry occurred in the early 1960s after the war with China. During the period 1964 to 1969 there was a large oversupply of technical and highly skilled personnel. There is, of course, a perpetual oversupply of unskilled and semi-skilled labour.

Since it was not possible to measure the changes in the 'Required Skill' levels for each industry, and changes in 'Physical Strength' required, the proxy 'Changes in the Capital Labour Ratio' has been chosen to represent the net effect of these two variables in the participation equation.

Since the variables have been expressed as percentage changes in most cases, rather than as levels, all the equations of the simultaneous model except for Equation 2, the Technological Change equation, are affected. This involves replacing the level with the percentage change for

the appropriate variables, reading Foreign Investment for Foreign Ownership in Equations 1, 3, and 5, and substituting Technological Change for Technical Level in the appropriate equations.

Lastly, as an industry-specific interest rate was not available, it will be assumed the change in the cost of capital was the same for all industries during the period. The change in the wage will be used to approximate the change in the relative factor costs for each industry in the Technological Change and Capital Labour Ratio Equations.

CHAPTER FOUR : THE FINAL MODEL

4.1 The Empirical Model

The Simultaneous Equation Model may now be presented symbolically in the following form:

	PART	TCH	W	FI	KE	FRON	O	OE	E
1	1	-C12	-C13	-C14	-C15	0	0	0	0
2	0	1	-C23	-C24	0	-C26	-C27	0	0
3	-C31	-C32	1	-C34	0	0	0	-C38	0
4	0	-C42	0	0	-C45	0	0	1	-C49
5	0	0	-C53	-C54	1	0	-C57	0	0

4.2 Identification

Since it is equations one and two which are of interest, the identification conditions must be checked for both.

Equation One: Order Condition

The number of omitted variables is 4, which is equal to the number of equations less 1. Therefore, the order condition holds.

Rank Condition

It must be possible to find a non-zero 4 X 4 determinant, formed from the omitted variables and the other equations.

$$\begin{vmatrix} -C25 & -C27 & 0 & 0 \\ 0 & 0 & -C38 & 0 \\ 0 & 0 & 1 & -C49 \\ 0 & -C57 & 0 & 0 \end{vmatrix} = -C25 \begin{vmatrix} 0 & -C38 & 0 \\ 0 & 1 & -C49 \\ -C57 & 0 & 0 \end{vmatrix}$$

$$= C25\ C38\ C49\ C57 \neq 0$$

provided none of the four coefficients are zero. Therefore the Participation equation is just-identified and can be estimated equivalently by Two Stage Least Squares or from the Reduced Form.

Equation Two: Order Condition

As there are again four omitted variables, the order condition holds.

Rank Condition

$$\begin{vmatrix} 1 & -C15 & 0 & 0 \\ -C31 & 0 & -C38 & 0 \\ 0 & -C45 & 1 & -C49 \\ 0 & 1 & 0 & 0 \end{vmatrix} = C49 \begin{vmatrix} 1 & -C15 & 0 \\ -C31 & 0 & -C38 \\ 0 & 1 & 0 \end{vmatrix}$$

$$= C49\ C38 \neq 0$$

provided neither C38 nor C49 is equal to zero. Therefore this equation is also exactly identified.

CHAPTER FIVE : RESULTS

5.1 Summary Regression Results

OLS R^2=.58 $\bar{R}^2$=.39 F =2.8 (significant at the 10% level)

(1) PART = 13.5 + .78 TCH + .75 W + 2.1 FI + 1.46 KE

The coefficients of TCH and KE are significant at the 5% level.

The coefficient of FI is significant at the 10% level.

2SLS R^2=.92 $\bar{R}^2$=.88 F =23.9 (significant at the 1% level)

(2) TCH = -6.44 + .66 O + 3.25 FI - 3.53$\hat{W}$ + 1.26 FRON

The coefficients of O and $\hat{W}$ are significant at the 1% level.

The coefficients of FI and FRON are significant at the 5% level. There is a possible multicollinearity problem between FI and FRON.

5.2 Detailed Results of the Regressions

Equation 1: The Participation Equation

The data was applied using both the simultaneous equation model and OLS. The Wu test for exogeneity was performed to determine whether the variables which were assumed to be endogenous in this equation could actually be treated as exogenous. It turned out that such was the case (see Appendix).

OLS R^2=.58 R^2=.39 F = 2.8 (significant at the 10% level).

(1) PART = 13.5 + .78 TCH + .75 W + 2.1 FI + 1.46 KE

The coefficients for TCH and KE were significant at the 5% level and, for FI, at the 10% level. There is some evidence of correlation between the independent variables but the highest are -.73 between TCH and FI, and -.70 between KE and FI. This should not cause severe multicollinearity. Though OLS was found to be the appropriate model for this equation, the Two Stage Least Square results are also presented for the purposes of comparison.

2SLS R^2=.41 R^2=.15 F =1.4 (not significant)

PART = 82.21 + .02 $\hat{TCH}$ + 4.95 $\hat{W}$ + 1.70 FI + 3.92 $\hat{KE}$

Only the constant and KE are significant at the 10% level of significance.

Equation 2: The Technological Change Equation

For the Technological Change Equation, the overall F for both Two Stage Least Squares and OLS indicated insignificance, and the corrected R^2s were very low.

OLS R^2 =.42 R^2 =.15 F = 1.45

TCH = 25.9 + .6 O - 3.2 FI - 1.2 W - 1.7 FRON

Neither the F nor any coefficients (except the constant) are significant.

2SLS R^2 =.32 R^2 =.03 F =.93

TCH = 25.6 + .6 O - 3.2 FI - 1.1 $\hat{W}$ - 1.7 FRON

Neither the F nor any coefficients are significant.

Since the underlying data appeared to have a fair amount of 'noise', TCH and KE were recalculated using a three year moving average. In other words, the percentage change taken for each, was that of the average for 1968, 1969, and 1970, as a percentage of the average for 1963, 1964, and 1965. This was not possible to do for FRON and FI, so they were not altered. W was recalculated using the percentage change between the average for 1968 and 1969, and the average for 1963 and 1964. The improvement was dramatic.

The Wu Test for Exogeneity indicated that the equation could not be properly represented by the OLS model. The Two Stage Least Square results are therefore presented.

2SLS R^2 =.92 R^2 =.88 F =23.9 (significant at the 1% level).

(2) TCH = -6.44 + .66 O + 3.25 FI -3.53 $\hat{W}$ + 1.26 FRON

All coefficients except the constant are significant. O and $\hat{W}$ are significant at the 1% level and FI and FRON are significant at the 5% level. In this equation, the two independent variables FI and FRON, show a very high simple correlation of -.96 which likely indicates the presence of multicollinearity. If multicollinearity is a problem, the coefficients of these two variables may reflect each other's influence and not be individually accurate. However, the R^2 and the F are not affected.

For the purposes of comparison, the OLS results are also presented.

OLS R^2=.85 R^2=.78 F =11.2 (significant at the 1% level).

TCH = 6.22 + .35 O - .26 FI - .36 W + .1 FRON

Only Scale of Output is significant (at the 1% level).

CHAPTER SIX : DISCUSSION OF RESULTS

6.1 Data

Attempting to gather data for this study was beset with problems. To begin with, most LDCs do not have highly developed statistical information systems. Secondly, statistics regarding women have, even now, fairly low priority. For example, no government collects statistics concerning much of the productive activities engaged in by the vast majority of women in the world (employed or unemployed) - food preparation, child care, craft work, unpaid labour in subsistence sectors and much of the unpaid labour in family businesses. As Elise Boulding points out, conceptions of the facts which are essential to enumerate have changed gradually from counting soldiers to counting production.* So gathering statistics from secondary sources for studies of this nature is difficult. Primary sources such as the Malaysian RAND data may be comprehensive and rich in detail but their usefulness is limited unless the classifications are designed to be compatible with those from secondary sources. It is obvious that most LDCs are attempting to improve their statistical bases, but timeliness and standardization remain problems. At the time of data collection, in 1980, for example, the only year for which factor shares by industry for Malaysia was available,

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* Elise Boulding, Handbook of International Data on Women, pp.5-6.

was 1971. In this area of study, it would be valuable to have data on the male/female breakdown of workers in all industries, at least for the one digit level, if not the two digit level of the SIC (Standard Industrial Classification), annually, for all countries. Many areas of research would benefit from standardized, annual and up to date figures for real capital stock and factor shares by industry. It would also be helpful to have cost of capital annually, by industry. These are rather moderate requests for data improvements, with the possible exception of real capital stock by industry which involves conceptual difficulties. A seemingly more radical request (with regard to the number of more statistically advanced LDCs which are currently publishing such data) is for more comprehensive statistics on foreign ownership, annually and by industry. These could be presented, for example, as a percentage of total assets owned by foreigners and by the percentage of gross industry sales accounted for by foreign controlled firms. It would also be helpful to have this further classified by direct foreign investment and portfolio investment, and by country of origin. It is hoped that international attempts to standardize the types of data available, their quality and classifications be continued and intensified. This is important not only for comparability between countries but also to give added encouragement to various statistical agencies and branches within a single country to utilize the

same standards and classification schemes for their various studies and publications.

6.2 Technological Change

The Solow measure registered a surprisingly high level of technological change in the Indian manufacturing industries in the last half of the 1960s. See Table 1 below.

Table 1
DATA (Percentage Change) *

	PART	TCH	W	FRON	OE	FI	O	E	KE
FOODS & BEV	-1.8	35.9	3.0	1.1	29.0	0.5	33.4	3.4	-14.3
TOBACCO	9.4	65.8	0.6	73.8	69.7	-31.7	101.8	18.9	6.2
TEXTILES	-10.0	15.3	-4.7	2.6	7.6	-0.4	-3.2	-10.0	-29.3
TRANSPORT EQUIPMENT	51.2	77.0	-0.7	4.8	70.2	0.0	16.3	21.2	-27.9
MACHINERY	14.6	18.6	7.8	8.5	11.1	-2.0	40.2	26.2	-27.5
BASIC METAL	-39.5	-5.3	6.2	1.9	-18.0	0.3	-9.1	10.9	-34.7
METAL PROD	26.3	12.6	7.4	7.8	10.9	1.7	29.9	9.0	-7.4
ELECTRICAL MACHINERY	39.6	17.6	22.0	11.7	11.0	-0.8	48.8	34.0	-17.4
CHEMICALS	-0.7	35.1	12.1	11.3	21.4	-2.8	74.4	43.6	-22.0
BUILDING MATERIALS	-3.6	27.5	0.5	3.9	20.7	0.6	25.9	4.3	-27.4
RUBBER	-12.0	22.4	-7.9	31.7	19.8	-7.6	56.9	31.0	-5.2
MISC.	8.1	49.8	5.7	6.1	40.5	1.0	55.5	10.7	-28.8
ELECTRICITY	-31.3	30.2	21.1	2.8	4.2	-1.4	51.6	45.5	-40.2

Table 1 continued

SMOOTHED DATA (Percentage Change) *

	PART	TCH	W	FRON	OE	FI	O	E	KE
FOODS & BEV	2.1	15.5	-3.8	1.4	7.2	0.5	10.4	3.0	-17.1
TOBACCO	8.7	50.2	-8.2	57.9	52.7	-31.7	71.0	12.0	9.8
TEXTILES	-11.7	14.1	-7.6	2.4	8.0	-0.4	1.1	-6.4	-23.1
TRANSPORT EQUIPMENT	43.2	15.7	-6.9	4.8	11.3	0.0	32.1	18.7	-18.3
MACHINERY	19.0	16.7	1.4	7.5	12.1	-2.0	33.6	19.2	-16.8
BASIC METALS	-36.7	-0.2	1.3	2.1	-10.7	0.3	-1.6	10.2	-28.6
METAL PROD	36.6	8.0	19.0	8.7	5.6	1.7	11.5	5.6	-10.4
ELECTRICAL MACHINERY	44.5	17.6	9.1	11.3	9.5	-0.8	47.5	34.7	-21.2
CHEMICALS	1.7	23.9	8.4	10.0	15.0	-2.8	62.8	41.6	-14.4
BUILDING MATERIALS	-4.6	7.4	-3.9	4.2	4.1	0.6	11.0	6.6	-13.4
RUBBER	-3.0	23.0	-10.7	28.0	10.5	-7.6	34.4	21.5	-24.4
MISC.	7.3	34.8	- 3.3	6.6	28.1	1.0	42.7	11.4	-20.8
ELECTRICITY	-39.2	31.4	2.5	2.1	7.7	-1.4	74.5	62.0	-36.6

* All coloumns except FRON

FRON & FI are not smoothed

Output per employee was rising while capital stock per employee was falling and manufacturing appeared to be making huge strides. Meanwhile, the index of real per capita Net National Product moved only from 103.9 in 1964, to 107.7* in 1969. If in fact technological progress in this sector was as great as it appears, the explanation for the meagre increase in per capita Net National Product must lie in stagnation of other sectors or increasing levels of unemployment.

Technical Change - Statistical Results

There is some support shown for the hypothesis that foreign ownership and investment were positively linked to technological change in India during the period 1964 to 1969. In other words, private technology transfer seems to have contributed significantly to technological change. There may be some specification bias present as a measure of governmental, scientific, and other technology transfer was not included. It is certain however, that technology transfer in total was an important explanatory variable for Technological Change.

The high negative simple correlation (-.96) between foreign investment and foreign ownership was probably the result of the investment climate and deliberate government policies to reduce the level of foreign ownership in those manufacturing

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* Indian Labour Bureau, Indian Labour Statistics.

industries which were most heavily foreign-owned. Since the assumption was made that the interest rate changed by the same percentage across all industries while the wage rate varied individually, (incremental capital being more mobile than labour) the negative coefficient for W could be interpreted to mean that when the relative price of capital rises, technological change is stimulated.

There is support for the hypothesis raised in Morley and Smith's article that increasing size in itself, leads to a change to a more efficient technique.

6.3 Women's Participation

India seems to be a good example of the expected trends outlined regarding technological change in society and the overall impact on women's participation. As noted in Table 2 below, the ratio of female workers* in the female population of working age has fallen (though not always consistently), between 1901 and 1961. In 1901, of the total female workers, 70.4 % were in the primary sector. Of total male workers, 74.5% were in the primary sector. By 1961, the primary sector's share of female workers had risen to 81.6% and its share of male workers had fallen to 68%. (See Table 5). While women's responsibility for agriculture increased, their total participation in the economy fell slightly.

The greater responsibility in agriculture must have been mostly for family plots, as it appears that women's agricultural employment opportunities have fallen over the 60 year period (see Table 3). The number of female cultivators to male cultivators has risen over the period (again not consistently) while the number of female to male agricultural workers has fallen.

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* This includes both agricultural and industrial.

Table 2

Percentage of (a) workers to total population and of (b) workers to population of working age 16-60.

(1901 to 1961).

Year.	Sex.	Workers to total population.	Workers to population of working age 15-60.
1901	Persons	46.61	78.95
	Males	61.11	103.68
	Females	31.70	53.60
1911	Persons	48.07	79.81
	Males	61.90	02.56
	Females	33.73	56.13
1921	Persons	46.92	78.65
	Males	60.52	101.13
	Females	32.67	54.96
1931	Persons	43.30	71.95
	Males	58.27	96.17
	Females	27.63	46.23
1951	Persons	39.10	68.49
	Males	54.05	93.90
	Females	23.30	41.19
1961	Persons	42.98	78.99
	Males	57.12	104.28
	Females	27.96	51.74

SOURCE: P.N.S. Panicker, A Handbook on Small Industries, P.152.

Table 3

Females per 1,000 of males in (1) Total population, (2) Working in each category

	1901	1911	1921	1931	1951	1961
Females per 1,000 males ...	972	964	955	955	947	941
Total workers ...	504	525	516	453	408	460
Number of female workers per 1,000 male workers as cultivators.	431	427	463	289	357	498
Number of female workers per 1,000 male workers as agricultural workers.	1,051	1,054	952	1,006	857	819
Number of female workers per 1,000 male workers as workers in plantations, forests, mining, quarrying.	335	337	372	337	491	297
(Mining and quarrying only) ...	639	500	562	396	434	...
Primary sector number of female workers per 1,000 male workers.	543	550	545	466	470	552
Number of female-workers per 1,000 male workers in household industry.	...	...	...	...	...	633
Number of female-workers per 1,000 male workers in manufacturing.	553	574	508	440	288	110
Number of female-workers per 1,000 male workers in construction—industry.	400	336	412	303	248	134
Number of female-workers per 1,000 male workers in the *Secondary sector.*	543	548	501	423	291	348
Number of female-workers per 1,000 male workers in trade and commerce.	485	513	479	396	187	115
Number of female-workers per 1,000 male-workers in transport, storage and communications.	65	62	65	41	61	27
Number of female-workers per 1,000 male-workers in services.	325	371	357	484	332	287
Number of female-workers per 1,000 male-workers in the *Tertiary sector.*	358	390	379	410	257	211
Number of female non-workers per 1,000 male non-workers.	1,707	1,676	1,629	1,656	1,580	1,581

SOURCE: P.N.S. Panicker, A Handbook on Small Industries, P.158.

It is also notable that over the 60 year period, the number of female to male workers has fallen also in manufacturing, construction, trade & commerce, and even in services. (See Table 3). The effect of urbanization and industrialization shows up in the difference in participation rates of women in rural versus urban India. In 1961, in rural India, 31.4 women per 100 were workers, while 58.2 men per 100 were workers. In urban India, at the same time, only 11.1 per 100 women were workers whereas 52 per 100 men were workers. (See Table 4).

In every age group, labour force participation of women is at least double, and in many cases more than triple in rural India compared to urban areas (see Table 4). The participation rates of young and older men also reflect this differential access to productive processes between rural and urban areas. While time series data is not available for regression analysis, it appears India fits the model outlined in the literature survey. Women's role in all sectors of the economy, except as cultivators, has fallen. The fact that agriculture has remained overwhelmingly the largest sector, and its relative decline in importance has been proceeding very slowly, appears to be the only factor which has prevented Indian women's overall participation rates from plunging rather than declining slowly as noted. Note in Table 5 that the share of employment of the 'Primary Sector', (which includes forestry, mining and quarrying as

well as plantations and other agriculture) has not declined at all in the 60 year period. One might possibly conclude that the higher the elasticity of urbanization with respect to technological change in society, the lower the overall participation of women will become, other things being constant.

Table 4

THE SEX-AGE-SPECIFIC LABOUR FORCE PARTICIPATION RATES FOR RURAL, URBAN AND ALL AREAS OF INDIA

According to the 16th Round of the NSS and Those Based on the 1961 Census Data for Maharashtra

(per cent

Age Group	India		Rural India		Urban I
	1961 Census	NSS 1960-61	1961 Census	NSS 1960-61	1961 Census
			MALES		
5 - 9	2.51	2.81	2.91	3.28	0.54
10 - 14	29.92	28.88	34.14	32.73	11.11
15 - 19	69.43	70.33	77.07	76.30	40.70
20 - 24	90.95	91.31	94.41	93.09	79.60
25 - 29	96.27	95.90	96.86	95.52	94.03
30 - 39	97.72	96.49	97.73	96.05	97.68
40 - 49	97.76	95.35	97.92	94.84	96.33
50 - 59	95.70	90.74	97.25	90.64	88.39
60 +	57.46	61.97	80.06	63.79	59.25
All Ages	57.12	55.06	58.22	55.67	52.40
			FEMALES		
5 - 9	1.69	2.12	1.98	2.40	0.24
10 - 14	22.78	20.01	26.71	22.97	5.22
15 - 19	40.56	33.52	47.17	37.81	11.43
20 - 24	43.07	37.07	49.26	41.03	15.55
25 - 29	44.76	41.29	50.76	45.67	17.03
30 - 39	45.59	47.56	53.34	52.01	21.19
40 - 49	50.11	47.18	54.56	50.90	24.75
50 - 59	42.91	38.37	46.94	40.60	20.71
60 +	22.42	16.89	24.35	17.64	11.48
All Ages	27.96	25.17	31.42	27.72	11.09

Note: The NSS rates for all areas of India have been obt weighting the rates for rural and urban areas acco the rural-urban distribution of the population of age group, as reported by the 1961 Census have bee from Reports 103 (p.23); 114 (pp.22,24)

Source: (1) The National Sample Survey, Reports 103 (p.: (pp.22,24)

(2) Pravin Visaria, "Estimates for Participatio and Labour Force, Including and Excluding U Family Workers, for India, 1961-1981", in P Commission, Government of India, Report of t Committee of Experts on Unemployment Estima Delhi, 1970, Appendix V.

Table 5

Percentage distribution of workers by sex, in three broad sectors (Primary, Secondary and Tertiary) 1901–1961.

Year	Sex	Total workers	Primary sector	Secondary sector	Tertiary sector
1901	Both sexes	100	71.76	12.61	15.6
	Males	100	70.37	12.31	17.3
	Females	100	74.46	13.25	12.2
1911	Both sexes	100	74.86	11.13	14.0
	Males	100	73.66	10.97	15.37
	Females	100	77.14	11.45	11.41
1921	Both sexes	100	75.99	10.41	13.60
	Males	100	74.54	10.51	14.95
	Females	100	78.80	10.21	10.99
1931	Both sexes	100	74.75	10.21	15.04
	Males	100	74.08	10.43	15.49
	Females	100	76.23	9.74	14.03
1951	Both sexes	100	72.12	10.62	17.26
	Males	100	69.08	11.59	19.33
	Females	100	79.57	8.26	12.17
1961	Both sexes	100	72.28	11.70	16.02
	Males	100	67.98	12.68	19.34
	Females	100	81.58	9.59	8.83

SOURCE: P.N.S. Panicker, A Handbook on Small Industries, P.154

However, technological progress, in itself, may have a positive impact on the proportion of women in each industry. The cross sectional data in this study present a little more optimistic picture. There is a small positive relationship between participation and technological change, despite the fact that the female participation rate combined over all 13 manufacturing industries fell, while technological change was large and positive for all but Basic Metals.

If technological change did in fact exert a positive influence on participation in manufacturing industries in India in the late sixties, the decline in the percentage of female workers in manufacturing during this period can be accounted for by the fall in the capital labour ratio and the decline in foreign ownership, both of which factors exhibit a positive impact upon participation according to the statistical results.

Participation - Statistical Results

According to Equation (1) for Participation, it appears that support is provided for a positive relationship between Technological Change and Participation in Indian Manufacturing between 1964 and 1969. Unfortunately, such data as 'manner of implementation' is unlikely to be obtainable without field studies and so is not possible to include as a variable in this equation. Without further research on other data sets, it is not possible to draw

conclusions about technological change being female labour displacing or encouraging, in general. As discussed before, there is no theoretical reason to believe that it must be one or the other, particularly in the non-agricultural sectors. There is some support however, for the conclusion that increased capital intensity (which may be associated with technological change particularly technological change associated with foreign influences) may lead to an increased proportion of women in an industry (though not necessarily increased female employment if capital intensity reduces the amount of labour, both male and female, that would otherwise be needed).

Both time series and field studies would help to clarify the ambiguity of how technological change may have a positive impact on women's the proportion of women in individual industries, as in Indian manufacturing between 1964 and 1969, and yet be associated with the declining proportions of women workers in all industries, except agriculture, in India between 1901 and 1961. Three possibilities exist: the technological change was female labour displacing over the sixty year period, and changed in the following decade, or the rural component of these industries declined relative to the urban component, or there was relatively little technological change over that period and its impact was small in comparison to other offsetting factors. Until the 1961 census for example, household industy was combined with

other manufacturing. This sector may have been responsible for a substantial proportion of female employment in manufacturing. This could account for the sudden drop in the ratio of female to male workers observed in Table 3 between 1951 and 1961. A decline in this subsector could, in itself, account for a large part of the decline in the proportion of women in manufacturing, observed in Table 3 between 1911 and 1951.

6.4 Foreign Business and Women's Participation

This study seems to suggest that foreign business investment in LDCs (from more developed countries) is positively related to the proportion of women in the host country industries in three ways:

i) The proportion of women in industry, (though not necessarily the proportion of economically active women) is much higher in the West. For whatever reason, perhaps due to 'habit persistence', or less discrimination, foreign business does seem to have a significantly positive impact upon the change in the proportion of women in an LDC industry.

ii) Technological Change, per se, has been shown to have a positive impact upon the participation of women in an industry, at least under some circumstances. Foreign business involvement in this study, shows a very strong relationship to technological change. For that reason, foreign business should also have a positive impact on the proportion of women in an industry.

iii) Foreign businesses, particularly multinationals, have a reputation both for paying premium wages, and for using more capital intensive processes than local firms. While the use of capital intensive processes in inappropriate instances is more likely to reduce than to increase total female employment, the statistical results of this study indicate that higher capital labour ratios are associated

with larger proportions of women workers in an affected industry.

CHAPTER SEVEN: SUMMARY AND CONCLUSIONS

Statistical evidence in support of the hypothesis that technological change had a small positive effect upon women's participation in Indian manufacturing industries between 1964 and 1969, was found. A statistical test of the effect of overall technological change on overall levels of women's participation in the economy was not possible. However, the data suggest that Indian women's overall participation in the economy has fallen slightly since the turn of the century, due to urbanization and industrialization (or technological change). It appears not to have fallen dramatically and consistently over this period since the share of employment accounted for by agriculture has remained consistently high. What has been noted, is that women's agricultural employment opportunites have appeared to fall and their responsibilites as cultivators of family plots have risen.

Lastly, statistical evidence linking technological change and the presence of foreign business was found for Indian Manufacturing industries between 1964 and 1969.

Future research efforts might be directed towards classifying technological change into categories designed to differentiate between those that encourage women's participation and those that displace women from an individual industry. It would be interesting to determine whether technological change has a beneficial impact upon

women's participation in individual industries in general, or only under certain circumstances. It would also be useful to have time series statistical studies of the hypothesis that technological change associated with rising levels of industrialization leads to a decline in the economy-wide female participation rate.

In conclusion:

1. Lack of standardized data in the following important areas is a serious hinderance to empirical research.

   a) Proportion of men and women in each industry, annually

   b) Real Capital Stock by industry, annually

   c) Cost of Capital, annually, by industry

   d) Factor Shares annually, by industry

   e) Foreign Investment and Ownership, (Direct and Portfolio) annually, by industry.

2. In the same vein, it is necessary that efforts to standardize industrial classification schemes between and within countries continue to press forward.

3. Considering how little growth in GNP occurred in India in the late 1960s, the Solow measure of technological change registers a surprisingly high level for Indian Manufacturing industries during this period.

4. Some statistical support is shown for the hypothesis that foreign ownership and investment were positively linked to technological change in Indian manufacturing during the period 1964 to 1969.

5. There is support for the hypothesis that increasing size, or scale of production, in itself leads to a change to a more efficient technique.

6. Women's total participation in the Indian economy has fallen slightly since the turn of the century though their involvement in agriculture (as cultivators not as employees) has risen.

7. A small positive relationship between female participation and technolgical change was found despite the fact that the female participation rate combined over all 13 manufacturing industries fell, while technological change was large and positive for all but Basic Metals.

8. The above can be accounted for by the fall in the capital labour ratio and the decline in foreign ownership, both of which demonstrate positive statistical relationships with women's participation in this study.

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APPENDIX ONE

The Wu Test for Exogeneity

The Wu test for exogeneity involves running two regressions and comparing their sum of squared residuals through the use of a Chow test. First, a regression is run with the actual values (no predicted values as would be done for 2SLS) of the included variables. This is the OLS regression. Next, another regression is run with the same regressors but, in addition, the predicted values as well as the actual values of the endogenous variables are included as separate explanatory variables.

For the Participation equation, the two regressions were:

OLS

$$PART = 13.5 + .78\ TCH + .75\ W + 2.1\ FI + 1.46\ KE$$

$$SSE = 3272.4 \quad DFE = 8$$

and

$$Part = 37.16 + 1.07TCH + 1.85W + 1.34FI + 1.01KE - 1.0\hat{TCH} - 1.24\hat{W} + .5\hat{KE}$$

$$SSE = 2105.3 \quad DFE = 5$$

$$F = \{(3272.4 - 2105.3) / (8-5) / (2105.3 / 5) = .92$$

which is insignificant even at the 25% level. Therefore it is not necessary to incorporate this equation in a Simultaneous Equation Model. The OLS model is appropriate.

The Wu test for the Technological Change Equation using the smoothed data was:

OLS

$TCH = 6.22 + .35\ O - .26\ FI - .36\ W + .1\ FRON$

$SSE = 315.53 \quad DFE = 8$

and

$TCH = 4.88 + .45\ O + .07\ FI - .26\ W - 1.15\ \hat{W}$

$SSE = 257.05 \quad DFE = 5$

$F = \{ (315.5 - 257.1) / (8 - 5) / (257.1 / 5) = 11.9$ which is significant even at the 1% level. Therefore, the predicted variables significantly add to the explanatory power and this equation should remain part of the simultaneous system.

APPENDIX TWO: DATA TABLES

Female Employee
Proportions by Industry (2)

(1)	1963	1964	1965	1968	1969	1970(P) (3)
Foods and Beverages	.21974	.22508	.21861	.24226	.22095	21384
Cigarettes and Tobacco	.63816	.64973	.65321	.71648	.71065	.68178
Textiles	.05566	.05163	.05110	.04749	.04646	.04594
Transportation and Equipment	.00285	.00365	.00385	.00359	.00552	.00571
Machinery and Machine Tools	.00741	.00706	.00750	.00802	.00809	.01001
Basic Metals	.02888	.02779	.02544	.01869	.01681	.01649
Metal Products	.01108	.01238	.01172	.01505	.01564	.01738
Electrical Goods	.03560	.04645	.04412	.05365	.06486	.06380
Chemicals and Products of Petroleum and Coal	.08229	.08805	.08859	.09077	.08740	.08527
Wood and Cork and Non-Metallic Mineral Products	.12405	.12224	.11993	.11516	.11789	.11639
Rubber Goods	.02585	.02578	.02676	.02244	.02269	.03092
Other Misc. Manuf., Furniture, Fixtures, Paper and Printing, Leather	.04016	.03988	.04036	.04143	.04310	.04465
Electrical, Gas, Steam Water and Sanitary Services	.01479	.01141	.01109	.00658	.00784	.00827
TOTAL	.10362	.10166	.09579	.08512	.09241	.08875

Source: Calculated from various issues of the Indian Labour Statistics

For Notes (1), (2), (3) see last page of Appendix 2

Real Value Added

(1)	1963	1964	1965	1968	1969	1970
Foods and Beverages	27,832	31,228	32,923	32,744	43,932	24,907
Tobacco	6,263	5,900	7,485	9,837	11,905	11,858
Textiles	88,097	93,154	88,088	86,604	90,174	95,432
Transportation Equipment	29,358	19,297	39,093	36,152	39,811	39,914
Manufacture of Machinery	13,810	17,853	21,415	20,652	25,027	25,228
Basic Metals	35,742	45,435	44,467	35,612	41,311	46,720
Manufacture of Metal Products	7,922	8,133	9,833	7,951	9,836	11,066
Manufacture of Electrical Machinery	13,080	15,116	18,117	18,400	22,489	27,441
Basic Industrial Chemicals and Products of Petroleum and Coal	33,241	34,361	41,323	52,169	59,912	65,240
Wood and Cork and Non-Metallic Mineral Products	8,764	9,150	11,354	9,886	11,522	11,086
Rubber Goods	7,961	6,713	7,944	9,900	10,534	9,938
Other Misc. Manuf., Furniture, Fixtures, Paper and Printing, Leather	23,871	25,914	25,415	29,038	40,304	37,998
Electricity, Light and Gas	19,090	29,178	31,264	41,172	44,234	53,392

Source: Calculated from Nominal 'Value Added by Manufacture from the Table' Annual Survey of Industries - by Industries' in various issues of the Statistical Abstract India by deflating by the 'Implicit Price Deflator Index of Gross Domestic Product' for Indian Manufacturing Industries from the United Nations Yearbook of National Accounts Statistics

(1): See notes on last page of Appendix 2

Nominal Productive Capital Stock (current 10,000,000 Rs.)

(1)	1963	1964	1965	1966	1968	1969	1970
Food and Beverages	33,396	33,468	40,470	46,606	47,714	53,127	57,657
Tobacco	3,330	3,579	3,865	3,909	6,343	7,584	7,225
Textiles	58,269	63,833	63,290	72,179	76,662	78,702	82,626
Transportation Equipment	25,299	31,217	35,394	45,845	51,550	53,611	56,818
Machinery	14,074	18,887	24,602	38,145	37,914	38,511	39,674
Basic Metals	102,210	111,763	123,108	136,865	156,671	162,516	170,299
Metal Products	6,478	7,299	8,956	10,274	9,687	12,228	13,541
Electrical Machinery	14,966	17,784	23,440	33,919	33,601	37,878	39,674
Chemicals	49,043	55,167	64,637	90,484	111,999	134,935	167,831
Building	10,500	11,799	13,075	14,731	18,898	20,709	25,172
Rubber	4,798	5,702	5,877	6,490	7,647	9,754	9,543
Miscellaneous Manufacturing	24,921	29,086	31,827	35,542	42,709	45,012	50,070
Electricity and Gas	82,639	136,175	191,501	219,153	300,965	338,747	395,355

Source: Calculated from 'Annual Survey of Industries - by Industries' in various issues of the Statistical Abstract India

(1) See notes on last page of Appendix 2

	Employment					
	1963	1964	1965	1968	1969	1970
Foods and Beverages	396,306	427,668	444,788	411,377	442,285	452,736
Tobacco	86,813	92,813	92,718	103,106	110,343	91,453
Textiles	1,253,869	1,310,142	1,279,653	1,194,007	1,178,820	1,226,063
Transportation Equipment	335,877	365,054	407,280	419,936	442,283	453,128
Manufacture of Machinery	144,986	164,921	205,318	204,008	208,083	202,017
Basic Metals	289,117	319,068	333,227	333,395	353,950	349,838
Manufacture of Metal Products	77,764	79,476	85,566	78,537	86,634	91,182
Manufacture of Electrical Machinery	111,457	127,774	139,645	154,145	171,268	184,950
Chemicals and Products of Petroleum and Coal	146,443	159,553	181,837	210,323	229,062	251,228
Wood and Cork and Non-Metallic Mineral Products	80,635	91,853	96,664	93,118	95,757	98,089
Manufacture of Rubber	46,374	43,607	45,846	53,003	57,134	47,658
Other Misc. Manuf., Furniture, Fixtures, Paper and Printing, Leather	325,509	350,692	361,435	370,215	388,272	397,758
Electricity, Light and Gas	158,702	267,019	279,207	343,133	388,429	410,523

Source: Calculated from'Annual Survey of Industries - by Industry' in various issues of the Statistical Abstract India

For Note (1) see last page of Appendix 2

Direct Investment Capital Component of Outstanding Long Term Foreign Investments in Corporate and Commercial Enterprises (Rs. crores)

(1)	1964	1969
Food and Beverages	34.0	49.1
Tobacco	26.4	31.9
Textiles	16.6	17.7
Transportation Equipment	15.0	25.7
Machinery	16.0	25.0
Basic Metals	13.7	29.3
Metal Products	19.4	31.9
Electrical Machinery	20.8	41.3
Chemicals	62.5	115.8
Building	4.6	9.3
Rubber	18.1	23.6
Miscellaneous Manufacturing	17.7	31.9
Electricity and Gas	38.1	46.0

Source: Reserve Bank of India Bulletin, July 1975

(1) See Note 1 on last page of Appendix 2

India Implicit Price Deflator
Index of Gross Domestic Product

Manufacturing Industries	1975=100
1963	40.2
1964	43.8
1965	47.7
1966	54.8
1967	59.0
1968	58.8
1969	61.2
1970	63.1

Source: United Nations Yearbook of National Accounts Statistics

Implicit Price Deflator Index
of Gross Fixed Capital Formation
for Manufacturing Industries
India

1975=100

1963	40.0
1964	41.1
1965	43.7
1966	46.8
1967	48.5
1968	51.1
1969	53.8
1970	57.4

Source: United Nations Yearbook of National Accounts Statistics

	Proportion of Fixed Capital to Productive Capital	Depreciation as a % of Fixed Capital
(1)		
Food and Beverages	.53615	.1049
Tobacco	.2948	.1604
Textiles	.5911	.1275
Transportation Equipment	.496	.1090
Machinery	.5407	.1082
Basic Metals	.6667	.0989
Metal Products	.4432	.1063
Electrical Machinery	.5135	.0902
Chemicals	.6607	.0986
Building	.6806	.1003
Rubber	.5890	.1346
Miscellaneous Manufacturing	.6211	.0988
Electricity and Gas	.8992	.0277

Source: Calculated from Tables in Annual Survey of Industries: Summary Results of the Factory Sector, 1970/71, 1971/72, 1973/74, 1974/75

Note (1) see last page of Appendix 2

Real Wages

(1)	1963	1964	1968	1969
Food and Beverages	802.27	767.73	719.30	790.63
Tobacco	648.93	595.47	543.78	599.12
Textiles	1407.53	1366.10	1260.05	1302.10
Transportation Equipment	1798.65	1680.55	1571.91	1667.98
Machinery	1485.33	1464.53	1411.78	1579.32
Basic Metals	1877.41	1813.45	1812.09	1926.30
Metal Products	1280.83	1230.41	1668.00	1321.17
Electrical Machinery	1829.56	1638.02	1786.05	1997.75
Chemicals	1997.12	1953.13	2093.96	2189.74
Building	987.46	962.08	906.98	967.06
Rubber	2159.42	2105.26	1867.85	1939.17
Miscellaneous Manufacturing	1372.56	1267.13	1213.30	1339.62
Electricity and Gas	1351.73	991.75	NA	1201.36

Source: Calculated from 'Per Capita Annual Money Earnings of Workers in Manufacturing Industries' in various issues of Indian Labour Statistics, deflated by the 'Consumer Price Index Numbers for working class for all India and General Index' in the same source

Note (1) see last page of Appendix 2

NOTES TO APPENDIX TWO

Note 1: For compatibility with the other data, some of the above categories aggregate more than one category from the source.

Note 2: While the source gives absolute numbers of men and women, this has been converted to a percentage of women to total employees.

Note 3: (P) refers to data designated 'preliminary' by the source.