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Abstract

Case study evidence from developing countries suggests that availability of educated female labour is an important determinant of success in exporting manufactures. This paper, based on a general model in which the pattern of trade is determined by supplies of human and natural resources, uses cross-country regression analysis as an alternative way to test the hypothesis of a linkage between female education and manufactured exports. The results give only weak support to the hypothesis, but are afflicted by collinearity in the cross-country data. Further research should thus focus on evidence at a level intermediate between case studies and cross-country regressions, and in particular on country studies.

I. Introduction

Manufactured exports from developing countries grew from about $1 billion in the mid-1950s to about $380 billion in 1990. However, this success has been very unequally distributed among developing countries. Two major explanations have been offered for this uneven export performance. The first sees differences in trade policies as the cause (e.g. Balassa 1982, World Bank 1987). The second sees trade as determined principally by resource endowments (e.g. Keesing and Sherk 1971, Leamer 1984), and in particular regards human resources as the basis of success in exporting manufactures (Bruchmann 1989, Wood and Berge 1994).

Two characteristics of the human resources engaged in export-oriented manufacturing in developing countries stand out: the workers are mainly educated, and they are mainly female. Case studies from the 1970s and 1980s show that workers who produce manufactured goods usually have (and require) at least a basic education - defined as completing primary school or becoming literate (Lim 1980: 11; Lee 1984: 82, 175; Pearson 1991: 150). The case studies also reveal the female intensity of the labour force in developing-country export-oriented manufacturing. The studies focus mainly on workers in export processing zones (EPZs) and multinational corporations. An overall estimate is that women comprise between 70 and 90 percent of the labour force in EPZs (UNIDO 1988: 7).

Moreover, the East Asian NICs which have led the field in export-oriented industrialization clearly started with relatively large supplies of educated labour, including educated *female* labour. In 1965 Hong Kong, Korea and Singapore had already achieved universal primary enrollment, well ahead of other developing countries (World Bank 1993: 43). Between twenty and forty percent of women had completed primary school, compared to less than five percent in most other developing countries. By the mid-1980s, average years of schooling for women had reached 6.6 in Korea, 6.5 in Hong Kong and 5.7 in Taiwan, not far short of the OECD average of 7.5 years (Barro and Lee 1993: table A.5).

This paper asks whether the apparent importance of female human resources for trade performance can be observed in more systematic cross-country comparisons. To our knowledge there has not been much statistical work on

the links between gender and exports. Wood (1991) found that developing
countries which exported a rising proportion of their manufacturing output
to the North also tended to employ an increasing proportion of females in
their manufacturing sectors. More importantly in relation to the present
study, he found a positive but weaker relationship in the mid-1980s between
the *level* of the export performance variable and the *level* of female
intensity.

The structure of the paper is as follows. Section II outlines the trade
model, with and without the gender dimension. Section III derives
regression specifications and reports on the empirical results. Section IV
draws conclusions and outlines ideas for further research.

II. A simple model of trade

This paper takes the view that factor endowments are the most important
determinant of the extent to which countries export manufactured goods.
Our model of trade is a standard Heckscher-Ohlin (H-O) framework, in which
the factors of production are simply human resources and natural resources.
Capital is excluded from the model on the grounds that it is mobile between
countries. Within the general framework, there are two distinct sub-models
to explain: a) the share of manufactured, as opposed to primary, exports in
total exports; and b) the composition of manufactured exports.

In the rest of this section, the two sub-models are first outlined without
any reference to gender (for a fuller statement and more empirical testing,
see Wood 1994b and Wood and Berge 1994). The theoretical basis for
introducing a gender dimension into the models is then developed.

Manufactured versus primary exports

This sub-model has two goods, manufactures and primary products; and two
factors of production, human resources (or skill) and natural resources (or
land). The essential distinction between the two goods is that production
of manufactures requires a higher ratio of skill to land than does the
production of primary products. What determines a country's comparative

advantage as between manufactures and primary products is therefore its relative endowments of skill and land.

In both sub-models, human resources are for simplicity divided into three skill categories. The first contains workers with no education (NO-EDs), who are not employable in manufacturing. The second category consists of workers with a basic general education (BAS-EDs). The final category includes all workers with substantial post-basic education and training (SKILD). The average skill level of a country's labour force (and hence its ratio of skill to land) thus depends on the relative sizes of these three categories: it can be thought of as a weighted average of the skill levels within each category, with their labour force shares as weights.

Composition of manufactured exports

Manufactured exports are a far-from-homogeneous category: there is clearly a lot of difference between cheap shirts or shoes and expensive machines or pharmaceuticals. The essential respect in which manufactures are taken to vary in the present model concerns their skill intensity: the production of machines and chemicals needs a higher ratio of SKILD to BAS-ED labour than the production of shirts and shoes. (For simplicity, we may assume that there are only two manufactured goods: skill-intensive and labour-intensive.) Each country's comparative advantage within manufacturing is thus determined by its relative supplies of SKILD and BAS-ED labour.

Introducing a gender dimension

If it is true, as the case studies mentioned above suggest, that workers producing manufactured exports in developing countries are predominantly female, as well as literate, how should the theoretical framework sketched above be modified? The first step, following H-O logic, is to differentiate both goods and human resources not only by skill but also by gender; the second is to think about the underlying causes of comparative advantage.

The minimum accounting modification is to add one more good and one more factor. Thus, as regards goods, we may distinguish three rather than two types of manufactures: a skill-intensive good and two types of labour-

intensive good - those which use female BAS-EDs intensively (textiles and electronics, say), and those which use male BAS-EDs intensively (other low-skilled manufacturing activities). The difference might be rationalised in terms of the common view that women's nimble fingers and docility make them more suited than men to meticulous, repetitive assembly line work.[1] Correspondingly, we split BAS-ED labour into two distinct factors: literate females ($BAS\text{-}ED_F$), and literate males ($BAS\text{-}ED_M$).

Having made these modifications to the categories, it is then important to ask why, from a theoretical point of view, developing countries might have a comparative advantage in female-intensive manufactures. H-O logic tells us that this must be because female labour, relative to male labour, is cheaper in developing countries than in developed countries, so we need to look for reasons why this might be the case.

The usual H-O explanation of differences in relative factor prices (in the absence of trade) is differences in relative factor supplies or endowments. However, this explanation does not seem plausible here: in the population at large, the ratio of females to males is much the same in developing as in developed countries; moreover, if attention is restricted to the literate population eligible for employment in manufacturing, the ratio of females to males is actually lower in developing than in developed countries (as will be documented below).

Nonetheless, if two of the usual H-O assumptions are modified, developing countries may still plausibly be argued to have a comparative advantage in female-intensive manufactures. The two assumptions are: identical demand patterns in all countries (given the relative prices of goods); and perfect factor mobility among sectors within each country.

Firstly, the sectoral composition of demand differs between developed and developing countries. In particular, services account for a much larger

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1. Pearson (1992) summarizes the literature on the preference for women workers. Lee (1984) cites the case of US multinationals moving production out of Malaysia and Singapore due to shortages of female labour. Hein (1986) reports on employers in Mauritius going to great lengths to hire women. Pearson (1991) suggests that the potential pool of female labour was a major inducement for North American firms setting up production in the *maquiladoras* of Mexico.

share of employment in developed countries. Services are generally non-tradable and female-intensive, and so their larger share raises the demand for (and hence the relative wages of) female relative to male workers. In other words, a large share of the female work force in developed countries is absorbed by services, thereby reducing the supply of female labour to the rest of the economy. By contrast, in developing countries, where the service sector is smaller, so is the economy-wide demand for female labour, and hence the supply of female labour to the tradable sectors is relatively cheaper.[2]

The inter-sectoral factor mobility assumption needs to be relaxed because women and men do not have equal access to all spheres of economic activity. Institutional constraints in all countries restrict women's access to many economic activities, and in particular tend to confine women to a limited set of occupations.[3] This restriction of opportunity tends to reduce the wages paid to females in these occupations.[4] It is plausible to suppose, moreover, that these restrictions are more severe in developing than in developed countries, both for cultural reasons and because of practical obstacles to female participation in modern sector employment (such as poor transport facilities and little mechanisation of domestic chores). This

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2. Moreover, services are more female-intensive in developed countries than in developing countries, perhaps because of the institutional constraints discussed below. This implies that an even greater share of the female labour force is absorbed by the service sector in developed relative to developing countries. Einhorn (1994) estimates that between 75 and 80 percent of women workers in industrialized market economies are in the service sector.

3. For example Islam in general and *purdah* (female seclusion) in particular constrains women's employment opportunities, by restricting women's mobility and visibility (Kabeer 1991) - though Kabeer stresses the interaction between cultural and economic forces. The notion that a family's honour resides in the virtue of its women demands constant surveillance of women so that they do not bring shame on the family. The preference is thus for women to work in the seclusion of their own homes (which may be accommodated by textile-industry outsourcing) or in situations where they are under constant supervision (factories).

4. Institutional norms also act directly on wage levels. Women's work is often valued less than men's work (for non-economic reasons) and women are therefore paid less. Moreover, since men are considered the family bread-winners, they are paid a family wage whereas a women's wage is considered supplementary "pocket money". This is true in both the North and the South, but the effect may be stronger in the South.

too could help to explain why the wages of females, relative to males, tend to be lower in developing countries, thus giving these countries a comparative advantage in female-intensive traded goods.[5]

Whether, and how widely, the wage gap between males and females is greater in developing countries ought to be tested empirically. However, there is a problem in doing so directly, since in principle the comparison of wages should be made *in the absence of trade* (since expansion of female-intensive manufactured exports tends to close the gap).[6] The approach to be taken in this paper, instead, is to ask whether the pattern of trade is consistent with the hypothesis of a difference in (autarky) relative wages.

In this regard, we will examine the two aspects of trade distinguished in the sub-models of the original framework, both of which are affected if a relatively low price of female labour confers a comparative advantage in labour-intensive manufactured exports. Among developing countries, those with larger endowments of female, relative to male, human resources would be more likely to have a comparative advantage in manufactured goods relative to primary products. Similarly, as regards the composition of manufactured exports, countries with larger endowments of literate females, relative to SKILD labour, would be expected to have more of a comparative advantage in labour-intensive, relative to skill-intensive, manufactures.

III. Regression Specification and Empirical Results

This section consists of four subsections. The first tests how far the ratio of manufactured to primary exports can be explained by relative endowments of human and natural resources. The second examines the relationship between the composition of manufactured exports and the skill composition of the educated labour force. The third is a hybrid, examining the effect of resource endowments on exports of labour-intensive

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5. It is possible, however, that among developing countries, those with more institutional compartmentalisation of employment opportunities for women also tend to be those with relatively low female literacy rates. If so, lower relative demand for literate female labour might be offset by lower relative supply, without much net effect on relative wages.

6. Some evidence of such a closing of the gap is provided by Addison and Demery (1989: 3, table 3).

manufactured goods relative to primary products. Within each subsection, the tests are first specified with respect to human resources in general, and then to human resources differentiated by gender. The fourth section incorporates demand side factors into the three basic models tested in the previous sections.

(a) Manufactured versus primary exports

This submodel suggests that the ratio of a country's exports of manufactured goods (X_m) to its exports of primary products (X_p) is determined by its relative endowments of human resources (HR) and natural resources (NR). For many purposes, it is more convenient to express this endowment ratio in terms of skill *per worker* (hr = HR/L) and land *per worker* (nr = NR/L), making these variables independent of population size. A simple and flexible specification of the relationship is then

$$(X_m/X_p) = A(HR/NR)^\alpha = A(hr/nr)^\alpha \tag{1}$$

where A and α are parameters. Equation (1) can be estimated in (natural) logs - denoted by ^ over the variable - as

$$(\hat{X_m/X_p}) = a + b(\hat{hr/nr}) + u \text{ or, equivalently,} \tag{2}$$

$$(\hat{X_m/X_p}) = a + c.\hat{hr} - d.\hat{nr} + u \tag{3}$$

where a should be A; b, c and d should be estimates of α, and u is the error term.

Equation (3) is estimated for the largest possible number of countries (114) with a population above one million, in the most recent available year. The trade data are from the UNCTAD *Handbook of Trade and Development Statistics* (1991, table 4.1), using the conventional division between primary exports (SITC 0-4 plus 68) and manufactured exports (SITC 5-8 minus 68). Human resources are measured by years of schooling, mainly from Barro and Lee (1993), while natural resources are measured by total land area. For a defence of these crude measures of skill and land, see Wood and Berge (1994, section IIIc).

The estimated OLS regression of equation (3) is

$$(X_m/X_p) = 0.88 + 0.81 \, \hat{hr} - 0.69 \, \hat{nr} \qquad R^2 = 0.57 \qquad (3a)$$
$$ (0.46) \quad (0.14) \qquad (0.09)$$

with standard errors in parentheses. The coefficients on both independent variables are significantly different from zero at the one percent level. This confirms that the ratio of a country's manufactured to primary exports is determined both by its natural resources and by the skill level of its labour force. The proportion of variance in trade composition which the model explains is quite high, as indicated by an R^2 of 0.57.

Incorporating gender

To examine the influence of gender on export composition, we include a gender-gap variable, FEMSHARE, which measures the share of female school years in each country's total school years (average years of schooling multiplied by number of people). Thus, in two countries with the same ratio of human to natural resources, we expect the country with the higher proportion of *female* human resources to have a greater comparative advantage in manufacturing. There are other possible ways of measuring the gender gap in education (for example, the difference in average years of schooling of the two sexes), but this one seems the most appropriate in the present context.[7]

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7. To illustrate the appropriateness of the share variable, consider two countries, A and B. In country A, women and men have an average of two and three years of schooling respectively. In country B, women and men have an average of five and six years respectively. Land per worker in country A is much lower, giving both countries the same human to natural resource ratio. Suppose also that only females can be employed in export-oriented manufacturing. The ratio of manufactured to primary exports is thus determined by the ratio of female years of schooling to land. The share of female years of schooling in total years of schooling (FEMSHARE) is higher in country B, and the ratio of female years of schooling to land is therefore also higher. The latter implies that country B has a greater comparative advantage in manufacturing (as indicated by a higher FEMSHARE). However, if the gender gap were measured by the difference in average years of schooling, the two countries would appear to have the same comparative advantage, which is not the case. If the gender gap were measured by the *ratio* of average female to average male years of schooling, the difference would be in the right direction, but the share measure more accurately captures its magnitude. (We experimented with the difference in average years of schooling and the ratio of average years of schooling as

The estimated OLS regression including FEMSHARE is

$$(X_m/X_p) = 0.05 + 0.58 \text{ hr} - 0.68 \text{ nr} + 0.027 \text{ FEMSHARE} \qquad (3b)$$
$$\quad\;\; (0.67) \quad (0.20) \qquad (0.09) \qquad (0.016)$$

$$R^2 = 0.59$$

The coefficient on the gender gap variable is positive and significant at the 10 percent level, indicating that a one percent change in the share of females increases the export ratio by 0.03 percent. However, the fall in the coefficient on hr and the increase in its standard error indicate collinearity between hr and FEMSHARE (R = 0.7), which makes it difficult to distinguish between the effects of total human resources and female human resources.

Developing countries only

The case study literature suggests that female human resources are particularly important in the production of *labour-intensive* manufactured goods.[8] While developing-country manufactured exports are predominantly labour-intensive, manufactured exports from developed countries are more skill-intensive. We would therefore expect gender to have a stronger effect on developing countries' export composition. To test this, regression (3b) was re-run for developing countries only.

The OLS regression for developing countries, without a gender variable, is

$$(X_m/X_p) = 1.15 + 0.54 \text{ hr} - 0.74 \text{ nr} \qquad (3c)$$
$$\quad\;\; (0.52) \quad (0.17) \qquad (0.10)$$

$$R^2 = 0.53$$

and, with the gender gap variable:

$$(X_m/X_p) = 0.68 + 0.42 \text{ hr} - 0.73 \text{ nr} + 0.15 \text{ FEMSHARE} \qquad (3d)$$
$$\quad\;\; (0.72) \quad (0.21) \qquad (0.10) \qquad (0.17)$$

$$R^2 = 0.53$$

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alternative gender-gap variables. Neither worked as well as the FEMSHARE variable.)

8. The gender composition of skilled labour, which is more relevant to developed than developing countries, lies beyond the scope of this paper.

Thus, contrary to expectations, for developing countries the gender gap variable is insignificant. Moreover, the coefficient on hr drops even further, while the correlation coefficient (R) between FEMSHARE and hr remains at 0.7. It thus appears that the reduction of the sample size has accentuated the problem of collinearity to the point where it is impossible to distinguish a specific gender effect from the effect of human resources as a whole.

(b) Composition of manufactured exports

The second sub-model postulates that the skill composition of a country's manufactured exports depends on its ratio of SKILD to BAS-ED labour. For example, assuming the same general relationship as in the other sub-model,

$$(X_{ms}/X_{mb}) = B(N_s/N_b)^\beta \qquad\qquad (4)$$

where X_{ms} and X_{mb} are, respectively, skill-intensive and (unskilled or BAS-ED) labour-intensive manufactured exports, and N_s and N_b are the numbers of SKILD and BAS-ED workers. X_{ms} are crudely measured as SITC 5 + 7 (chemicals and machinery and equipment) and X_{mb} as SITC 6 + 8 (everything else). A rough adjustment is made for exports of electrical equipment from the South to the North, which are classified as labour-intensive. SKILD workers are imperfectly measured as those with a complete secondary or tertiary education, and BAS-ED workers as those with more than zero but less than complete secondary schooling. (For further discussion of the data, see Wood 1994b, section 7.)

This sub-model is estimated in unlogged form, because ß is approximately unity, and because the logged form generates an unreadable scatter. Using a reduced (due to data availability) sample of 73 developed and developing countries, the regression is:

$$(X_{ms}/X_{mb}) = 0.50 + 1.00\ (N_s/N_b) \qquad R^2 = 0.21 \qquad (4a)$$
$$\phantom{(X_{ms}/X_{mb}) = }(0.13) \quad (0.23)$$

The fit of the composition of manufactures regression is much worse than that of the manufactured-versus-primary export regression, probably mainly because of data problems - the rough categorisations of the skill intensity

of manufactured goods and the skill composition of the labour force.[9] (Studies for specific countries suggest a stronger association between their skill endowments and the skill intensity of their manufactured exports: Wood 1994a, ch. 3). Regression (4a) indicates that a unit increase in the ratio of SKILD to BAS-ED labour leads to a unit increase in the ratio of skill- to labour-intensive exports. Although the fit is poor, the coefficient on the skill intensity ratio is robust (i.e. not much affected by changes in the sample).

To test the effect of gender on the composition of manufactured exports, the gender gap variable $FEMSHARE_{be}$ (the share of females in each country's BAS-ED labour force) is added to equation (4a). Note that, in this specification, if educated females confer a comparative advantage in labour-intensive manufacturing, we expect $FEMSHARE_{be}$ to have a *negative* effect on the dependent variable, which measures the ratio of skill-intensive to labour-intensive exports.

$$(X_{ms}/X_{mb}) = - 1.02 + 0.82 (N_s/N_b) + 0.04\ FEMSHARE_{be} \qquad (4b)$$
$$\phantom{(X_{ms}/X_{mb}) = } (0.47) \quad (0.23) \qquad\quad (0.01)$$

$$R^2 = 0.32$$

The fit of the regression is improved, but the coefficient on $FEMSHARE_{be}$ is positive (and significant), the opposite of what we expected.

The explanation seems to be that $FEMSHARE_{be}$ is highly correlated ($R = 0.7$) with average years of schooling, which may in practice be a better proxy for the skill level of the educated labour force than the measure that we are using, based on the numbers above and below the complete secondary school line. In other words, differences among countries in average years of schooling usually reflect differences *both* in the size of the NO-ED share of the labour force *and* in the average years of schooling of non-NO-ED workers. The latter may be a better measure of the relative supply of highly skilled labour, and hence of comparative advantage in skill-intensive manufactures, than our simple ratio of SKILD to BAS-ED numbers.

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9. As reported in Wood (1994b, section 7), the fit is even worse ($R^2 \approx$ 0.10) if the US is excluded. The tests reported below were therefore also run excluding the US, but this made no material difference to the conclusions regarding gender.

An alternative test is to run two simple regressions, with different independent variables, the first excluding BAS-ED males and so defining the skill ratio as SKILD/BAS-ED$_F$, the second excluding BAS-ED$_F$ and defining the skill ratio as SKILD/BAS-ED$_M$. The fit of the first of these regressions (using BAS-ED females only) should be better if the number of literate females is truly a more important determinant of comparative advantage in labour-intensive manufacturing than the number of literate males.

The two OLS regressions are

$$(X_{ms}/X_{mb}) = \underset{(0.13)}{0.47} + \underset{(0.12)}{0.52} \ (SKILD/BAS\text{-}ED_F) \qquad R^2 = 0.21 \qquad (5a)$$
and
$$(X_{sk}/X_{be}) = \underset{(0.12)}{0.56} + \underset{(0.11)}{0.42} \ (SKILD/BAS\text{-}ED_M) \qquad R^2 = 0.18 \qquad (5b)$$

The fit of the first regression is indeed better than that of the second, but only marginally so, mainly because SKILD/BAS-ED$_F$ and SKILD/BAS-ED$_M$ are highly correlated (R = 0.9). The coefficient on the independent variable in the first regression (SKILD/BAS-ED$_F$) is also larger: this probably reflects the fact that in countries with low levels of literacy there tends to be a greater literacy gap between males and females.

As before, the regressions were re-run for developing countries only. This experiment yielded no significant results, even using the initial gender-free skill ratio, N_s/N_b. This outcome is not surprising, since the equation for the full sample does not fit well, and since the bigger differences in the skill-intensity of manufactured exports are *between* developed and developing countries. Thus within the developing-country subsample, the slighter true differences are swamped by the errors of measurement in both the dependent and the independent variables.

(c) Hybrid specification: labour-intensive versus primary exports

Another possible reason (in addition to collinearity) for the insignificance of FEMSHARE in the primary versus manufactured exports regression (3d) using the developing-country-only sample is that developing-country manufactured exports are less labour-intensive (and thereby less female-intensive) than is usually assumed. To test this we

can omit exports of skill-intensive manufactures entirely, in order to assess the impact of gender on exports of labour-intensive manufactures relative to primary products. Thus regression (3d) is re-run using (X_{mb}/X_p) as the dependent variable. The OLS regression for developing countries is:

$$(X_{mb}/X_p) = 0.70 + 0.44 \; \bar{hr} - 0.75 \; \bar{nr} + 0.01 \; FEMSHARE \qquad (6)$$
$$\qquad\quad (0.90) \quad (0.45) \qquad (0.13) \qquad (0.03)$$

$$R^2 = 0.44$$

The gender gap variable is still not significant, and its inclusion renders the coefficient on human resources insignificant. Otherwise, there is little difference between the regression coefficients of regressions (3d) and (6), and the fit of regression (6) is worse, perhaps because of misclassification of skill-intensive and labour-intensive exports.[10]

A recurring problem in interpreting the results reported above is the collinearity between total human resources and the gender gap. Countries with more educated people also tend to have smaller differences between male and female educational levels. Although the gender variable was significant in regression (3b), this multicollinearity renders the coefficients on hr and FEMSHARE unreliable. Figure 1 shows the relationship between the gender gap and the overall level of human resources. There is a clear positive relationship between average years of schooling and the share of females in total human resources. However, once the population has achieved an average of six years of schooling, the share of females in total human resources hovers around 50 percent.

(d) Including demand-side influences

It was argued above that although the relative *supply* of educated female labour is lower in developing countries, differences in *demand* for female labour may still result in relatively lower female wages. The above three models tested whether differences in the supply of educated females affect

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10. Because it is BAS-EDs who are used intensively in the production of X_{mb}, we also experimented with the number of literate adults as the human resource variable (and the share of women in literate adults as the gender gap variable). However, the coefficients on these variables were not significant.

Fig. 1 Female and average schooling
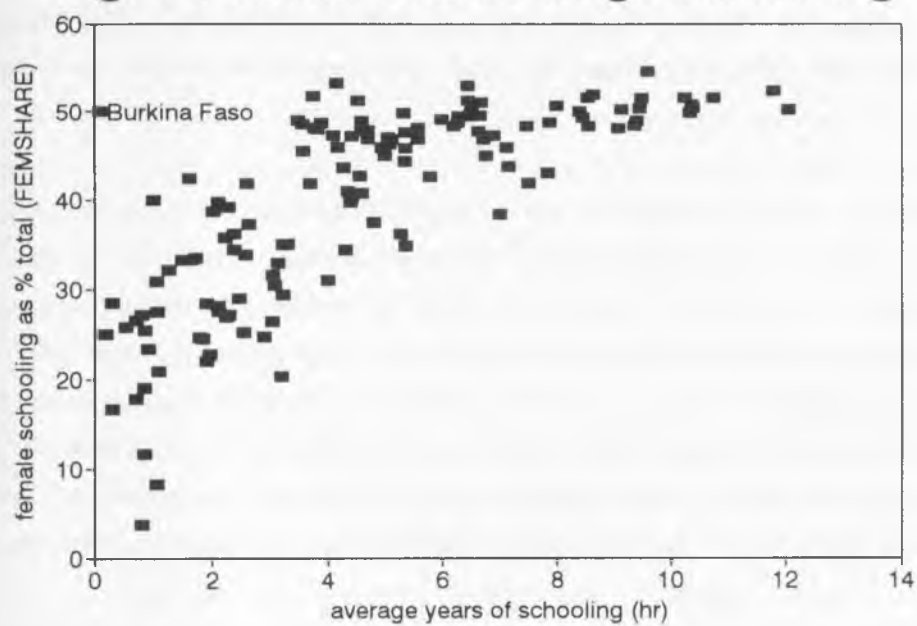
export composition. However, a better specification should also control for differences in demand.

The most conspicuous such difference concerns the demand for female labour generated by the service sector. Developed countries tend to have larger service sectors and thus a higher demand for female labour, putting upward pressure on relative female wages in the traded sectors. We therefore include the share of services in GDP as an additional independent variable.[11]

Cultural factors also influence the demand for female labour, and may particularly affect women workers' inter-sectoral mobility. In many countries, social conventions restrict women's access to waged employment in general and certain types of employment in particular. This tends to reduce women's wages across the board, as women workers are crowded into sectors deemed suitable for them. Furthermore, where social and cultural practices dictate women's activities, direct downward pressure on women's wages is less likely to be countered by opposition from female employees.

As one possible rough proxy for cultural influences on the demand for female labour, we include variables measuring the percentage of the population adhering to the major world religions: Christianity (Catholic and non-Catholic), Islam, Hinduism, Buddhism, and the residual category 'other religions'. We would expect countries with stricter religious restrictions on women's economic activity to have greater comparative advantage in labour-intensive manufacturing - provided of course that there are relatively few restrictions on factory employment.

In addition to restrictions on occupational mobility, women's geographical mobility is often limited. In many countries, it is considered inappropriate for women to travel long distances to their work place. To allow for this, we also include urbanization (percentage of the population living in urban areas) in the regression. A higher level of urbanization should enable more women to enter the manufacturing labour market.

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11. The best measure would probably be the share of females employed in the service sector. Second best is the share of services in employment, which is closely related to our measure (services/GDP).

We tried these several demand-side variables in all three of the sub-models explaining export composition - as between (a) manufactured and primary goods, (b) skill-intensive and labour-intensive manufactures, and (c) labour-intensive manufactures and primary goods.

The coefficients on service share and urbanization are not significantly different from zero, and the inclusion of these variables renders the coefficient on human resources insignificant. This reflects the high correlations between the service share, urbanization and human resources ($R_{hr,SERV} = 0.52$, $R_{hr,URB} = 0.62$ for the all-country sample), which cause collinearity in all three models. Including services and urbanization therefore does not improve the model specification.[12]

Since the sum of religious affiliations approximates 100 percent for each country, we need to specify a reference category. 'Other religions' on its own is too small to be a meaningful reference category. We therefore chose to use the sum of Christianity, Buddhism and 'other religions' as the reference category, with dummy variables for the percentages of the population adhering to Islam (ISLAM) and Hinduism (HINDU).[13] We also included a dummy variable for oil exporting countries (= 1 for oil exporters, 0 otherwise), which is highly correlated with ISLAM.[14] The result for model (a) for 100 developed and developing countries is:

(X_m/X_p) = -1.02 + 0.78 hr - 0.57 nr + 0.034 FEMSHARE + 0.016 HINDU
         (0.90)   (0.45)   (0.13)   (0.019)   (0.009)

+ 0.011 ISLAM - 1.72 OIL R^2 = 0.69   (7a)
  (0.004)   (0.41)

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12. We also included services and urbanization separately, but this had the same effects as including them together.

13. If we use Islam, Hinduism and 'other religions' as the reference category, the coefficient on Christianity is negative. The coefficient on Buddhism is insignificant whatever the reference category.

14. Without the oil exporter dummy, the coefficient on Islam would be negative (contrary to expectations). Oil exporters are countries in which oil and gas accounted for more than 50% of exports in 1989, as defined in the *World Development Report 1991*. More information on our experiments with including oil and other specific natural resources in the regressions is available from the authors on request.

and for 81 developing countries:

$$(X_m/X_p) = -0.93 + 0.73 \hat{hr} - 0.56 \hat{nr} + 0.028 \text{ FEMSHARE} + 0.018 \text{ HINDU}$$
$$\quad\quad\quad (0.87)\quad (0.23)\quad\quad (0.09)\quad\quad (0.021)\quad\quad\quad\quad (0.009)$$

$$+ 0.011 \text{ ISLAM} - 1.57 \text{ OIL} \quad\quad\quad R^2 = 0.66 \quad\quad\quad (7b)$$
$$\quad (0.004)\quad\quad\quad (0.44)$$

The coefficients on ISLAM and HINDU are all positive and significant (at the ten percent level), and their inclusion increases the size and significance of the coefficient on FEMSHARE. This tentatively suggests that the restrictions placed on women's activities in certain religions may indeed make female labour in manufacturing relatively cheaper in the countries concerned.

The inclusion of demand-side variables does not improve the composition-of-manufactured-exports sub-model. In section (b) above, we found that FEMSHARE has a positive and significant coefficient (the opposite of what the model predicts) apparently because FEMSHARE is correlated with average years of schooling (which may be a better proxy for the skill level of the educated labour force than our SKILD/BAS-ED variable). The coefficients on ISLAM and HINDU were not significant in model (b), and their inclusion raises the coefficient on FEMSHARE slightly.

In model (c) - labour-intensive manufactured versus primary exports - the regression for 62 developing countries is:

$$(X_m/X_p) = -1.42 + 0.64 \hat{hr} - 0.53 \hat{nr} + 0.029 \text{ FEMSHARE} + 0.024 \text{ HINDU}$$
$$\quad\quad\quad (1.12)\quad (0.44)\quad\quad (0.12)\quad\quad (0.030)\quad\quad\quad\quad (0.011)$$

$$+ 0.012 \text{ ISLAM} - 1.97 \text{ OIL} \quad\quad\quad R^2 = 0.55 \quad\quad\quad (7c)$$
$$\quad (0.006)\quad\quad\quad (0.67)$$

The coefficients on ISLAM and HINDU are positive and significant (at the five percent level), and the coefficients on human resources and FEMSHARE become more significant when demand-side factors are included (although they are still not significant at the 10 percent level). As noted in section (c) above, the fit of this regression is worse than that of the total-manufactured-versus-primary-exports model (7a) because of possible misclassification of skill-intensive and labour-intensive exports.

Although the inclusion of demand-side influences did not improve the composition-of-manufactured-exports model, there was some improvement in the models explaining the composition of exports as between manufactures and primary goods. The increased significance of FEMSHARE in regressions (7a) to (7c) suggests that, when demand-side influences are controlled for, educating more females does give countries more of a comparative advantage in manufactured goods.[15]

IV. Conclusions and further research

Overall, the cross-country regressions give only weak support to the view that manufactured exports depend more on the education of women than of men. Some of the results show a significant relationship in the expected direction (particularly when we control for demand-side influences), but many are insignificant or have the wrong sign. The weakness of the results is surprising, given the case-study evidence of the predominance of female workers in labour-intensive manufacturing for export.

There are two alternative interpretations of these findings. Firstly, a country's supply of educated women is truly more important in determining its export performance than its supply of educated men, but collinearity in the data makes it impossible to isolate this effect. We cannot be sure whether the effect is due to the gender gap or to the overall level of human resources. Alternatively, the lack of significance of the gender-gap variable could indicate that the underlying hypothesis is false: that the gender composition of a country's human resources has little or no impact on its exports.

In principle, collinearity might be less of a problem if we had a larger sample. For each ratio of human to natural resources we might then have more variation in the proportion of females in total human resources. (See Figure 2 for the scatter of FEMSHARE against hr/nr.) In practice, however, we cannot increase the sample size. Moreover, even if we could do so,

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15. The low significance level and relatively unstable coefficients on hr and FEMSHARE underscore the tentativeness of these results. In the labour-intensive manufactured versus primary exports model (c) the inclusion of FEMSHARE still leaves the coefficient on hr insignificant.

Fig. 2 Female schooling and resources
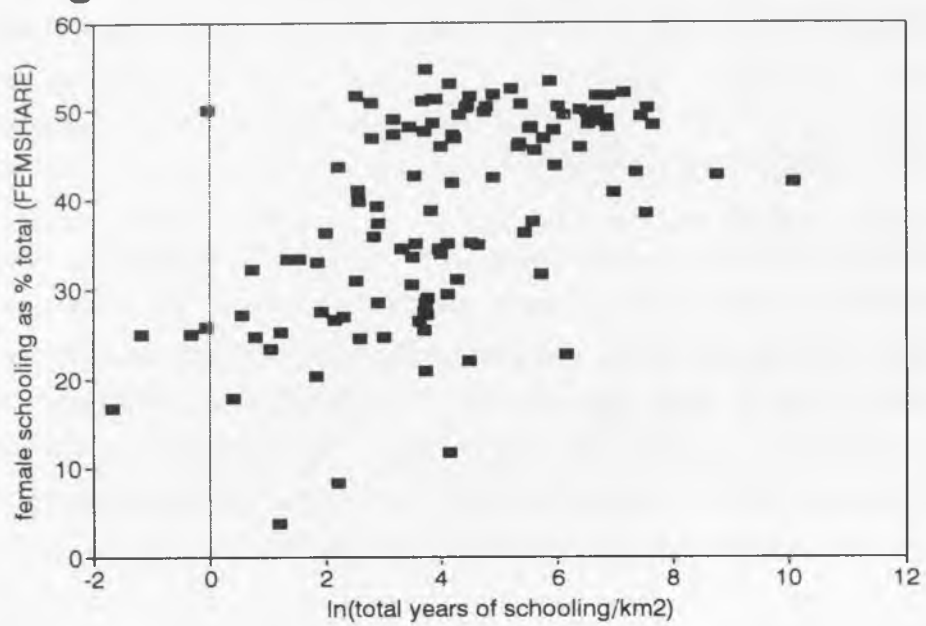
there are good reasons for believing that the problem would not be much reduced: the collinearity between overall education and the male-female gap is not coincidental, but largely the result of both variables being influenced by national attitudes, culture and politics.

Why might the gender composition of human resources not matter for exports, contrary to the findings of the case study literature? One possible reason is that developing-country manufactured exports are less female-intensive than the case studies suggest. Most of these studies draw their findings from export processing zones, and there are few if any data on the employment of women in developing-country export-oriented manufacturing as a whole.[16] A second possible reason for the insignificance of the gender-gap variable is that there are large differences in the female-intensity of particular industries across countries. This may not have been picked up by the case studies, which have focused mainly on the East Asian and Latin American NICs.[17]

The current state of the evidence on the importance of female education for export-oriented manufacturing is thus unsatisfactory: case studies which say it is important, cross-country regressions which say maybe not. The most appropriate direction for further research is thus probably the analysis of data at a level intermediate between the case studies and the cross-country regressions. In particular, it would be well worth examining national data from household or labour force surveys, which provide full coverage of all workers and sectors in a country (unlike the EPZ studies), linked up with trade data on each sector's exports. This should ideally be done for a representative selection of countries (developed as well as developing).

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16. Although women make up about 80% of the labour force in EPZs, these zones employed only about 1.9 million workers in the mid-1980s. By comparison, multinational corporations employed 7 million workers in developing countries, approximately 20 percent of whom were women (Kreye et al. 1985: 15). (According to the same source, approximately 70% of MNC production in developing countries was in manufacturing.)

17. Intra-regional comparisons would be revealing in this respect. It may be inappropriate to include African and East Asian countries, with drastically different human to natural resource ratios, in the same regression.

In addition to cross-country comparisons using the intermediate-level data, it might also be illuminating to see how the female intensity of sectors evolves over time within countries as their trade patterns change. For example, do sectors which were previously male-intensive become female-intensive as export opportunities increase?[18] It is possible, among other things, that rapid *change* in the female intensity of developing-country exports is taking place (as Wood 1991 found) which is not yet fully reflected in *levels*. In other words, countries with well-educated women may be in the process of increasing their manufactured exports, but for most countries this linkage is still not a major influence on exports.

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18. Preliminary evidence for this is provided by Joekes (1982) for Morocco and Hossain et al. (1990) for Bangladesh.

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