



OECD DEVELOPMENT CENTRE

Working Paper No. 149

(Formerly Technical Paper No. 149)

ECONOMIC OPENING
AND THE DEMAND FOR SKILLS
IN DEVELOPING COUNTRIES:
A REVIEW OF THEORY AND EVIDENCE

by

David O'Connor and Maria Rosa Lunati

Research programme on:
Reform and Growth of Large Developing Countries



TABLE OF CONTENTS

RÉSUMÉ	5
SUMMARY	6
PREFACE	7
I. INTRODUCTION.....	8
II. SKILLS: MEASUREMENT ISSUES AND METHODS	11
WAGE AND WAGE SHARE STUDIES	11
MAPPING CHANGES IN THE SKILL COMPOSITION OF EMPLOYMENT	13
III. TECHNOLOGY, CAPITAL AND SKILLS	15
TECHNOLOGY–SKILL COMPLEMENTARITY	15
CAPITAL–SKILL COMPLEMENTARITY	21
LABOUR MARKET EQUILIBRIUM	23
IV. OPENNESS AND SKILLS DEMAND IN DEVELOPING COUNTRIES	26
NEW GROWTH THEORY AND CONDITIONAL CONVERGENCE	26
EXTENSIONS OF THE STANDARD TRADE MODEL	29
TECHNOLOGY DIFFUSION MODELS	31
EDUCATION, ENTREPRENEURSHIP AND OPENNESS	35
V. POLICY IMPLICATIONS	38
NOTES	41
BIBLIOGRAPHY	45
OTHER TITLES IN THE SERIES/AUTRES TITRES DANS LA SÉRIE	51

RÉSUMÉ

La dynamique du développement entraîne une réaffectation de la main-d'œuvre d'activités à faible productivité vers des activités à productivité plus élevée (généralement plus intensives en capital et exigeant le plus souvent des compétences supérieures). L'accroissement de l'offre de main-d'œuvre qualifiée qui accompagne la hausse des revenus par habitant est à la fois cause et conséquence de cette évolution de la demande de compétences. Sur la longue durée, si l'offre et la demande de compétences progressent à un rythme comparable, le revenu supplémentaire associé aux qualifications reste stable. Mais sur des périodes plus courtes, les décalages inévitables entre l'offre et la demande peuvent se traduire par une hausse ou un effondrement de ce gain différentiel.

Une réforme des politiques, comme la libéralisation des échanges, peut accélérer l'évolution structurelle de l'économie, influant de manière exogène sur la demande relative de facteurs. Dans certains pays en développement, il peut en résulter un accroissement de la demande de compétences lié à l'adoption de nouvelles technologies étrangères, ainsi qu'à un abaissement du coût des équipements de production importés. L'influence sur la demande peut être permanente ou seulement temporaire, mais dans tous les cas il est probable que l'offre de qualifications devrait augmenter en réaction à une rémunération plus attractive. Toutefois, si l'accès à l'éducation est fortement biaisé au départ, l'ajustement de l'offre de main-d'œuvre qualifiée peut prendre du temps, amplifiant du même coup les inégalités de revenus liées aux compétences pendant la période de transition.

Plus inquiétant est le cas des pays dans lesquels l'ouverture des échanges et des investissements n'entraîne pas un accroissement de la demande de compétences. Si la technologie et les capitaux étrangers disponibles grâce à cette ouverture se présentent comme des compléments aux compétences, ils ne se dirigeront pas en priorité vers les pays à faible main-d'œuvre qualifiée. Il est même possible que, dans certains pays à faibles revenus, les individus aient encore moins intérêt à acquérir des compétences suite à la libéralisation. Une telle évolution peut être interprétée d'un côté comme une réduction bienvenue des inégalités de revenus ; mais elle peut aussi être vue comme une réduction regrettable des incitations à investir dans l'éducation. Dans la mesure où une diminution des investissements dans l'éducation aujourd'hui se traduit par un abaissement des niveaux de revenu par habitant et par un ralentissement de la croissance demain, la libéralisation devrait être accompagnée par des initiatives des pouvoirs publics visant à renforcer les incitations à se former pour les individus. Conséquence négative de ce processus : les pays concernés par ce type de mesures d'accompagnement compteraient vraisemblablement parmi les plus pauvres et leur gouvernement manque des ressources indispensables pour investir davantage dans l'éducation (d'où l'importance de l'aide étrangère dans ce secteur). Mais l'aspect positif du même processus est qu'une réduction des inégalités de revenu devrait permettre aux ménages pauvres de ces pays d'offrir plus facilement une formation à leurs enfants, dans l'hypothèse d'un maintien des incitations financières.

SUMMARY

A basic feature of development dynamics is the reallocation of labour from low-productivity to higher-productivity activities (generally more capital-intensive and also often more skill-intensive). The expansion of skilled labour supply that accompanies rising per capita incomes is both cause and effect of this shift in skills demand. Over long periods, if skills supply and demand grow apace, skill premia would show little secular change; over shorter periods, however, inevitable lags may show up as growing or shrinking premia.

A policy reform like trade liberalisation can accelerate structural change in an economy, causing an exogenous shift in relative factor demands. For some developing countries, the result may be an increase in skills demand associated with the adoption of newly available foreign technology and lower cost imported capital goods. This demand shift may be permanent or only temporary, but in either case the skills supply should eventually increase in response to higher returns. One concern, however, is that with an initially highly skewed distribution of education the skilled labour supply adjustment may be prolonged; likewise any transitional increase in skill-based wage inequality.

Of greater policy concern are those countries where trade and investment opening is not associated initially with an increased demand for skills. If newly accessible foreign technology and capital are skill complements, they will not flow readily towards countries where skills are scarce. It is even possible that, for some low-income countries, individual returns to skill would decline *post* liberalisation. What — from one perspective — might be viewed as a welcome reduction in earnings inequality could — from another perspective — be seen as an unwelcome reduction in the incentive to invest in education. Insofar as reduced educational investments today imply lower future *per capita* income levels and perhaps slower long-run growth, liberalisation measures may need to be accompanied by special government efforts to bolster individual educational incentives. On the negative side, the countries where such efforts are required are likely to be among the poorest countries, where governments lack the necessary domestic resources to augment educational support (hence, the importance of foreign assistance to education). On the positive side, reduced income inequality may better enable poor households to afford education for their children, assuming the financial incentives are maintained.

PREFACE

This study reviews and establishes connections between two parallel strands of theoretical and empirical literature: the one examining the relationship between economic opening and the return to skills, and the other examining the relationship between human capital and growth.

The importance of educational and other investments in human capital to a society's welfare is now taken for granted. Apart from enhancing the quality of life and allowing more meaningful participation of people in the political process, education is now understood to be an important contributor to a country's income-generating potential. Yet, not all countries derive comparable benefits from their investments in education. Educational attainment has been rising secularly in the developing world, yet growth performance varies widely across countries and regions. Clearly, if education is necessary, it is not sufficient for strong growth.

Efforts to explain divergence in growth performance across countries over the last several decades often identify policy variables like trade openness as major factors differentiating high from low growth performers. Yet, as important as economic openness is to growth, it too may not be sufficient on its own to sustain high growth. The numerous studies based on cross-country growth regressions have not yet adequately demonstrated what it is about openness that promotes growth. One potentially significant factor is that openness makes possible a more rapid diffusion of technologies from the more to the less advanced countries. This is where the level of education (and skills more generally) of the labour force enters the picture, since the effective absorption and utilisation of the technologies made available through trade and foreign investment depend importantly on the supply of skilled labour. In short, the new technologies and capital goods imported from abroad tend to be strong skill complements.

For labour-abundant, low-income countries, the normal process of specialisation attendant on trade liberalisation tends to favour relatively unskilled-labour-intensive goods and processes. In order for these countries not to be relegated indefinitely to producing such goods, they need to sustain investment in educating new labour force entrants. The costs of failure to anticipate the growing demand for skilled labour as countries begin to climb the "quality ladder" is evident in a country like Thailand, where the period of economic boom from the mid-1980s to mid-1990s witnessed a marked widening of income inequality. Other countries would do well to take heed.

This study was undertaken as part of the Development Centre's 1996-98 research project on Skills and Economic Opening, under the Programme on "Reform and Growth of Large Developing Economies".

Ulrich Hiemenz
Director for Co-ordination
OECD Development Centre

June 1999

I. INTRODUCTION*

There has been much debate among trade and labour economists in the last several years on the importance of trade with developing countries in explaining growing wage inequality in the United States and certain other OECD countries (see Cline, 1997, for an excellent review of that literature). Much less attention has been focused on the other side of the coin, viz., trade's impact on the relative wages of skilled and unskilled workers in developing countries. This is perhaps to be expected, as the standard neoclassical trade theory predicts that, in augmenting relative demand for their abundant factor — unskilled labour, trade opening should reduce wage inequalities in those countries. Thus, its distributional consequences could safely be ignored.

Recent empirical evidence on relative wages of educated workers, notably in Latin America, suggests this conclusion may be premature (Robbins, 1996). For some countries at least, the recent past has seen a widening of education-based wage differentials, even as these countries have opened up their economies more widely to international trade and capital flows. Is this anything more than coincidence? In our view, it could well be. In piecing together what we think is a plausible explanation for the apparent anomaly between the predictions of the standard trade theory and at least some empirical evidence, we have had to draw upon a number of different literatures and modelling approaches. In that sense, what emerges is an eclectic theory of trade-skill (and foreign investment-skill) linkages in developing countries — not a formal mathematical model but rather a descriptive model in the tradition of what Nelson and Winter (1982) call “appreciative theorising”.

The logic of our analysis can be stated simply. An integral part of the process of economic development is the reallocation of labour from low productivity to higher productivity sectors (the Syrquin effect), normally accompanied by a process of capital deepening. If capital is complementary¹ with skilled labour, this reallocation raises the return to skills and encourages greater investment in human capital. Over time, both the demand for and the supply of skilled labour tend to grow in parallel, albeit with lags. The liberalisation of an economy to foreign trade and investment represents a discrete policy shift (or shock) that can alter this “balanced growth” relationship. In the simplest (one-cone, 2x2x2) version of the neoclassical trade model, where the two factors are skilled and unskilled labour, following trade liberalisation the skill-scarce country/region will experience an increase in the relative price of unskilled-labour-intensive goods and in the relative wages of unskilled workers [the HOS (Heckscher-Ohlin-Samuelson) effect].

What if we were to introduce greater complexity by relaxing some of the assumptions of this model? For instance, suppose that the two regions differ in their technology levels within any given sector and that trade liberalisation facilitates technology diffusion from the more advanced to the less advanced trading partner. Then, what effect this has on the relative demand for skills in the latter depends on the skill-intensity of the imported technology relative to that currently in use. There is fairly strong empirical evidence of skill-biased technical change in the developed countries, induced in part by growing skill abundance. While those countries do not necessarily transfer their most advanced technologies to developing countries, it seems reasonable to assume that the technologies

transferred are relatively skill-intensive. Also, if capital is treated explicitly as a productive factor, it seems reasonable — based on available empirical evidence — to treat it as a skill complement. Many of the newly available, or newly cheap, foreign technologies are embodied in capital equipment and intermediate goods that in turn make up the bulk of incremental developing country imports following liberalisation. If, as seems likely, liberalisation lowers the domestic prices of capital goods in developing countries, it should also contribute to capital deepening. Capital deepening combined with greater reliance on imported capital equipment and technology would tend to augment the relative demand for skilled labour. Thus, this set of effects runs counter to the HOS effect noted above. In short, even as resources shift towards unskilled-labour-intensive sectors, the degree of skill intensity (and capital intensity) tends to increase within each sector (more than it would have in response to a change in relative wages alone). If the technology and capital deepening effects are sufficiently strong, the returns to skilled labour could rise not fall. This is one possible explanation of the observed wage trends in some developing countries. Depending on initial income distribution and the magnitude of any changes, this may pose a more or less serious policy dilemma to governments concerned with social equity. Given already high inequality in Latin America, any further widening of wage differentials could pose particular political challenges there.

Another possibility arises once we allow for learning-by-doing within sectors and knowledge spillovers across sectors (or products). Then, following Stokey (1992) and Young (1992), if technologically advanced sectors offer more opportunities for both, and also require more skilled workers, trade liberalisation might cause skill-scarce countries/regions to specialise in products with few learning opportunities and spillover effects, thereby reducing the returns to human capital. This is a variant of the standard HOS effect, but with the addition of a dynamic dimension whereby fewer knowledge spillovers implies lower long-run economic growth. If, in addition, the extent of technology diffusion via trade between rich and poor countries is a positive function of the latter's human capital endowment (hence, absorptive capacity), then the skill-scarce country is further handicapped and there is little or no offsetting effect from this source on the returns to human capital. Ultimately, the question of whether in some countries economic opening reduces the returns to investment in human capital is an empirical one, as is the question of what this implies for long-run growth performance. (At present, more is known about the latter than the former.) If these effects should prove significant in some low-income developing countries, they carry an important policy message — viz., that their governments may need to reinforce support measures for education to offset any negative effect on returns to human capital investment arising from liberalisation. Since technological dynamism is crucial to ensuring the growth in learning opportunities — hence the demand for human capital — over time, maintaining an outward-oriented, liberal policy stance is also crucial.

This paper reviews the theoretical and empirical literature bearing on the question of how trade and investment liberalisation may affect the demand for (and returns to) skill in developing countries. Apart from some limited analysis of the changing relationship between computer use and income per capita across countries, it contains no original empirical work. It is organised as follows. The next section briefly reviews some definitional and measurement issues in the study of skills and skill-based wage differentials. Then, given the important role played by capital-skill and technology-skill complementarity in our analysis, evidence of these is reviewed in section III, both for the OECD countries (where

it is abundant) and for developing countries (where it is sparse). This section also discusses the dynamics of labour market adjustment to an exogenous shift in the demand for skilled labour. Section IV then reviews evidence in support of the claim that greater economic openness² may have caused such a demand shift in developing countries through induced capital deepening and/or technological change. Because of the importance of self-employment in many developing countries, it also considers how economic openness may affect the returns to education in entrepreneurship. Section V concludes with some policy reflections.

II. SKILLS: MEASUREMENT ISSUES AND METHODS

There are two broad approaches to the analysis of work-related skills, viz., to treat them as attributes of individuals or as requirements of jobs. (The distinction acquires significance in the presence of labour market frictions, where the matching of individuals to jobs becomes an issue.) The literature seeking to explain skill-based wage premia almost exclusively adopts the first approach (identifying supply and demand side determinants of wage changes of different groups of individuals — e.g., those with a certain level of education). A related set of studies seeks to explain changes in the wage-bill share (including both price and quantity effects) of “skilled” workers — generally defined by occupational group. The second approach examines directly the changing skill mix of the labour force, identifying within and between occupations as well as within and between industry shifts. While allowing a richer representation of skills than in the first approach, such workforce composition studies tend to be merely description, offering few insights on their own into the economic forces driving compositional shifts.

In most instances, the first type of study makes use of indirect measures of skill, with education and experience variables assumed to capture the principal dimensions of skill. Individual ability (or talent) goes unmeasured, with its importance reflected in the size of the residual in Mincer-type wage regressions. The standard education variable (years of schooling) is clearly less than satisfactory as a measure of cognitive skills, since it assigns the same value to all individuals reaching a given level of education, irrespective of performance. Where educational standards are fairly uniform and are strictly enforced throughout the area of study, this may not pose a serious problem, but this seems unlikely to be the case in many developing countries. Where more direct measures of cognitive achievement are available (e.g. in the form of standardised test scores), they may provide a more satisfactory measure of at least one type of skill than does education *per se* (see Bossiere *et al.*, 1985, for an interesting example of this approach applied to Kenya and Tanzania).

Wage and Wage-share Studies

Those studies examining wage differentials and returns to skill normally make use of population surveys (e.g., Mincer, 1991; Katz and Murphy, 1992; Juhn *et al.*, 1993; Davis, 1992, for the United States and some other countries), which contain data on years of schooling and of work experience as well as a variety of other individual characteristics. Wage-bill share studies (e.g., Berman, Bound *et al.*, 1994) rely on manufacturing survey/census data, in which workers are classified by occupation and these in turned are grouped into skill categories. A common distinction is made between “blue-collar” and “white-collar” occupations or, alternatively, between production workers and non-production workers. In either case, the former category is generally assumed to be “low-skilled” and the latter “high-skilled”³. The limitation of this approach is evident, viz., the imperfect correspondence between these dichotomies and the “skilled/unskilled” dichotomy. Some studies have provided a finer parsing of the categories — e.g., Colecchia and Papaconstantinou (1996) distinguish between the high-skilled and low-skilled for both white-collar and blue-collar workers.

Studies that seek to explain trends in relative wages of skilled and unskilled workers must deal with the problem that observed wages are simultaneously determined by supply and demand. Thus, wage trends alone are insufficient to indicate what is happening to skills demand. Even if the relative demand for skilled workers were increasing, their relative wages might be constant or falling if the relative supply of skilled workers were increasing fast enough (as appears to have been the case, e.g., in the United States during the 1970s). Empirically, it is necessary first to identify the relative supply curve to be able to estimate the effect of demand shifts on relative wages.

Wood (1998) observes that, over much of the last century, the relative demand for and the relative supply of skilled labour in developed countries have tended to rise in unison and by roughly similar magnitudes, suggesting a possible interaction between them. One explanation of such interaction, formalised in Machin and Manning (1997), posits imperfect labour markets characterised by search costs for both employees and firms, so that an increase in the supply of a particular type of labour leads to an increase in the proportion of firms offering jobs requiring the particular skills they possess, thereby lowering search costs and increasing demand for such workers. Acemoglu (1998) proposes another sort of dynamic, according to which an expanding supply of skilled workers lowers the relative costs of skill-intensive technologies, inducing skill-biased technical change⁴. If skills supply in effect creates its own demand, as these two models suggest, then disentangling the two sources of influence on wages becomes even more difficult.

Most of the empirical studies of skills premia assume well functioning (i.e., frictionless) labour markets and independently identified labour supply and demand curves (i.e., no induced, factor-biased technical change⁵). The studies for the United States fairly consistently find the following trends: *a*) the returns to education and the returns to experience have both been rising, the latter more persistently over a longer period; *b*) after falling in the 1970s, educational premia have been rising rather steeply since the early 1980s; and *c*) wage differentials have been widening even among people with similar educational attainment and work experience. They also generally find that, while the shift of labour demand between industry-occupation cells explains a significant share of rising wage inequality, the more significant factor has been intra-sectoral shifts in skills demand (a combination of shifts in the job mix within broad occupational groups and skill upgrading of specific jobs). Most attribute this phenomenon to skill-biased technical change (SBTC) and some actually test for this (see next section).

One of the few examples of a relative wage study employing a direct measure of cognitive skills is Murnane *et al.* (1995). Using mathematics test scores⁶ as their skills measure, they examine whether cognitive skills have a significant effect on earnings six years after high school graduation. By comparing two cohorts of high school graduates (1972 and 1980), they are able to test whether the returns to cognitive skills have changed significantly over time. Their findings are that a very substantial part of the increase in the college/high school wage premium, 1978–86, represents an increase in the return to cognitive skills, a result consistent with the work of Wolff (1996) discussed below.

The analysis of returns to skills in developing countries faces the same simultaneity problem as in OECD countries, compounded by data deficiencies. Also, given different starting points, labour market dynamics in the former countries may be rather different from those in the latter. On the demand side, the faster an economy's growth, the more rapid its structural transformation and the associated reallocation of labour across sectors⁷. That having been said, the change in sectoral GDP shares generally occurs more rapidly

than the change in sectoral employment shares thanks to differential sectoral productivity growth. The latter in turn is partly a result of different sectoral capital–labour ratios. On the supply side, starting from a smaller base than in OECD countries, educational attainment tends to rise at a faster rate in developing countries, especially where *per capita* income growth is strong. For the most part, though, rising educational attainment is expanding the ranks of primary and secondary school leavers, not of college graduates as in the OECD countries. In short, as in OECD countries, so in developing countries, skills supply and demand could be expected to expand in parallel — though clearly with leads and lags — in the course of economic development. Thus, for both groups of countries, the question concerning trade and investment opening is whether recent liberalisation measures and accelerated economic integration have caused a significant departure on one but not the other side of the labour market from this historic trend.

Mapping Changes in the Skill Composition of Employment

Another group of studies takes a more direct approach to measuring changes in the skill composition of the labour force (without attempting to explain labour market outcomes for individuals) — viz., using quantitative skill indices of specific occupations listed in the US government’s *Dictionary of Occupational Titles* (DOT). This source contains skill descriptions and ratings for hundreds of occupations, and Rumberger (1981) and Wolff (1996) make use of it to examine changes in the skill structure of the US economy. While the Rumberger study was too early to provide insights into the 1980s rise in earnings inequality, the Wolff study finds, in contrast to most wage studies, that much of the growing demand for skills can be attributed to inter–industry shifts (hence, perhaps to sector–biased but not to pervasive SBTC).

Rumberger (1981) examines the evolution of skill requirements over the period from 1960 to 1976. Using a single measure of skill — viz., the GED (General Educational Development) level required to achieve average performance in a particular job — he is able to show both broad patterns of occupational skill requirements [e.g., professional workers are much more heavily represented in the top two (out of six) GED levels than are labourers] and also the rather imperfect match between specific occupational groups and broad skill classifications like “high–skilled” [e.g., over half of managerial jobs require only middle–level skills (GED levels 3 and 4), but in most wage studies managers are simply classified as skilled workers; moreover, craft “blue collar” jobs in general have higher skill requirements than clerical and sales “white collar” jobs].

Combining his estimates with those of Eckaus for 1940 and 1950, Rumberger concludes that there has been a steady increase in the educational requirements of jobs in the US economy since 1940: overall, average GED levels of jobs (in educational equivalents) increased 18 per cent over the period, with the largest increase occurring between 1950 and 1960. The Rumberger results confirm those of other studies which suggest that the upskilling of the US labour force is a long–term phenomenon. Those studies that have updated the story (though not always with the same methodology) suggest that the most recent period of rising wage inequality (essentially since the early 1980s) may not even have been the period of the most dramatic change in skill levels.

Rumberger’s focus on education–linked skills is broadened in Wolff (1996), who examines (in addition to GED) three other DOT skill categories: motor skills, interactive skills, and cognitive skills (or substantive complexity). While the last is closely linked to

educational attainment, the first two are less so. They may also be imparted through formal vocational training, on-the-job training and work experience. Studying the period from 1950 to 1990, Wolff finds that of the different types of skill the demand for cognitive skills grew most rapidly over the entire period, but with growth peaking in the 1960s and slowing subsequently. Interactive skills were the only type to experience rapid growth after the 1960s, with 1980s growth of roughly similar magnitude to that of two decades earlier⁸. From the 1970s onward, motor skills experienced declining demand at an accelerating rate. Wolff decomposes changes in the skills mix into intra-industry occupational shifts (attributed to technological change) and shifts in the inter-industry distribution of jobs (attributed to demand shifts)⁹. In the case of cognitive and motor skills, the changes 1950–90 are about equally attributable to the two causes, while two-thirds of the change in demand for interactive skills comes from within-industry shifts towards occupations intensively using such skills. In the decade of the 1980s, on which most of the wage inequality studies focus, the story is somewhat different: the bulk of the change in skills demand, for cognitive and interactive skills (which increased) and for motor skills (which decreased), was attributable to inter-industry demand shifts not to intra-industry occupational shifts. This is consistent at least with a trade explanation of changing skills demand in the OECD area.

What emerges from most studies, whatever their approach, is evidence of a shift in the relative demand for skilled labour (reflected in rising returns to both education and experience) and, in particular, in the demand for cognitive (and, where studied, interactive) skills. There is still no consensus among economists on the relative importance of various causes, with those finding skill-biased technical change (SBTC) to be the primary cause confronted with mounting evidence of trade's importance (and the two together still leaving a significant share of the increase in wage inequality unexplained). In any case, as discussed below, trade's effects and technology's effects cannot be so easily separated.

What are the implications for developing countries? On the one hand, growing trade and investment links with developed countries may serve to transmit to developing countries the former's apparently growing (cognitive) skill bias. As Acemoglu (1998) argues, the capital goods and technologies transferred through trade with OECD countries are likely to be more skill using than locally available ones, having been developed in an environment where skills (notably cognitive ones) are relatively abundant. On the other, shifting patterns of specialisation associated with economic integration between the two groups of countries may well have contributed to the observed decline in demand for motor skills in the former (with manufacturing's declining employment share and new technology's substitution for such skills); if so, the same forces may be increasing relative demand for motor skills in developing countries (though for the moment this is mere speculation).

III. TECHNOLOGY, CAPITAL AND SKILLS

What lies behind the increasing relative demand for skills noted in the previous section? Most explanations refer to “technology–skill” and/or “capital–skill” complementarity¹⁰. Conceptually, the two are different, with the first referring to the factor bias of technical change and the second referring to substitution elasticities between factors for a given technology. Empirically, the two can be difficult to distinguish since a factor–biased technical improvement is often effected through new capital investment¹¹. As Howitt and Aghion (1998) observe, “just as capital accumulation cannot be sustained indefinitely without technological progress to offset diminishing returns, so too technological progress cannot be sustained indefinitely without the accumulation of capital to be used in the R&D process that creates innovations and in the production process that implements them” (p. 112).

Technology–Skill Complementarity

When speaking of technology–skill complementarity, it is useful to distinguish between the innovation process and the implementation (or adoption) process. In the former, currently — if not always historically — highly educated scientists and engineers play a rather critical role. Much of this innovation still occurs in OECD countries, as is evident for example from patent data. In the latter, developing countries are also active participants. It seems intuitively plausible that different levels, if not types, of skill are needed to master the two processes, though little empirical evidence exists on this question. One possibility is that, while innovation depends primarily on high educational attainment, implementation depends more on “learning–by–doing” (though with some level of education presumably as prerequisite).

Nelson and Phelps (1966) were among the first to propose a model in which technology and education (in effect, cognitive skills) are complements, so that the rate of return to education is greater the more technologically dynamic is the economy. In their words, “educated people make good innovators, so that education speeds the process of technological diffusion” (p. 70). Formally, the higher the level of human capital, the narrower the gap (at any point in time) between the state–of–the–art technology and the average technology in use. Moreover, if an economy is characterised by technological stagnation, the returns to education may be non–existent.

The Evidence for OECD Countries

Goldin and Katz (1996) find strong evidence of technology–skill complementarity in US manufacturing dating to the early 20th century. They argue that this was caused initially by the transition from the factory system of the late 19th century (in which capital and unskilled labour were complements) to continuous process and batch production, reinforced by the widespread diffusion of electric motors¹² (and the associated increase in demand for skilled technicians to maintain costly equipment subject to greater wear and tear). Case studies of several manufacturing industries affected more recently by the introduction of new process technologies also point to a significant increase in the demand for skilled maintenance technicians and engineers. For instance, in their study of an automobile

assembly plant, Milkman and Pullman (1991) note that the introduction of new, technologically complex machinery increased demands on the plant's skilled maintenance staff.

Examining the automation of machine shops, Attewell (1992) notes a number of factors that appear to have contributed to the "upskilling" of jobs: an increase in the importance of maintenance skills for automated equipment; a shift from manually guiding machines to monitoring by sight and sound; overseeing several machines that work simultaneously; an increase in the complexity of forms cut and tighter tolerances made possible by the new machines; an increase in responsibility, since operator negligence or sloppiness could cause costly damage to expensive equipment.

Other studies find evidence of "skill levelling", whereby technological change reduces demand for both highly skilled and unskilled workers relative to those in the intermediate skill range. This appears to be consistent with the pattern of evolving skills demand observed by Rumberger (see above). In a study of the diffusion of numerical control (NC) technology in the US machine tool industry (1975–83), Keefe (1991) concludes: "The spread of microelectronics appears ... to have left machine shops unchanged in many respects: it remains noisy, often boring, and slow-changing though a little less stratified by skill level and somewhat more socially interdependent".

Penn *et al.* (1994) find evidence for the United Kingdom in the 1980s of increased skills demand associated with technical change, though the patterns of skill evolution are generally too complex to be captured by the simple phrase "upskilling". In a number of instances, moreover, technical change does not appear to have been accompanied by any significant change in the level of skill required of broad classes of workers. Their results suggest that the introduction of computers and microelectronics-based technologies has been a significant contributor to the demand for new skills, and that — within manufacturing establishments — computer diffusion has occurred more widely in white-collar jobs than on the shop floor. Production work is more often characterised by semi-automation than full automation¹³.

Based on a comparative study of matched manufacturing industries and establishments in several European countries, Prais (1995) concludes that a major explanatory factor of productivity differences is "inter-country differences in the ability to maintain complex machinery in efficient running order" (p. 61), which in turn depends on the skill level of the workforce¹⁴.

Some studies examine statistically the relationship between technological innovation and skills demand. For instance, Berman, Bound and Griliches (1994) find a significant positive relationship between R&D intensity and change in skills demand across US industries (as measured by the non-production workers' share in the wage bill); they find a similar relationship between the share of computers in a sector's total investment and changes in its demand for skilled workers. Chapman and Tan (1992) find, for Australia, that the returns to on-the-job training of young workers are greatest in those industries with the highest rates of total factor productivity (TFP) growth. Allen (1991) finds similar results for the United States. A number of studies focus specifically on the role of computer technology in shifting outward the demand for skilled labour. Analysing US data, Autor *et al.* (1997) find evidence that a significant portion of the increased skill premium during the 1980s and of the increased wage share of educated workers since 1970 can be explained by the more rapid spread of computer technology. While computer diffusion on a large scale began during the 1970s, the rapid expansion of the educated workforce

during that decade dampened growth in wage differentials. While Autor *et al.* find some evidence of overall capital–skill complementarity in manufacturing, capital investment specifically in computers and related equipment is strongly associated with within–industry skill upgrading. Moreover, this within–industry upgrading is not confined to manufacturing; indeed, it appears to have occurred first in certain information–intensive service industries (like financial services) (Wolff, 1996).

Berndt *et al.* (1992) find evidence, for US manufacturing, of capital–skill complementarity and, in particular, “high–tech” capital–skill complementarity (as proxied by the share of computer and office machinery in total capital stock). Analysing results of a US Bureau of Census survey of 10 000 manufacturing establishments, Dunne and Schmitz (1992) report that non–production workers’ share in total employment was 2.5 percentage points higher in establishments using three or more advanced (computer–based) technologies than in those using none. Haskel (1996) examines various hypothesised causes of rising wage inequality in the United Kingdom, concluding that computer introduction can explain around one–half of the increased skill premium in manufacturing over the 1980s.

For the most part, these econometric studies do not offer an explanation for the computer–skills link. Others have ventured tentative explanations, of which Bresnahan (1997) is one of the more elaborate. He maintains that one of the most significant impacts of computer–based technologies has been the substitution of machine decision making for human decision making in low– and medium–skilled white–collar work. At the same time, the strategic, organisation–wide application of computer–based innovations has raised the demand for highly–skilled workers, principally but not only to implement the organisational changes needed to reap the full productivity benefits of computer technologies. In this view, the increased demand for skills encompasses not only cognitive skills associated with formal education but also interpersonal skills, which would help explain the trends observed in Wolff (1996) and discussed above.

Levy and Murnane (1996) take a micro approach to analysing the effect of computers on skills, looking at the operations of one unit of a bank that offers custodian services for mutual and pension funds. Noting Spenner’s (1990) decomposition of skill changes into those from a shift in the mix of occupations and those from a change in skill content of individual occupations, they find little evidence of either. Computers have contributed to a rapid expansion in the financial services industry, including a proliferation of mutual funds. Thus, this bank unit’s business has grown rapidly during the 1980s, causing a quadrupling in its staff of accountants. All new hires, moreover, were college graduates¹⁵. Levy and Murnane argue, though, that the tasks performed by these accountants, before and after computerisation, are essentially the same. So, whatever the reasons for hiring exclusively college graduates, increased skill demands of the job do not appear to be an important one. They go on to speculate that, given the high rate of job dissatisfaction (as indicated by high quit rates) and the lost in–house training investments these imply, the bank may decide that a more thorough job redesign is needed to be able to retain its highly educated workforce. If so, this is consistent with Bresnahan’s view that realising significant productivity gains from computerisation may depend on extensive organisational change.

Lindbeck and Snower (1996) present a formal model of organisational changes associated with computerisation, linking these to growing wage inequality. In their view, by permitting the low–cost manipulation of large quantities of information, computer technologies have shifted the terms of the trade–off between task specialisation and multi–

tasking. Organisations where the informational externalities from multi-tasking (i.e., where a worker can use the information and skills acquired at one task to improve his/her performance at another) are sufficiently large are transforming themselves from Tayloristic (single task per person) type organisations to holistic (multi-tasking) organisations. For those multi-skilled workers whose jobs permit them to exploit these externalities, the rewards are correspondingly higher. The wage gap would tend to widen between them and those still stuck in Tayloristic type jobs. One question raised by this line of argument is what characteristics of firms and industries are good predictors of the likelihood of transformation from one organisational type to the other. For the moment, the empirical evidence in support of this theory of widening wage gaps remains anecdotal¹⁶.

Technology–Skill Links in Developing Countries

Thus far there have been very few studies of technology–skill complementarities in developing countries. Yet, if the historical analysis of Goldin and Katz (1996) and the other analyses cited are correct about OECD trends, then one might well expect similar technology–skill complementarities to manifest themselves in developing countries as they expand and modernise their manufacturing and service sectors, introducing both electrically powered machinery and computerisation on a wider scale. Whereas the electrification and computerisation of industry were sequential processes in the United States and other developed countries, they are likely to occur simultaneously in many late industrialising countries, perhaps accelerating the growth in skills demand and/or causing demand for several different types of skill to grow simultaneously.

Berman *et al.* (1998) examine trends in industrial skills demand (as measured by the employment ratio of non–production to production workers) for a cross section of OECD and other countries over the 1980s. They find a widespread tendency towards rising ratios, including in developing countries. Moreover, they note that the ratio of non–production worker to production worker earnings changed little in these countries despite the strong expansion in the ranks of educated workers. They propose skill–biased technical change as a possible explanation, perhaps induced by technology transfer from the developed countries. A second possibility mentioned is increased capital investment, combined with capital–skill complementarity. In this regard, greater economic openness could increase skills demand in two ways. First, it could increase the share of capital goods imports in total capital investment expenditures (indeed, between 1970 and 1994, the average ratio of equipment imports to gross domestic investment rose by 9 percentage points for a sample of 25 developing countries and by the same amount for OECD countries¹⁷). If the capital equipment supplied by developed countries is more skill–intensive than that locally available, relative demand for skills would rise. Second, if removing trade and investment barriers were to lower the domestic cost of capital, it could result in a higher investment rate. With capital–skill complementarity, this capital deepening would also raise the relative demand for skills.

While the Berman *et al.* study relies on highly aggregated data, other studies make use of micro data sets on firms and industries in developing countries. Tan and Batra (1997) utilise Census of Manufactures data to examine the relationship between measures of technology and skills demand in Colombia, Mexico and Chinese Taipei. Their hypothesis is that skill–based wage differentials result from firms’ technology–generating activities, namely R&D, worker training and exports. Several findings are of interest for our purposes. First, industries tend to divide into two distinct groups, high wage and low wage. The

former include chemicals and pharmaceuticals and various engineering industries (in short, those generally considered more technically advanced), while the latter include various traditional industries like food and beverages, clothing and textiles, leather products, and wood and furniture products (so-called “low tech” industries). Second, firms that invest in technology pay higher average wages than those that do not, with the wage differential larger in the case of skilled workers than unskilled ones. Third, of the three activities mentioned above, higher skill premia are more strongly associated with R&D and training than with exports. This is not particularly surprising, since among the traditional export sectors of these countries are several “low tech” industries. Thus, if trade has a significant effect on technology acquisition and skills demand, it is probably more closely linked to imports (e.g., of capital equipment) than to exporting activities (see discussion in next section).

Rush and Ferraz (1993) provide evidence, from a survey of 132 large Brazilian industrial firms, of a relationship between “Japanese-style” technical and organisational innovations¹⁸, on the one hand, and changes in skills demand, on the other. For example, in each of the five types of activity considered (design, production, planning, quality control, and maintenance), two-thirds or more of firms indicated that innovations would increase their demand for technicians; in the maintenance area, 80 per cent of respondents saw a need for more technicians. Similarly, a very high proportion (consistently over 80 per cent) of respondents indicated that the skills of technicians would need to be upgraded. With respect to “unskilled operators”, a high proportion of respondents (across all types of firms) indicated that this set of innovations would reduce demand, though there was less agreement on whether remaining unskilled workers would require higher levels of skill. Managers indicated that the skill profile of shop-floor workers needed to use new organisational techniques efficiently should include a high level of oral and written skills, which are normally associated with a certain amount of formal education.

A Special Issue of *World Development* (1995) examines the diffusion of “Japanese management techniques” (essentially the same set of methods as in Rush and Ferraz, 1993) in the manufacturing sectors of a range of developing countries. Several of the articles consider the implications of this diffusion for workforce skills. Posthuma (1995) finds that, in a sample of Zimbabwean firms, neglect of the human resource requirements of introducing new techniques can render productivity improvements unsustainable. While low basic education levels of workers may raise firms’ training costs somewhat, they do not appear to prevent effective introduction of these innovations. Sustained improvements in productivity require not only adequate investment in worker training but also financial incentives linked to enhanced job responsibility and performance.

Our own estimates of the cross-country relationship between the density of use of computer technology and per capita income are suggestive of an accelerated diffusion of such technology in lower income countries over the last two decades. Per capita income is indeed a very powerful positive predictor of the density of computer use (measured by MIPS per thousand population), but the size of the coefficient on this variable has declined significantly over time (see Table 1). This is to be expected in view of the steeply declining unit price of computing power. It suggests that, over time, countries at progressively lower levels of income are experiencing (and are likely to experience) rising demand for the skills required to use computer technologies. Still, most developing countries have rather low per capita access to computing power, with India’s computer density (computers per 1 000 population) in 1995 being only 1.5 per cent of the European average (Petska-Juliussen and Juliussen, 1996).

Table 1. Regression Results
Dependent variable: MIPS/'000 persons

	constant	per capita GDP	Adjusted R ²	No. obs.
OLS for 1980	-12.0**	1.25**	0.80	45
OLS for 1989	-7.6**	1.22**	0.87	48
OLS for 1995	-1.6*	1.06**	0.89	48
<i>Panel data estimation</i>				135
<i>1. Pooling</i>		1.18**	0.97	
dummy 1980	-11.46**			
dummy 1989	-7.16**			
dummy 1995	-2.64*			
<i>2. Between (OLS on means)</i>		1.19**	0.86	
<i>3. Within (fixed effects)</i>		0.52*	0.99	
dummy 1980	-8.99**			
dummy 1989	-4.58**			

Notes: MIPS: millions of instructions per second. Both the dependent and the independent variable are in natural logs.

** and * indicate a significance at the 1 per cent and 5 per cent levels, respectively.

The sample includes all OECD countries (except for Iceland, Luxembourg and Germany) and 22 non-OECD countries (Argentina, Brazil, Bulgaria, Chile, China, Colombia, Hong Kong India, Indonesia, Israel, Malaysia, Peru, Philippines, Romania, Russian Federation Saudi Arabia, Singapore, Slovak Republic, South Africa, Thailand, Ukraine, Venezuela).

Source: Our estimations based on data from the *8th Annual Computer Industry Almanac* (1996) and the World Bank Development Indicators data.

In summary, the limited empirical evidence available for developing countries suggests a relationship between technical change and skills demand broadly similar to that documented (by Goldin and Katz, Milkman and Pullman, and others) for the OECD countries. In the former group of countries, technical change is often accompanied by the importation of technologies and capital goods from the latter, where relative skill abundance appears to have influenced the factor bias of innovation. At the same time, the rapidly declining cost of computer power has stimulated diffusion in middle-income developed countries, and future declines in cost should extend computers' reach even in lower income countries. If, as suggested by a number of OECD country studies, computer use is associated with increased demand for cognitive skills, this has potentially significant implications over the longer run for the returns to education in the developing world.

Capital–skill Complementarity

In an extensive review of the literature on labour–demand and factor–substitution elasticities, Hamermesh (1993) concludes that additional education reduces labour–demand elasticity and also the substitutability of capital for labour. In short, the more education a worker possesses, *ceteris paribus*, the less negatively is demand for his/her labour affected by an increase in its own price and the more positively is it affected by a fall in the price of capital.

In the case of the United States, Fallon and Layard (1975) seek to explain why, despite a rapid expansion in the supply of educated labour over this past century, the return to education has remained relatively stable over time. While this had previously been explained by the high elasticity of substitution between educated and uneducated workers¹⁹ (so that a fall in the relative price of the former resulted in a strong shift towards their more intensive use), Fallon and Layard suggest the rising capital–to–GDP ratio, combined with capital–skill complementarity, as an alternative explanation.

In their historical analysis of the US manufacturing sector, Goldin and Katz (1996) provide support for this view. They find fairly strong evidence of capital–skill complementarity beginning early in the 20th century. There is a significant positive relationship, for example, between an industry’s capital–labour ratio in 1909 and 1919 and the educational level of its labour force in 1940 (when the education data series begins). As noted above, they attribute this to two factors: the switch from factory to continuous–process and batch production methods, and electrification and the adoption of unit–drive machines. The latter was greatly facilitated by the falling cost of electricity.

Capital–skill complementarity in manufacturing has a number of dimensions. First, the increased use of expensive machinery in production implies increased costs of machine downtime, hence a higher return to preventive maintenance. This in turn requires skilled technicians²⁰. Second, higher priced capital equipment generally incorporates more sophisticated technology, and more educated labour is often needed to operate that equipment effectively. Third, higher capital intensity is often associated with economies of scale, which can be fully exploited only if a firm has a sufficiently large market. Thus, there is a stronger incentive to engage in marketing and advertising activities in order to increase market share²¹, also a need to manage the generally greater complexity of a large organisation. The first two sorts of capital–skill complementarity imply an augmented demand for skilled blue–collar workers, while the third increases demand for skilled white–collar workers.

Some empirical work has tested separately for general capital–skill complementarity and for complementarity specifically between new capital equipment and skills or, alternatively, between computer investment and skills. In the first vein, Bartel and Lichtenberg (1987) find for the United States that both capital deepening and more rapid installation of newer capital equipment raise the labour cost share of more educated workers (defined as those with 13+ years of education). They argue that the effect of age of equipment on demand for skills reflects the comparative advantage of educated workers in the implementation of new technologies. In the latter vein, Autor *et al.* (1997) examine overall growth in capital investment as well as growth in computer investment as influences on the non–production worker share of the wage bill in US manufacturing. The latter is by far the stronger influence, but separate regressions for three subperiods (1959–69, 1969–79, 1979–89) suggest that general capital–skill complementarity may have increased over

the past 30 years. While they do not propose an explanation, one possibility may be the shifting sectoral composition of capital investment towards “high tech” industries (e.g., semiconductors, computers) that employ highly skilled labour, particularly in research and development and product design.

Using pooled cross–section time–series data, Wolff (1996) regresses specific skill types on a range of explanatory variables, including TFP growth, growth in the capital–labour ratio, measures of computer intensity, and a measure of R&D intensity. The results suggest that the strongest contributor to the increased demand for cognitive and interactive skills is the growth in the capital stock per worker (or new investment). Both computerisation and R&D intensity have a significant positive effect on interactive skills but a less marked effect on cognitive skills. This latter result is somewhat puzzling, especially as regards the relatively weak link between R&D and cognitive skills.

Studies covering shorter periods (usually from the 1970s onward) generally support the Autor *et al.* and Wolff findings of strong computer–skill complementarity and somewhat less marked (but possibly increasing) general capital–skill complementarity.

Denny and Fuss (1983) have done a detailed empirical study of technical change in a single industry (and firm), in this case a telecommunications service provider. They find evidence of strong technological substitution of capital for unskilled labour (overwhelming any effect of their observed price complementarity²²), while capital substituted more weakly for higher levels of skill. Of the four occupational groups considered, only white–collar employees (the highest skill category) experienced a significant wage increase over the period (1952–72), but the dampening effect on demand of this wage increase combined with the weak technological substitution of capital for white collar workers was overwhelmed by the output expansion effect. The authors hypothesise that, with growing firm and market size, operations have become more complex, demanding a larger number of supervisory and managerial personnel.

The micro evidence is thus broadly consistent with the cross–industry evidence of a significant positive link between technical change and rising capital intensity, on the one hand, and the demand for skills on the other. The Denny and Fuss results suggest, however, the importance of distinguishing in empirical work between the effects of growing capital intensity induced by lower costs of capital (for a given technology) and increased capital intensity associated with capital–using technical change.

For developing countries, the evidence on capital–skill complementarity is if anything sparser than that on technology–skill complementarity. It is reasonable to suppose, though, that over the long run similar forces are at work there to those in the more advanced countries. The growth of manufacturing is likely to be accompanied by rising capital intensity, both from technical advance within given sectors and firms and from a shift towards more capital–intensive and technologically advanced industries. The implications for skilled labour demand are likely to be similar to those observed in OECD countries. McMahon (1998) finds for East Asia a strong positive relationship between physical investment rates (investment–to–GDP ratios) and initial educational enrolment rates, particularly for secondary school enrolment. There is also a strong positive relationship between initial secondary school enrolment and subsequent growth in *per capita* GDP. He speculates that this may reflect the role of human capital in offsetting diminishing returns to physical capital and in attracting foreign direct investment from abroad. Lucas (1990) also suggests that a lack of human capital may deter foreign direct investment from a country, since physical capital tends to go to areas where human capital is abundant.

Romer (1993) reports results of cross-country growth regressions in which the interaction between secondary enrolment rates and the share of imported machinery and equipment in GDP has a strongly positive effect on GDP growth, consistent with the view that rapid growth is a function of both access to foreign technology and the domestic capability to use it²³. At the same time, there is no evidence of a growth-enhancing interaction between the human capital variable and national investment. Thus, the skill requirements of using imported capital goods would appear to be greater than for domestically produced capital goods.

Even so, it is possible that those imported capital goods are less skill-intensive than those used domestically in OECD countries. Barba Navaretti *et al.* (1998) provide evidence that low-income developing countries choose in some cases to import from OECD countries older vintage (or second-hand) capital equipment that requires fewer skills to operate than state-of-the-art equipment. Also, OECD countries do not have a monopoly on the export of capital equipment, with capital goods exporters like Brazil, India, Korea and Chinese Taipei supplying machinery that is usually somewhat older and less skill-intensive than the newest OECD models.

Labour Market Equilibrium

The effect of increased skills demand (whether from technology-skill or capital-skill complementarity) on labour market equilibrium could be different between developed and developing countries. Given the scarcity of skilled labour in most developing countries, an increase in relative demand could generate a rather large relative wage increase for skilled workers. How large the increase is will depend on the elasticity of substitution between skilled and unskilled labour and how enduring it is will depend on the supply elasticity of skilled labour.

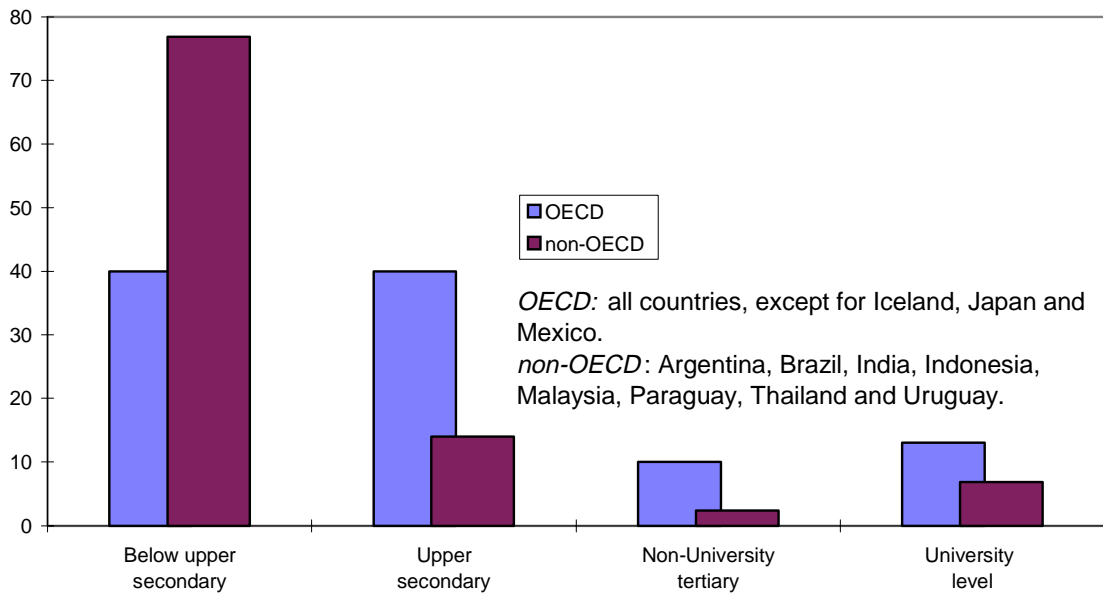
Studies which provide separate estimates of price elasticities of demand for skilled and unskilled labour usually find markedly higher absolute values of the latter, and Slaughter (1997) finds for US manufacturing that the elasticity of demand for production workers has increased significantly since the mid-1970s while that for non-production workers has if anything declined over time²⁴. For Colombian manufacturing, Roberts and Skoufias (1991) find evidence of a larger elasticity of demand for unskilled than for skilled workers. The relatively inelastic demand curve for skilled workers suggests that, assuming an autonomous increase in skills demand (say, from skill-biased technical change), their wage increase in the new equilibrium would be greater than for unskilled workers who experience a similar demand increase. Thus, even if demand for both groups of workers were to grow proportionately (and assuming short-run inelastic supply for both), the skilled-unskilled wage differential could widen.

Wherever relative factor prices change, one would expect a substitution in the direction of the now cheaper factor. In the case of skilled and unskilled labour, the greater the elasticity of substitution between them the smaller the net change in relative wages to be expected in a new equilibrium. (In the case of perfect substitution, there would be no change). On this question there is a paucity of research for developing countries. The research on OECD countries contains elasticity estimates that vary, in the case of substitution between production and non-production workers, from highly positive²⁵ to slightly negative (in which case, the two are complements) (see Hamermesh, 1993, for a review of various studies). The evidence, noted above, of a lower own-price elasticity of

demand for skilled than for unskilled labour also implies a greater difficulty of replacing skilled labour by some combination of other factors than of doing the same for unskilled labour. Thus, the question here is whether there is any *a priori* reason to suppose that the difference in demand elasticities between these two types of labour is greater in developing countries than in developed countries. This could be the case, for example, if one were to suppose that, for any distribution of “skilled” jobs there are some that can be more readily performed by those with fewer skills and others that cannot (e.g., advertising *versus* theoretical physics experiments). Then, in a skill–scarce economy, the few workers with high skill levels may be allocated to those highly specialised jobs where substitution is difficult, whereas in a more skill–abundant economy, besides the specialised jobs skilled workers might also perform many of those same jobs that would have been performed by less skilled workers in the skill–scarce country. This would then show up as a higher average elasticity of substitution between skilled and unskilled workers in the former than in the latter.

With respect to the supply elasticity of educated labour, this depends importantly on the initial distribution of educational attainment across the population. If, for example, a large proportion of the age cohort is already enrolled in secondary education and the relative demand for college graduates increases, supply adjustments can occur fairly rapidly, at least among new labour force entrants. If, on the other hand, secondary enrolments are very low²⁶, then significantly increasing the number of college graduates will inevitably take more time. In short, what matters is the degree of skewedness of the educational distribution. Arguably, this distribution is also an important determinant of the near–term substitutability between more and less skilled workers in production. Workers possessing a high school education are likely to be more readily substitutable (with perhaps some additional training) for college–educated workers than are those with only a primary education or less. Compared to OECD countries, the educational distribution tends to be considerably more skewed in the average developing country (see Figure 1). This suggests that, for a given increase in relative demand (say for college graduates), the latter group of countries will — other things equal — experience a larger increase in relative wages than the former, providing greater incentives for substitution in demand towards less skilled workers and for expansion of skilled labour supply, but also that substitution possibilities may be limited and supply responses relatively inelastic in the short run. In sum, then, any relative wage rise from a demand shift towards skilled labour could well be rather protracted, depending on the shape of the workforce education/skill distribution.

**Figure 1. Educational Attainment of the Population
(OECD and non-OECD countries, 1996)**



Source: *Education at A Glance - OECD Indicators 1998*, Table A1.1.

IV. OPENNESS AND SKILLS DEMAND IN DEVELOPING COUNTRIES

Our focus in this section is on globalisation's impacts on skills demand and relative wages in developing countries. These potential impacts need to be put in context of the ongoing structural change that occurs in the process of economic development, whether a developing economy happens to be open or closed. Economic opening can (indeed, probably will) affect both the rate and direction of such change. It may also affect the rates of technical progress, of capital accumulation, and of *per capita* GDP growth. It is through the combination of these that its effect on the relative demand for, and rewards to, skilled labour will make itself felt.

In a stylised view of the initial labour market conditions in a low-income developing economy, a large reserve of low-productivity, largely unskilled workers coexists with a much smaller number of skilled workers. Initially, growth is largely the result of labour force expansion and capital accumulation, but with little capital deepening and labour productivity (hence, wage) growth. Where markets, institutions and policy offer the prospect of higher returns, investment rates rise and with them productivity and GDP growth rates. As profit opportunities vary considerably across sectors, resources are reallocated, with manufacturing and later services accounting for a large share of incremental GDP. While employment shares lag behind output shares, over time a growing share of the workforce finds employment in industry and services. Capital deepening and technical improvement occurs across sectors, including in agriculture, permitting a shrinking agricultural labour force to feed a growing industrial one. With this transformation, and assuming some capital-skill and technology-skill complementarity, the demand for skills could be expected to rise. Mincer (1995) notes the general tendency for skills demand to rise with development as a result of both capital accumulation and technological change. Schultz (1963) emphasises the role of education in enhancing labour force flexibility to respond to structural change²⁷. With rising per capita incomes, education levels are also likely to rise, so the net effect on relative wages will depend on the relative strengths of skill demand and supply shifts. For long periods, the two may be roughly balanced and relative wages fairly stable. In sum, development is a process that involves, *inter alia*, a secular rise in human capital investments, with no *a priori* reason to suppose anything more than a temporary imbalance between skills demand and supply. It is against this background that the effects of economic opening are to be considered.

Even if the broad outlines of the development process are similar across countries, rates of economic growth are not. Two recent strands of growth theory have focused, respectively, on economic openness and on human capital as explanations for differential growth performance. In only a handful of cases have the two strands intersected. A brief review of the major findings of each follows, with an emphasis on their points of intersection.

New Growth Theory and Conditional Convergence

Studies of conditional convergence seek to explain why countries at similar initial levels of *per capita* income grow at very different rates, rather than converging at roughly the same rate towards the productivity and income levels of the most developed countries. There appears to be no general tendency for catch-up of poor countries with richer ones;

indeed, income gaps between the poorest and richest countries have widened over time. Yet, some countries have managed to close the income (and productivity) gap. What are the common conditions for successful catch-up?

Several studies (Azariadis and Drazen, 1990; Barro, 1991; Benhabib and Spiegel, 1994) find evidence that a country's initial endowment of human capital is a significant variable explaining its subsequent GDP growth²⁸. In Barro (1991), the stock of human capital affects growth principally through physical capital investment, with the two types of capital being complementary. It also positively influences *per capita* income through its negative association with fertility rates. Benhabib and Spiegel (1994) find little evidence that their human capital measure influences output growth as a factor input in a standard neoclassical production function, but they do find a significant positive association between the stock of human capital and productivity growth. They hypothesise that this reflects the role of human capital in both the domestic generation of technology (contrary to the findings in Romer, 1993) and the successful imitation of technologies developed abroad (consistent with Romer). Also, following Lucas (1990), they suggest that the stock of human capital serves to attract investment in physical capital, notably through foreign direct investment.

While investment in physical capital (and particularly capital equipment) is an important growth determinant (DeLong and Summers, 1991), the cross-country variation in the investment rate is partly a function of absorptive capacity, which in turn depends on human capital availability (but also on the larger institutional framework; see Romer, 1993). Benhabib and Spiegel (1994) find, in cross-country regressions, a significant positive relationship between the stock of a country's human capital and the rate of physical capital investment. In other words, the rate of return on investment in physical capital would appear to be a positive function of the supply of human capital; where the latter is scarce, the former is low and so too is the incentive to invest. If so, it follows that raising levels of educational attainment should, all else equal, increase the returns to physical capital investment and thereby boost investment rates. The reverse should also hold, viz., that raising investment in physical capital, by boosting demand for human capital, would raise its return. Looked at differently, human capital investment can (at least partially) offset the tendency towards diminishing returns in physical capital investment.

As noted above, capital-skill complementarity is to a significant degree a reflection of the skills required to master technologies embodied in newly acquired capital equipment. Nelson (1994) develops the implications of this for technology leaders and laggards, suggesting that for the latter (i.e., for the bulk of developing countries) investing in both physical and human capital is crucial to adopting more productive technologies.

Not all technology, however, is embodied in capital goods (or in blueprints, software programmes, technical documents or other "tradables"). Another element consists of tacit knowledge embodied in individuals, teams and organisations. In this case, Nelson (1994) suggests that mastery of a technology is like a skill that needs to be learned, normally at the level of an organisation or team. Effective learning-by-doing depends on the education and skills possessed by the workforce, with interactive skills of particular importance in fostering teamwork²⁹. The cross-border transfer of such tacit know-how is generally facilitated through closer than arm's length transactions between separate organisations. Indeed, this is one important rationale for foreign direct investment.

Besides human capital (narrowly defined), Abramovitz (1986) cites technological, organisational and social capabilities (with the latter two sometimes grouped together under the heading, "social capital") as important preconditions for sustained productivity

catch up. Nelson (1994) suggests that what accounts for rapid growth is the combination of education (and skills otherwise acquired) with technologies employed in organisations well designed to exploit them. Both Nelson and Abramovitz emphasise the extent to which technological capabilities are socially and institutionally determined. The mere accumulation of human capital is not itself sufficient to ensure the successful innovation or acquisition of new technologies. Organisations, institutions and their interaction constitute the environment within which technology adoption occurs. The insufficiency of human capital alone to foster strong technological capabilities is evident in the formerly centrally planned economies, where high levels of education of the labour force were not associated with technological dynamism. (This raises the question of how the policy environment and, in particular, the degree of openness of an economy may shape its organisations and institutions.)

Economic opening may expose developing countries to new ideas and technologies. Their costs of adoption, however, are a function of the suitability of a number of domestic conditions (Parente and Prescott, 1994), of which the size and quality of the stock of human capital is only one (albeit an important one). Others may include a conducive legal and regulatory framework, relatively low hidden transactions costs of doing business (which implies among other things a low level of corruption), and labour market institutions that do not significantly raise the costs of introducing new technologies. Rosenberg and Birdzell (1986, chap.4) describe the emergence in Western societies from the 15th century onward of a number of institutions conducive to commerce³⁰, among which were: a legal system designed to give predictable, rather than discretionary, decisions; the introduction of bills of exchange, which provided the credit needed for commercial transactions; the rise of an insurance market; double–entry bookkeeping, which facilitated the separation of the individual family’s property and transactions from those of the enterprise; and the change of government revenue systems from discretionary appropriation to systematic taxation. While some of these institutions are now nearly global in their reach (e.g., double–entry bookkeeping), others are still relatively weak in many developing countries. While an environment conducive to commerce is not synonymous with one conducive to technological dynamism, neither are the two unrelated (again, the example of the formerly centrally planned economies comes to mind).

A number of studies have sought to test the hypothesis that more open economies tend to grow faster or that they exhibit faster total factor productivity growth (Dollar, 1992; Harrison, 1995; Sachs and Warner, 1995; and Edwards, 1997). The results of Sachs and Warner are particularly interesting because they incorporate a measure of economic openness into a Barro–type growth regression where human capital is also an explanatory variable. While openness has a significant effect on growth performance, its inclusion weakens the significance of the human capital measure. They interpret their results as showing unconditional convergence among open economies, and no significant tendency towards convergence among closed ones³¹. In short, human capital (at least on their measure of initial year primary and secondary school enrolment rates) does not appear to matter to growth.

Another noteworthy result of Sachs and Warner in the present context is that trade openness does not affect the supply of human capital — i.e., open economies do not appear to accumulate human capital at a faster rate than closed ones³² — while openness does seem to stimulate investment in physical capital. Thus, if human capital and physical capital are complements, the higher investment–to–GDP ratio in open economies would tend to augment their demand for skilled labour without a corresponding augmentation of supply. This could be one source of any tendency for relative wages of skilled workers to rise with economic opening.

Apart from the demand effects of openness on skills, moving from a closed to an open economy could also alter the relationship between skills supply and returns. As noted by Berthélemy *et al.* (1997), in a closed economy an expansion of the supply of educated labour would tend to depress educational returns. In an open one, however, relative supply changes (at least in the simple one–cone HO trade model) have no effect on relative factor rewards. Thus, an exogenous expansion of the supply of educated workers in an open economy would not exert the same downward pressure on their rewards as in a closed one. Meanwhile, trade opening may positively affect skills demand through a number of channels discussed below. Berthélemy *et al.* find some evidence of positive demand effects for workers with secondary education: in cross–country regressions, their private returns to schooling are positively and significantly related to trade openness.

In summary, there is evidence suggesting that a more educated labour force can raise the returns to investment in physical capital, i.e., that skills and capital are complementary. Similarly, the stock of human capital appears to be positively correlated with technological dynamism, as reflected for example in TFP growth rates. There is also fairly strong evidence that more open economies grow faster, *ceteris paribus*, and greater openness in turn seems to be positively correlated with higher rates of investment in physical capital and of technical change (as measured by TFP growth). Given capital–skill and technology–skill complementarity, this suggests that more open economies should experience a more rapid growth in demand for skilled workers than closed ones.

Extensions of the Standard Trade Model

As noted above, the prediction (and apparent evidence) of rising skill differentials with economic opening in (some) developing countries does not square well with the simple (one–cone, 2x2x2) HOS trade model. Wood (1997) suggests ways in which this framework might be extended to explain this apparent anomaly. Though not the first to do so, he notes that the inclusion of non–traded goods and many factors may lead to results that reverse the standard predictions on movements in relative wages.

Relaxing first the two–good assumption, Wood presents the case of a country with an abundant supply of unskilled labour, and a comparative advantage in labour–intensive goods, where a labour–intensive non–traded good is produced which is a close substitute for an imported good. If opening to trade lowers the price of the imported good, substitution in consumption from the non–traded good to the imported one would result. A possible outcome is a fall in the relative wage of unskilled workers, if the effect of substitution in consumption more than offsets the increase in demand for unskilled labour needed in the production of the exported good. The final equilibrium would depend on the elasticity of substitution in consumption between traded and non–traded goods.

The second case of “perverse” effects of trade on relative wages involves relaxation of the two–factor assumption. Suppose a country with three factors, skilled and unskilled labour and infrastructure. The factor infrastructure is abundant and complementary in production to skilled labour, but the country has a low ratio of skilled to unskilled workers. If this country, with a comparative advantage in infrastructure–intensive goods, is exposed to more trade, the export demand for these goods will boost the demand for skilled workers. Once again, the wages of skilled workers will increase relative to those of the unskilled. [Of course, this case is not materially different from one where the third factor is (internationally immobile) capital.]

Wood (1998) notes another possible explanation for widening wage disparities in developed countries, but this one has somewhat ambiguous implications for relative wages in developing countries. The mechanism is a fall in “co-operation costs”, by which he means the costs of combining highly skilled workers from OECD countries with workers (and other factors) in developing countries. With declining transport and communications costs, it has become cheaper for skilled OECD workers to make short visits to production sites in developing countries and to communicate, in the meantime, with those sites via computer, telephone and fax. That this should raise the relative demand for skilled workers from OECD countries is evident, but how it affects developing countries depends on further specification of the production technologies there. Wood argues that such transfer of skilled labour enables developing countries to move into production of higher quality goods, which could plausibly involve an increased relative demand for skilled labour. On the other hand, it is possible that skilled OECD “migrant” workers would act to raise the productivity of low skilled workers in developing countries, perhaps even raising their relative returns. Thus far, there has been no empirical work to establish what the effects are of declining co-operation costs on labour markets in developing countries.

Feenstra and Hanson (1995a) propose a model with free trade in which a move to international capital mobility results in increased relative wages of skilled workers in both the North and the South. Their approach is to assume a single final good produced from a continuum of intermediate goods whose production requires varying proportions of skilled to unskilled labour. Prior to capital mobility, the minimum cost locus of the South lies below that of the North for very labour-intensive intermediate goods and, beyond some skilled-unskilled labour ratio, the North becomes the lower cost producer. With capital mobility, and assuming the returns to capital are higher in the poorer Southern region, capital flows from the North to the South, lowering the cost locus of the latter and raising that of the former. The intersection of the two cost loci thus shifts rightward towards goods requiring a higher skilled-unskilled labour ratio. The average skill intensity of Southern production rises³³, as does that of Northern production (the latter because the least skill-intensive goods it formerly produced now shift to the South), and the relative wages of skilled workers therefore rise in both regions³⁴.

A final possibility (relaxing the two-region assumption) is that middle income developing countries are relatively labour-abundant *vis-à-vis* their OECD trading partners and relatively skill-abundant *vis-à-vis* their low income developing country trading partners. Trade liberalisation involving greater openness towards both groups of countries would therefore have ambiguous effects on the relative demand for skilled labour. If one thinks of sectors as arrayed along a skills continuum, then the net effect of trade opening on skills demand will depend on relative size of the intersectoral resource reallocations induced by each of the expanding bilateral trade flows. If the effect of trade with lower income countries is especially strong, then the relative demand for unskilled workers in the middle income country would tend to fall. There is one piece of empirical evidence (for Mexico) which suggests such an effect of trade liberalisation. Building on work by Revenga (1994) and Bernard (1995), Cragg and Epelbaum (1996) seek to explain the rising skill premia observed in Mexican industry during the period of rapid liberalisation (i.e., roughly from the mid-1980s). They note that trade liberalisation has two possible effects: to reduce the cost of capital goods and, if capital and skills are complements, to increase skills demand; to reduce costs of imported consumer goods, many of which have been produced in Mexico with labour-intensive methods, forcing domestic companies either to adapt by moving to more skill-intensive methods or to cease operation. They find that, while high-skill

employment grew rapidly (1987–93) in both the non–traded services and the traded manufacturing sector, low–skilled employment grew much less rapidly in the latter, which is consistent with a relatively strong trade–induced adjustment of the skill mix in manufacturing.

Technology Diffusion Models³⁵

Beyond the accustomed resource allocation effects, trade expansion may have an effect on technology levels of trading partners. Grossman and Helpman (1992) propose a model in which technological change is endogenous, responding among other things to trade pressures. Openness is hypothesised to affect the technology level in a number of ways: imported inputs often embody new technology; access to export markets increases the potential returns to innovation compared with domestic market alone (which should be of particular importance to small economies); trade may affect a country’s degree of specialisation in research–intensive production (perhaps lowering it in unskilled–labour–abundant countries). Thus, trade’s effects on technology levels are not unambiguously positive for all countries. Even in high–income countries it is possible (à la Schumpeter) that increased import pressures would discourage innovation by reducing expected profits of competing domestic enterprises.

Pissarides (1997) presents a model of trade and technology in developing countries (“the South”) that seeks to provide a theoretical rationale for the empirical evidence on rising returns to skill following trade opening. The model shows two possible cases: one in which, following liberalisation, skill differentials widen but only temporarily in the transition from one steady state to another; a second in which the widening of skill differentials is long–lived. Following Romer (1990), a key feature of the Pissarides model is the distinction between the process of imitation (in Romer, invention) and the process of production, each with its own technology. The former involves learning either to use or to make imported capital equipment, and it is assumed that the technology of learning (i.e., technology transfer) is skill–intensive. By comparison, the technology of production is labour–intensive. Moreover, the returns to investment in technology transfer in the South are directly related to the size of the technology gap with the North. In effect, trade opens up new possibilities for profitable imitation by exposing the technology follower to a wider range of capital goods from the North (in terms of the model, it widens the gap between all varieties of capital goods known to the South and that subset of varieties that it has already successfully imitated). To narrow that gap again, skilled labour must be reallocated from production to imitation (e.g., R&D, reverse engineering). This shift towards skill–intensive activities raises the relative earnings of skilled labour, but only temporarily. Eventually, the returns to imitation will decline, and so will the proportion of skilled workers employed in this activity³⁶. The picture changes, however, if the technology imitated happens to be skill–biased, in which case there will be a permanent increase in the relative wages of skilled workers³⁷. This seems a plausible assumption inasmuch as evidence presented above suggests that much recent technical change in the North has been skill–biased, and in the model — as in reality — the imitation of Northern technologies is a principal means of technical progress in the South.

Young (1991) and Stokey (1991) analyse trade opening in the context of models of learning–by–doing, in which learning is bounded in any particular product (process) but can spill over to related products (processes). If the knowledge spillovers are sufficiently

large, then countries can sustain productivity growth in the long run by continuously moving into the production of new products of higher quality (climbing the “quality ladder”). With the introduction of trade, some countries specialise in sectors where learning possibilities have been largely exhausted, while others specialise in those with high learning potential (and high spillovers). Over time the latter group’s technological lead widens and their economies grow faster than the former group’s. These models assume, however, that knowledge spillovers are purely domestic in nature, neglecting the possibility of international spillovers such as have been found in some of the empirical studies discussed below. The extent of the latter spillovers may, however, depend importantly on the human capital stock in the recipient country — a relationship not explicitly tested in that literature.

The Stokey model is the more relevant of the two to the current discussion in that human capital accumulation is a central feature. The technology of human capital accumulation is such that private investment in schooling has an external effect, causing the social stock of knowledge to grow and thereby increasing the effectiveness of time spent in schooling by later cohorts. This is the source of long-term growth in the model. Labour is differentiated by quality (which is in turn a function of education) and different labour qualities are imperfectly substitutable for one another: i.e., only higher quality labour is able to produce higher quality goods. As aggregate human capital grows, output growth occurs as production of lower-quality goods is replaced by production of higher-quality ones. The situation faced by the small “skills-poor” economy is that, by lowering the domestic price of skill-intensive goods, trade liberalisation reduces the returns to the skilled labour used in producing those goods. By reducing investment in human capital, this results in lower steady-state GDP growth. The principal difference with the standard HOS model is in this dynamic effect resulting from human capital investment’s social spillovers. By assuming labour (of varying skill) to be the only productive input, the model cannot capture the possible effect of trade opening on domestic costs of imported capital goods and the technologies they embody (and in this way perhaps indirectly on skills demand).

Empirical work by Levine and Renelt (1992) suggests a positive link between trade openness and the rate of capital investment that is robust to alternative model specifications. Trade would thus appear to affect growth at a minimum through access to lower cost investment goods. Insofar as skills and capital are complementary, then a rising investment rate would tend to raise the relative demand for skilled labour. Besides any reallocation of domestic expenditure towards investment attendant on economic opening, one would also expect to witness (as indeed we do) a shift in investment expenditure towards imported capital goods (recall the figures cited above). To the extent that these are relatively more skill-intensive than domestic ones, the effect would be further to augment the relative demand for skills.

Besides trade, foreign direct investment (FDI) can act as a conduit for international technology diffusion. Findlay (1978) presents a model in which FDI plays just such a role. He notes that, by being the first to adopt an innovation, subsidiaries of multinational corporations can have a “demonstration effect” on other firms, persuading them that the new technology can be profitably employed in the local environment. As Findlay puts it: “While the migration of individuals, such as Dutch shipwrights to Sweden or Italian architects to Russia, was the chief form of technological diffusion by ‘contagion’ in earlier times, their role is now mostly taken over by large organizations such as the multinational corporations” (p. 4). Findlay makes only passing reference to the role of host country skills in facilitating such diffusion, but he does cite the earlier work of Nelson and Phelps (1966) where the adoption rate is an increasing function of the level of human capital.

Wang and Blomstrom (1992) model the degree of “contagion” or “spillover” of technology from multinationals to domestic firms as a function of the transfer costs within the former (from parent to subsidiary) and the learning (absorption) costs of the latter. Neither cost function incorporates the level of skill of the workforce as an explicit argument, but the domestic firm’s learning investment function contains an efficiency parameter whose value would presumably be strongly and positively influenced by the level of workforce skills. In related work, Wang (1990) does link human capital accumulation to the efficiency of technology adoption in domestic firms.

Lucas (1990) considers alternative explanations for why, contrary to predictions from neoclassical theory, capital does not flow inexorably from rich to poor countries. In one hypothetical example, wherein each worker’s productivity depends positively — and fairly strongly³⁸ — on the human capital of other workers, the returns on capital investment in countries with little human capital turn out to be hardly greater than those in rich countries, offering little attraction to foreign investors. In other words, as observed above, investment in human capital is a critical support to the marginal productivity of physical capital.

Empirical Evidence of Trade–Technology–Skill Links

Empirical evidence on trade–technology–skill links takes a number of forms. Most studies tend to focus on imports (whether as source of technology spillovers or as market discipline). A few look at the technological stimulus provided by competition in export markets, or the economies of scale made possible to small countries through expanding exports. The main focus here is on the former group. One strand in the literature seeks to identify and measure R&D spillovers via trade. Coe and Helpman (1995) find that foreign R&D has a significant positive effect on domestic productivity growth, especially for smaller economies. The US R&D stock has the largest effect on other OECD countries’ productivity growth, because of both the large size of that stock and the large share of their imports coming from the United States. Coe *et al.* (1997) find evidence, for a large sample of developing countries, that openness to equipment and machinery imports from technologically advanced countries significantly contributes to an economy’s total factor productivity. On average, a 1 per cent increase in the R&D capital stock in the industrial countries raises output in the developing countries by 0.06 per cent.

The widening US trade deficit in the 1980s also stimulated research interest in the import side. Scherer and Huh (1992) find that, in response to high–tech import competition, companies in more concentrated industries, with large domestic markets and more diversified sales, tend to respond more strongly with increased R&D expenditures. MacDonald (1994) comes to a similar conclusion, viz., that import competition results, with a lag, in significant increases in labour productivity only in highly concentrated industries³⁹. Using total factor productivity (TFP) as his measure of technical change, Lawrence (1998) finds evidence that, in the case of US manufacturing, rising imports have had a small positive impact on TFP growth in labour–intensive sectors, but little effect on TFP growth in skill–intensive sectors⁴⁰. While part of this may be the result of technological improvements, part may also be from the closure of the least efficient plants in an industry. (Interestingly, Lawrence also finds a negative association between exports and productivity growth.)

While we are not aware of comparable studies for developing countries, the above results suggest that trade's effects on their technology effort could also be differentiated by industry and enterprise. It seems unlikely that, for most developing countries, trade liberalisation would significantly raise formal R&D expenditures, since R&D remains a relatively unimportant activity there. More plausibly, it could result in lower costs of imitation of foreign technologies. Whether the effects are likely to be felt uniformly across tradables sectors, or be differentiated between import-competing and exporting sectors is not clear, though it is plausible (consistent with the Lawrence results) that they would be stronger in the former (which, in the developing country case, are likely to be the more capital- and skill-intensive ones). As in the United States, within any given sector those firms already accustomed to relatively advanced technology (i.e., with low adoption costs), as well as those with larger profits to invest in new technologies, are likely to respond most positively to the challenges and opportunities provided by lower cost imports. Arguably, those firms are also likely to employ a ratio of skilled to unskilled workers higher than the sectoral average, in which case their expansion would raise the relative demand for skills. The employment share of skilled workers in the successful firms may also rise. Whether economy-wide skills demand rises or falls depends on the balance between intra-industry and intra-firm skills upgrading, on the one hand, and intersectoral reallocation toward relatively unskilled-labour-intensive export sectors, on the other.

Empirical Evidence of Foreign Investment–Technology–Skill Links

In the case of FDI, the link to technology transfer is potentially stronger than with trade. Foreign investors may bring to their overseas subsidiaries or joint ventures a variety of managerial, organisational and technical innovations that would not otherwise have diffused (or diffused as rapidly) to the host country. Those innovations may, in turn, spill over to domestic suppliers and/or customers, or even to domestic competitors through the movement of skilled personnel. Training of personnel in the new methods is often part of the FDI package, though training by capital goods suppliers of their overseas customers is also possible.

Still, much of the evidence on foreign direct investment's impact on skills demand is anecdotal. Only a few studies have utilised a sufficiently rich data set to make statistical hypothesis testing possible.

Borensztein *et al.* (1995) use a theoretical framework derived from Nelson and Phelps to test empirically for the impact of FDI on host country growth. Their results suggest that FDI contributes to growth in larger measure than domestic investment in a cross-section of 69 developing countries. They also confirm a strong complementarity between FDI and human capital, with the growth boost from FDI depending on a minimum stock of human capital⁴¹. Moreover, there appears to be a significant crowding-in effect of FDI on domestic investment, wherein a one-dollar increase in FDI results in an increase in total investment in the country of more than one dollar. Thus, besides its positive effect on technology levels, FDI contributes to growth by raising overall investment rates.

Feenstra and Hanson (1995*b*) examine the relationship between foreign manufacturing investment and non-production wage share across Mexican states. They use OLS and IV regressions to test the hypothesis that this wage share (assumed to represent skilled workers) is systematically higher in states with a higher proportion of foreign investment (measured by "maquiladoras") in total manufacturing investment. They find a positive and significant relationship between the two, and a decomposition of the wage share changes

into quantity and price effects suggests that the predominant effect of FDI has been on relative wages rather than on the employment shares of skilled workers⁴². The significance of using “maquiladoras” as a measure of FDI is that such investments are directly linked to trade between Mexico and the United States. They are often established by US firms for the purpose of outsourcing labour-intensive processes (e.g., component assembly). Often, the resultant trade flows are intra-industry, even under a fairly disaggregated industry classification. Feenstra and Hanson further calculate that over 90 per cent of the change in non-production wage shares during the 1980s occurred as a result of intra-industry skill upgrading, with less than 10 per cent resulting from inter-industry shifts in employment. Two results follow: *i*) unlike in the simple HOS trade model, a change in relative wages has occurred as a result of increasing intra-industry trade rather than growing specialisation across industries; and *ii*) the direction of the relative wage change in the labour-abundant country (in this case Mexico) is opposite to that predicted by HOS theory. In effect, growing intra-industry trade (combined with FDI) has been associated with a rise in the relative wage of skilled workers in both the skill-abundant and the labour-abundant country.

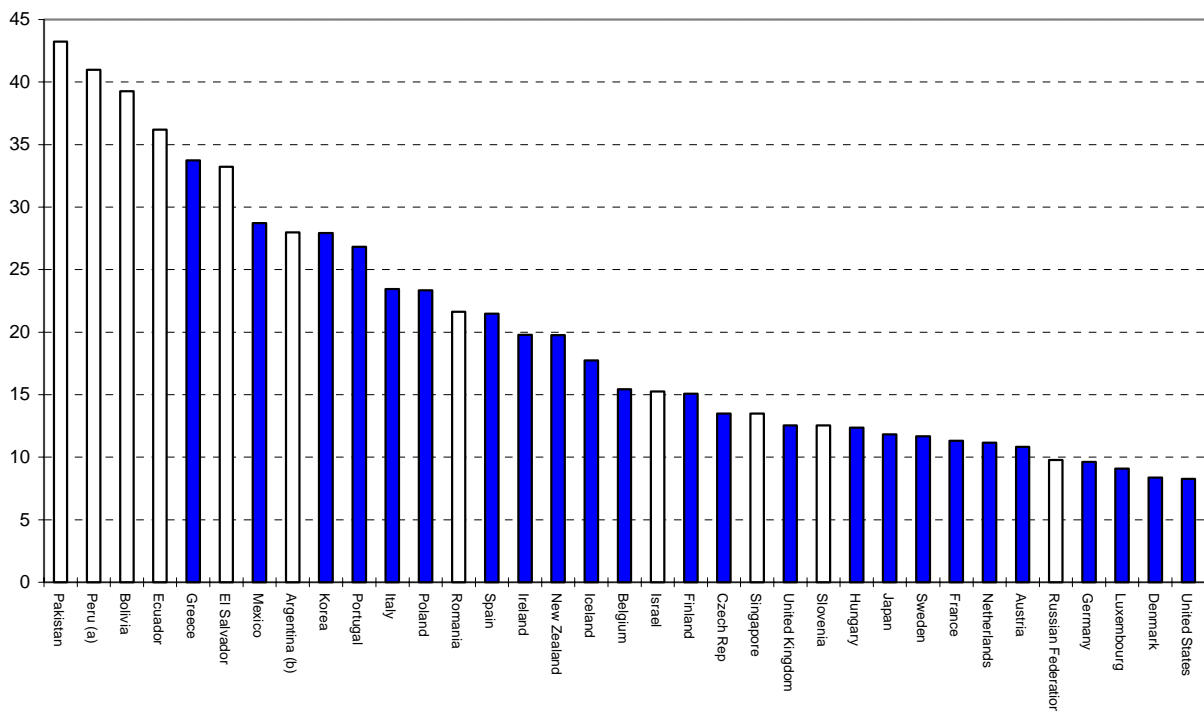
Foreign direct investment flows from OECD countries to developing countries have been increasing very rapidly since the mid-1980s. Assuming such flows are a conduit for the transfer of technologies from the home countries of OECD multinationals, then their impact on relative demand for skilled labour (and relative wages) in the small (i.e., price-taking) host country will, following Haskel and Slaughter (1998), depend importantly on their sector-bias⁴³. In effect, if the sectors where FDI is concentrated are skill-intensive ones, and if the net result of the technology introduction is an increase in these sectors' relative profitability, one would expect FDI to pull other resources into these sectors and, in so doing, raise relative demand for, and wages of, skilled workers⁴⁴. On the other hand, FDI concentrated in unskilled-labour-intensive sectors that raised their relative profitability would have the reverse effect on relative demand and wages. In this regard, it would be interesting to know whether the “crowding-in” effect found by Borensztein *et al.* (1995) is localised to sectors of high FDI concentration or is more diffuse. A possible area for future research would be, as a first step, to determine the direction and degree of sector-bias of FDI inflows into specific developing countries and, as a second, to test whether sector-biased FDI has the expected effect on relative wages.

Education, Entrepreneurship and Openness

Questions rather neglected in the OECD-oriented literature on earnings distributions but arguably of paramount importance in developing countries is what effect education has on the returns to entrepreneurship and how, in turn, those returns may be conditioned by a country's economic openness. The reason for its importance stems from the composition of the labour forces of many developing countries, wherein self-employment accounts for a very sizeable share of total employment (partly a function of the large numbers of owner-cultivators in agriculture, partly a function of the large urban informal sector) (see Figure 2). (Arguably, many developing countries are also hotbeds of the sorts of disequilibria on which — Schultz, 1975, suggests — entrepreneurs thrive.) In a developing country context, the studies coming closest to answering the first part of the above question are those estimating farmers' returns from schooling (see Lockheed, Jamison and Lau, 1980; also, Taylor and Yunez-Naude, 1999 forthcoming, Chapter 1, for an extensive review). Taylor and Yunez-Naude (1999) analyse household data for rural Mexico, employing a model in which they control for selection of rural household members

into different activities (production of various crops, off-farm employment, and migration). They then look at returns from education in each of those activities, and estimate education's effect on total household income. Their results suggest a strong positive effect of education on rural household income beyond the lower-secondary level (i.e., over 9 years of schooling). Moreover, an important source of those returns is the "entrepreneurial" decision of how best to allocate work effort and other family resources across different income-generating activities. Lockheed *et al.* (1980) conclude from their survey that, while estimated returns from schooling vary widely, they tend to be higher in more dynamic economic environments (Schultz's disequilibria).

Figure 2. Self-Employment as % of Total Employment
[OECD (black) and non-OECD (white) countries, 1996]



Notes: (a) Urban areas; (b) 1995.

Sources: Eurostat, *Labour Force Survey. Results 1996*; ILO, *Yearbook of Labour Statistics 1997*.

Comparable studies of returns from schooling in entrepreneurial activities outside a predominantly agricultural setting (e.g., in commerce or industry) are rarer, partly because of more limited data availability⁴⁵. There are, however, *a priori* grounds for supposing that the returns are positive. Education provides the entrepreneur with an intangible asset that can be invested in a risky venture but that is not appropriable by creditors or other claimants in the event of bankruptcy. For this reason, she may be more inclined towards commercial risk-taking than the entrepreneur having only tangible (and alienable) assets to invest. (The other side of this is that educated entrepreneurs may face higher opportunity costs than less educated ones.) The educated entrepreneur may also be better prepared to execute the various managerial tasks involved in running a profitable business (though clearly how important that ability is will vary with the size and complexity of the business).

Lall and Wignaraja (1997) offer some evidence for Ghana that education of the entrepreneur is a useful predictor of the “technical competence” of manufacturing firms. Also for Ghana, Vijverberg (1995) finds a small positive impact of an entrepreneur’s education on family enterprise income, but a more significant effect from education of other family members⁴⁶. Burki and Terrell (1998) find, for Pakistan, that technical efficiency of small manufacturing enterprises is significantly improved when the owner has at least a primary education, corroborating evidence reported in Little *et al.* (1987) for a number of developing countries. Nafziger and Terrell (1996) have examined the determinants of survival of Indian firms over a 22-year period, from 1971 to 1993. They find that higher educational attainment of the founding entrepreneur is associated with a smaller probability of firm survival, concluding that *i*) the opportunity costs of entrepreneurship may have been greater for those with more education and *ii*) the returns to rent seeking were reduced with India’s liberalisation (the well-educated also being the better connected and hence more effective in rent extraction). Bates (1990) finds contrasting evidence for the United States, where small business longevity is positively and significantly related to entrepreneurs’ human and financial capital inputs. These two types of capital input are correlated in that the size of start-up loans extended by commercial banks to entrepreneurs is directly related to the latter’s education⁴⁷. The difference between the India and US results may be due to sample characteristics, but it may also point to the importance of the institutional and policy environment in shaping the incentives facing entrepreneurs⁴⁸.

If indeed the protected policy environment dominant before the early 1990s in India had diverted entrepreneurial energies in unproductive directions (on this point, see Baumol, 1990), this suggests that economic opening could in the long run boost the returns to entrepreneurship by redirecting it towards more productive undertakings. If the educated entrepreneur had benefited disproportionately from the *status quo ante*, does this imply that the benefits of education to entrepreneurship are less marked in a more liberal economic environment? Perhaps, inasmuch as success no longer depends on one’s links to the “old boy network”. There are plausible arguments on the other side, however. For a small country, greater outward orientation, by expanding the size of the potential market, would — all else equal — multiply the expected returns to any initial investment in entrepreneurial human capital. Also, the requirements of exporting (or competing with imports) may well put the educated entrepreneurs at a stronger competitive advantage than in the pre-liberalisation market environment. In short, the educated entrepreneur may be better placed to avail of new information — e.g., about new products, more efficient production methods, improved quality control, and more effective marketing techniques. Nelson and Pack (1998) argue that the growing supply of well-trained technical people in the Asian newly industrialising economies has facilitated successful entrepreneurship. For the moment, though, these are merely hypotheses.

V. POLICY IMPLICATIONS

We have sought to shed light on the question of whether, in a developing country context, skills investments and economic opening are complementary, in the sense that the rewards to one are a positive function of the extent of the other. The theoretical arguments for such a positive relationship seem compelling and they are for the most part consistent with what empirical evidence is available. This suggests not that there are no gains from liberalisation without human capital investment but only that the gains (particularly in the long run) are likely to be greater *with* than *without* such investment. By the same token, the returns to investment in skills development will be limited to the extent that governments fail to create an environment — among other things, through trade and investment liberalisation — wherein those skills can yield the highest possible returns.

Recent empirical work suggests a strong positive link between economic opening and enhanced growth in total factor productivity. A number of theoretical studies suggest that an important aspect of this acceleration of technical change is the increased diversity (and quality) of products (including capital goods) to which a country is exposed through trade (and also foreign direct investment). It may still be true that, for a developing country with an abundance of unskilled labour, the immediate effect of trade liberalisation is to shift resources into relatively low-skill sectors and activities. What determines the long-term benefits of such liberalisation are *i*) the strength of the incentives to move up the “quality ladder” to progressively higher-skilled activities and sectors and *ii*) how successful enterprises and entrepreneurs are in responding to them⁴⁹. Insofar as this depends on the availability of higher quality human capital, then it may well be to a country’s advantage if liberalisation were to raise returns to skill and thereby encourage higher rates of investment in skill acquisition. It is in those low-income countries where the private returns to human capital do not rise (or even fall) following liberalisation that there may be a particular need for government policy to sustain incentives for human capital formation. How sizeable a problem this is requires further empirical investigation, though Wood and Riddo-Cano (1999) suggest it may be non-trivial. Since the problem is apt to be most acute in the poorest countries, mobilising additional government revenue for education may be especially difficult without additional external sources of finance (e.g., through official development assistance). In any event, it is clear that backtracking on liberalisation as a way of countering any decline in private returns to education would be counterproductive, since it threatens the very technological and entrepreneurial dynamism that tends to reward investment in education and skill acquisition.

When looked at from a different perspective, any decline in returns to education in poor countries following economic opening would, all else equal, represent an improvement in income distribution, with wages of uneducated workers rising relative to those of the more educated. If, as in many poor countries, investment in education beyond primary level is household-income-constrained, then rising wage incomes for unskilled workers should improve their own and, more importantly, their children’s educational opportunities. Moreover, depending on how far private returns may be depressed and how far incomes rise, the greater affordability of education could partially offset the effect on demand of reduced returns.

Where economic opening is accompanied by widening skill-related wage differentials in well-functioning labour markets, this provides a useful price signal to individuals and enterprises to invest more in education and training. Thus, if there is any problem requiring policy makers' attention, it is more a political than an economic one. How much of a problem growing wage inequality proves to be depends on several factors: *a)* what the initial wage (and income) distribution was; *b)* how quickly the distribution is changing (and whether the change involves an absolute decline in income at the lower end of the distribution); *c)* how persistent any increase in inequality is expected to be; and *d)* how tolerant individuals are of (worsening) income inequality. Wage inequality becomes an economic problem only if, due to some combination of *a)* to *d)*, governments feel compelled to engage in redistributive policies on a scale that threatens to undermine investment incentives, work incentives, and growth⁵⁰.

Fortunately, in many developing countries, any unequalising effect from greater economic openness (due to skill-biased technology transfer and capital deepening) will tend to be muted by two other factors already noted, viz., the HOS effects of trade liberalisation and — more importantly — an expansion of the supply of educated workers. Also, while in OECD countries the wages of unskilled workers have not only declined *relative* to skilled wages but in some cases absolutely⁵¹, by contrast, in those developing countries enjoying rapid *per capita* income growth, real wages of unskilled workers are likely to rise, even if at a slower pace than those of skilled workers.

Whether the supply of educated workers expands fast enough to hold inequalities in check cannot be known *a priori*. In any case, as the new growth literature emphasises, the expansion of skilled labour supply is not simply a distributional issue but a determinant of long-term GDP growth prospects. Even in traditional growth theory, it is an important determinant of the *level* of per capita income in the long run. Since educational attainment levels in many developing countries remain low compared with OECD countries (and educated female labour force participation rates are also often substantially lower — notably in Latin America), the medium- to long-run elasticity of skilled labour supply should be relatively high in these countries.

Still, the supply response to rising wage differentials may vary significantly across countries, depending on how binding is each of a set of constraints — including institutional and physical constraints on the expansion of secondary and/or tertiary enrolments (not enough classrooms, not enough schools), budget constraints that may slow the rate at which institutional/physical constraints can be relieved, human resource constraints (not enough adequately trained high school teachers and university instructors), and foreign exchange constraints that make it difficult to expand the supply of human capital (including university faculty) through overseas education. With respect to the last, the importance of outward orientation — more specifically, strong export performance — to generating the foreign exchange needed to send sizeable numbers of students abroad for higher education should not be underestimated.

Even in the absence of the aforementioned constraints, raising significantly the educational attainment of the workforce takes time. A doubling of secondary (or tertiary) enrolment rates would only have a gradual effect on labour supply, as students work their way through the educational system and enter the labour market. How quickly the supply of new high school or college graduates increases depends critically on the demographic

structure of the population. If new labour force entrants (say in the 18–24 age cohort) represent 10 per cent of the total labour force, the effect of doubling the number with a high school diploma will clearly be very different than if they represent only one per cent of the total labour force. In this respect, demographics are working in favour of most developing countries, with their relatively young populations and expanding labour forces.

Until new cohorts of educated workers enter the workforce, investing in additional training for the current workforce may provide an imperfect substitute — the more imperfect the lower its average educational attainment. Beyond learning basic work discipline and rudimentary manual skills, much workplace training is more likely to complement than to substitute for formal education. Also, if developing countries do succeed in creating the conditions of technological dynamism that fosters a restructuring towards progressively more skill-intensive activities, then workers will have a growing need for continual (or “lifelong”) learning, to update their skills and keep abreast of new technologies. Some of this may be firm-specific and provided through the workplace, but much will involve enhancement of generic skills through formal education and training.

In conclusion, both the theoretical and the empirical literatures suggest the importance, for a developing country, of co-ordinating investments in human capital with trade and investment liberalisation measures. Human capital investment alone, without economic opening, may well face steeply diminishing returns, since a closed economy will not enjoy the continuous stream of learning opportunities associated with constant exposure to foreign technologies and markets. Economic opening alone, without human capital investment, may yield allocative efficiency improvements, but is unlikely to enable a country to shift its comparative advantage towards higher quality goods demanding higher skills in their production. In short, the productivity benefits of economic opening in the absence of human capital investment, and *vice versa*, are apt to be short-lived; those associated with co-ordinated economic opening and human capital upgrading are apt to prove far more enduring.

NOTES

- * Without implicating them, the authors would like to thank Colm Foy, Kiichiro Fukasaku, Helmut Reisen, David Turnham, and Adrian Wood for helpful comments on an earlier draft.
1. Strictly speaking, we refer here to q -complements in the Hamermesh (1993) sense: see footnote 10 below.
 2. Various measures of openness have been used in the literature, normally referring to trade openness. Trade-to-GDP ratios (adjusted for country size) are among the most common. Policy-based measures (like effective tariffs) are less so, principally because of their more limited geographical and temporal coverage. Some studies (e.g., Harrison, 1995; Edwards, 1997) experiment with several measures of openness to test the robustness of results.
 3. Studies that use the production/non-production distinction to reflect unskilled and skilled workers justify this by reference to the close positive correlation between wage differentials based on this measure and those based on schooling measures.
 4. In this case, skill premia would be expected to fall initially in response to the growing supply, before being bid up by SBTC. Indeed, Acemoglu uses his model to explain the observed pattern of skills premia in the United States, with falling premia in the 1970s followed by rising premia in the 1980s. See also Kiley (1997) for a similar model of endogenous biased technical change.
 5. Skill-biased technical change (SBTC) is possible in these studies — indeed, it is frequently identified as a major source of rising skills premia — but it is assumed to be exogenous.
 6. The mathematics test results analysed by Murnane *et al.* reflect ability normally expected of those with 8 years of schooling in the United States; in other words, knowledge of advanced algebra or geometry were not tested.
 7. An index of industrial structural change constructed by UNIDO (see UNIDO 1995 for definition) broadly confirms this, with the index (1980–95) showing a high value for the high-growth East and Southeast Asian region (excluding Japan) and much lower values for slow-growing sub-Saharan Africa and Latin America.
 8. The late 1970s through the late 1980s were a decade when the share of sales workers in the labour force roughly doubled, which may have some part to play in the vigorous growth in demand for interactive skills (see Wolff 1996, table 1).
 9. Unlike Rumberger, Wolff does not take into account the reclassification of specific jobs according to their level of skill from one DOT edition to another.
 10. Complementarity as used here is perhaps closest to Hamermesh's (1993) p -complementarity (whereby a decrease in the price of one input increases the demand for the other, holding output constant); Hamermesh also discusses q -complementarity (whereby an increase in the quantity of one input increases the marginal productivity, hence the returns, to another). In the case of only two inputs, they must be q -complements and p -substitutes. What is interesting are the possibilities presented by three or more inputs (say, capital, skilled labour, unskilled labour). Then, the question can be raised, e.g., of what effect capital deepening — an increase in the supply of capital — has on the relative returns to skilled *versus* unskilled labour. An increase in the relative returns to skilled labour would suggest capital-skill q -complementarity, but capital-labour q -substitution.
 11. In summarising his review of evidence, Hamermesh (1993) notes: "We are fairly sure that capital and skill are p -complements. We are fairly sure that technological change is q -complementary with skill" (p. 135).
 12. Goldin and Katz also note that electric motors made possible the automation of hauling and conveying operations, which had previously required unskilled labour.
 13. It is possible, of course, that semi-automation is simply a way station on the road to full automation.

14. Prais (1995) also finds that, in metalworking, British firms tend to have more serious teething problems than their Continental counterparts in introducing new computer–numerical–control equipment and that this has caused them to lag behind in such introduction, adversely affecting sectoral productivity.
15. This story of rapid expansion in a skill–intensive sector is consistent with the findings of Bernard and Jensen (1997) for the US manufacturing sector, where between–plant employment shifts explain much of the rise in the relative wages of non–production workers during the 1980s.
16. Testing the hypothesis would appear to be fraught with difficulties, since it would require measuring the marginal productivity of specific tasks performed by workers in “multi–task” jobs.
17. GDI figures from World Development Indicators of the World Bank; equipment import figures from CHELEM database.
18. Most definitions of “Japanese” management techniques include Total Quality Control, with the establishment of Quality Circles; Statistical Process Control; the use of just–in–time (JIT) production methods; and team–working with multi–skilled workers, frequently involving job rotation.
19. There appear to be only a few studies explicitly estimating elasticities of substitution between workers by educational level (estimates of substitution between production and non–production workers are far more common). Prior to Fallon and Layard (1975), who find a substitution elasticity of 0.61 between workers with more than 8 years of schooling and those with less, Johnson (1970) is the other major study, estimating a substitution elasticity of 1.34 between college and high school workers.
20. Goldin and Katz (1996) note that the demand for skilled technicians may follow a technology life–cycle, higher at first when machinery is new and there are still many “bugs” to be worked out, then declining over time as the equipment is fine–tuned to function smoothly with a minimum of further intervention.
21. This does not necessarily imply that more capital–intensive sectors are also more advertising–intensive, since returns to advertising are likely to depend on a variety of industry characteristics other than capital intensity.
22. This finding of price complementarity of capital and unskilled labour runs counter to the more common finding that they are price substitutes. Denny and Fuss suggest that the latter may be an artifact of model specifications which assume Hicks–neutral technical change, thereby confounding technical substitution with price substitution.
23. It should be noted that Romer (1993) is making a point about the difficulty of coming to closure about the merits of competing growth theories [e.g., the augmented Solow model à la Mankiw *et al.* (1992) *versus* endogenous growth models] solely on the basis of cross–country regressions. The results can be (and are) used to “justify” competing explanations. Hence, his appeal — given the deficiencies of statistical tests on available data in establishing causal links — for greater appreciation of “appreciative theorising”.
24. While this is consistent with the argument of Rodrik (1997) that trade liberalisation increases the elasticity of demand for unskilled labour in developed countries, Slaughter’s regression results do not give strong support to such an interpretation.
25. Hamermesh (1993) introduces a note of caution about the high substitution elasticity estimates generated by studies using translog production systems (p. 112).
26. The assumption here is that the percentage of the active population with a secondary education is also very low; otherwise, it is conceivable that the number of college graduates could be expanded fairly quickly through investment in continuing higher education. This assumption is borne out by the fact that for the 13 non–OECD countries participating in the World Education Indicators (WEI) programme, the average current upper secondary graduation rate is 49 per cent, while for the OECD countries it is 85 per cent; see OECD (1998).
27. In his words, “Economic growth, under modern conditions, brings about vast changes in job opportunities. Schooling in this connection is valuable because it is a source of flexibility in making these occupational and spatial adjustments” (Schultz, 1963, p. 41). See also Schultz (1975) for further development of these ideas.

28. Despite the positive relationship between initial capital stock and subsequent growth performance, much of the empirical literature finds a weak (or even negative) correlation between human capital *accumulation* and productivity growth (see Pritchett, 1996, for evidence on a cross-section of 91 countries). Lopez, Thomas and Wang (1998) find that, once the distribution of education is controlled for, this “education puzzle” is partly solved. In short, for any mean educational attainment of the workforce, the more equitable the distribution of education is the more it contributes to growth. Griliches (1997) suggests an alternative explanation, viz., that a very significant share of educated labour in many developing countries enters the government sector (including education) and various service industries, where productivity growth is not adequately measured — even assuming that they make a significant contribution to such growth.
29. A possible explanation for the recent increase in demand for interactive skills noted by Wolff (1996) could be the organisational innovations introduced by many US firms in the last two decades, including the greater reliance on production teams.
30. The Rosenberg/Birzell list is not necessarily definitive, nor were all institutional innovations equally important to the rise of commerce. Moreover, in the late 20th century, other institutions may be important to entrepreneurship and innovation that were much less developed (or perhaps unknown) in earlier centuries (e.g., venture capital markets).
31. Ben-David (1993) comes to a similar sort of conclusion based on a comparison of convergence rates among EU countries pre- and post-trade liberalisation as well as a comparison of EU members with non-EU members and with EFTA countries. Essentially, he concludes that per capita incomes tend to converge among countries as they become more closely linked through trade, while in the absence of free trade there is little basis for expecting income convergence. One possible explanation is that technology diffuses rather freely across borders of trading partners.
32. This result may, as Wood and Riddo-Cano (1999) suggest, merely disguise a divergence of factor endowments between skill-rich and skill-poor countries following trade opening. They find evidence, following trade liberalisation, of a significant divergence in secondary and tertiary enrolment rates between the two (presumably reflecting divergent returns to education). While Wood and Riddo-Cano dismiss differential income elasticities of demand for education as a competing explanation, another possibility not explicitly considered is that other policy variables — e.g., fiscal austerity measures associated with structural adjustment programmes — may have contributed to a decline in the availability and/or quality of educational services in poor countries during periods of liberalisation. This may explain, e.g., the stagnation of primary enrolment rates in sub-Saharan Africa during the 1980s.
33. The range of goods of differing skill intensities produced in the South also widens, while that in the North narrows.
34. See Cline (1997, pp. 120–122) for a clear graphical exposition of the argument.
35. For a valuable summary of the literature on trade and technology, see Grossman and Helpman (1995).
36. Note that this is independent of any supply response; in the Pissarides model, the relative supply of skilled workers is held constant, but clearly over time it may expand in response to higher expected returns, which would reinforce the demand-side effect tending to narrow skill differentials once more.
37. Here, as in the previous case, supply should respond endogenously to the prospect of higher returns to skill, thereby dampening the growth in differentials and eventually causing them to narrow once more.
38. In Lucas’ calculation, the elasticity of labour productivity with respect to an increase in the average human capital of the workforce was 0.36.
39. A better measure of technical change would have been total factor productivity, since labour productivity growth may arise from a shift towards more capital-intensive activities following liberalisation or from an across-the-board increase in investment ratios (see Lawrence 1998).
40. The Lawrence findings provide some empirical support to the conjecture of Wood (1994) that trade competition with the South induces relatively rapid productivity growth in the labour-intensive industries of OECD countries, though Lawrence emphasises that the causation runs in both directions — from trade to technical change and *vice versa*.

41. In particular, in their results, the threshold corresponds to a 1980 average of 0.45 years of secondary schooling for male population above 25 years of age. See their footnote 10 for details of the calculation.
42. This would seem to suggest a rather inelastic short-run supply of skilled labour.
43. Haskel and Slaughter (1998) find evidence supporting a significant role for sector-biased technical change in explaining changes in skill-based wage differentials in 10 OECD countries.
44. This result holds unequivocally only if domestic output prices are regulated by world prices, though even if domestic prices are allowed to vary as a result of sector-biased technical change, the result may still hold if, e.g., demand is sufficiently elastic in the relevant sector.
45. Based on a 1993 survey of some 1 440 businesses in China, it was found that the education level of owners was relatively high compared with that of the working population as a whole (as reported in the 1990 census); see The Project Group, 1995.
46. This serves to reinforce the case made by Taylor and Yunez-Naude for broadening the measure of education used in econometric analyses beyond that of the household head to include other household members.
47. In Ecuador, Baydas *et al.* (1994) find that the education of a business owner is positively related both to demand for and supply of credit from microenterprise credit programmes.
48. Baumol (1990) argues from historical evidence that the number of entrepreneurs in a society is probably not so important to economic performance as the “rules of the game” that define the set of rewards to entrepreneurship and thereby influence how entrepreneurs allocate their efforts and talents among competing activities — e.g., rent-seeking *versus* wealth-creating activities.
49. This may but need not involve moving into wholly new industries; a moment’s reflection on the quality range within the textile/clothing sector alone makes evident the scope for technical improvements within ‘traditional’ industries.
50. Alesina (1995) contains a summary of the substantial recent literature on how a highly skewed income distribution can adversely affect growth through ill-conceived redistributive policies.
51. Mishel and Bernstein (1994) report a real hourly wage decline for high school dropouts in the United States of 22.5 per cent between 1973 and 1993.

BIBLIOGRAPHY

- ABRAMOVITZ, M. (1986), "Catching Up, Forging Ahead, and Falling Behind", *Journal of Economic History*, 46, pp. 5–53.
- ACEMOGLU, D. (1996), "A Microfoundation for Social Increasing Returns in Human Capital Accumulation", *Quarterly Journal of Economics*, Vol. CXI, No. 3, August, pp. 779–804.
- ACEMOGLU, D. (1998), "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality", *Quarterly Journal of Economics*, Vol. CXIII, No. 4, November, pp. 1055–1089.
- ALESINA, A. (1995), "The Political Economy of Macroeconomic Stabilizations and Income Inequality: Myths and Reality", *IMF Conference on Income Distribution and Sustainable Growth*, Washington, D.C., 1–2 June.
- ADLER, P.S. (ed.) (1992), *Technology and the Future of Work*, Oxford University Press, New York.
- ATTEWELL, P. (1992), "Skill and Occupational Changes in US Manufacturing", in ADLER (ed.), *op. cit.*, pp. 46–88.
- AUTOR, D.H., L.F. KATZ AND A.B. KRUEGER (1997), "Computing Inequality: Have Computers Changed the Labour Market?" NBER Working Paper No.5956, March, Cambridge, MA.
- AZARIADIS, C. AND A. DRAZEN (1990), "Threshold Externalities in Economic Development", *Quarterly Journal of Economics*, May, pp. 501–526.
- BARBA NAVARETTI, G., I. SOLOAGA AND W. TAKACS (1998), "When Vintage Technology Makes Sense: Matching Imports to Skills", World Bank Working Paper No. WPS 1923, Washington, D.C.
- BARRO, R.J. (1991), "Economic Growth in a Cross Section of Countries", *Quarterly Journal of Economics*, Vol. CVI, pp. 363–94.
- BARRO, R.J. AND J.-W. LEE (1993), "Losers and Winners in Economic Growth", NBER Working Paper No. 4341, April, Cambridge, MA.
- BARTEL, A.P. AND .R. LICHTENBERG (1987), "The Comparative Advantage of Educated Workers in Implementing New Technology", *The Review of Economics and Statistics*, Vol. LXIX, No. 1, February, pp. 1–11.
- BATES, T. (1990), "Entrepreneur Human Capital Inputs and Small Business Longevity", *The Review of Economics and Statistics*, Vol. LXXII, No.4, pp. 551–559.
- BAUMOL, W.J. (1990), "Entrepreneurship: Productive, Unproductive, and Destructive", *Journal of Political Economy*, Vol. 98, no. 5, pp. 893–921.
- BAYDAS, M.M., R.L. MEYER AND N. AGUILERA-ALFRED (1994), "Credit Rationing in Small-Scale Enterprises: Special Microenterprise Programmes in Ecuador", *The Journal of Development Studies*, Vol. 31, No.2, December, pp. 279–309.
- BEN-DAVID, D. (1993), "Equalizing Exchange: Trade Liberalization and Income Convergence", *Quarterly Journal of Economics*, Vol. CVIII, No.3, August, pp. 653–679.
- BENHABIB, J. AND M.M. SPIEGEL (1994), "The role of human capital in economic development: Evidence from aggregate cross-country data", *Journal of Monetary Economics*, 34, pp. 143–173.
- BERMAN, E., J. BOUND AND Z. GRILICHES (1994), "Changes in the Demand for Skilled Labor Within US Manufacturing Industries: Evidence from the Annual Survey of Manufacturing", *Quarterly Journal of Economics*, Vol. CIX, No. 2, May, pp. 367–397.
- BERMAN, E., J. BOUND AND S. MACHIN (1998), "Implications of Skill-Biased Technological Change: International Evidence", *Quarterly Journal of Economics*, Vol. CXIII, No.4, November, pp. 1245–1279.
- BERNARD, A. (1995), "Exporters and trade liberalization in Mexico: Production structure and performance", processed.

- BERNARD, A.B. AND J.B. JENSEN (1997), "Exporters, skill upgrading, and the wage gap", *Journal of International Economics*, 42, pp. 3–31.
- BERNDT, E., C.J. MORISSON AND L.S. ROSENBLUM (1992), "High–Tech Capital Formation and Labor Composition in US Manufacturing Industries: An Exploratory Analysis", NBER Working Paper No. 4010, March.
- BERTHÉLEMY, J.–C., S. DESSUS AND A. VAROUDAKIS (1997), "Capital humain, ouverture extérieure et croissance: estimation sur données de panel d'un modèle à coefficients variables", Document technique no. 121, OECD Development Centre, Paris, January.
- BOISSIERE, M., J.B. KNIGHT AND R.H. SABOT (1985), "Earnings, Schooling, Ability, and Cognitive Skills", *American Economic Review*, Vol. 75, No.5, December, pp. 1016–1030.
- BOOTH, A.L. AND D.J. SNOWER (eds.) (1996), *Acquiring skills: market failures, their symptoms and policy responses*, Cambridge University Press, Cambridge.
- BORENSZTEIN, E., J. DE GREGORIO AND J.–W. LEE (1995), "How Does Foreign Direct Investment Affect Economic Growth?" NBER Working Paper No. 5057, March.
- BORJAS, G.J. AND V.A. RAMEY (1993), "Foreign Competition, Market Power, and Wage Inequality: Theory and Evidence", NBER Working Paper No. 4556, December.
- BRESNAHAN, T.F. (1997), "Computerization and Wage Dispersion: An Analytical Reinterpretation", Paper prepared for the NBER Summer Institute, 4 August.
- CAMERON, G., J. PROUDMAN AND S. REDDING (1997), "Productivity Convergence and International Openness", Bank of England, processed.
- CHAPMAN, B. AND H. TAN (1992), "An Analysis of Youth Training in Australia, 1985–88: Technological Change and Wages", in GREGORY AND KARMELE (eds.).
- CLINE, W.R. (1997), *Trade and Income Distribution*, Institute for International Economics, November, Washington, D.C.
- COE, D.T. AND E. HELPMAN (1995), "International R&D spillovers", *European Economic Review*, 39, May, pp. 859–87.
- COE, D.T., E. HELPMAN AND A.W. HOFFMAISTER (1997), "North–South R&D Spillovers", *The Economic Journal*, 107, January, pp. 134–149.
- COLECCHIA, A. AND G. PAPACONSTANTINOU (1996), "The Evolution of Skills in OECD Countries and the Role of Technology", STI Working Papers 1996/8, OECD, Paris.
- CRAGG, M.I. AND M. EPELBAUM (1996), "Why has wage dispersion grown in Mexico? Is it the incidence of reforms or the growing demand for skills?" *Journal of Development Economics*, Vol. 51, pp. 99–116.
- DAVIS, S.J. (1992), "Cross–Country Patterns of Change in Relative Wages", *NBER Macroeconomics Annual 1992*, MIT Press, Cambridge, Mass.
- DAVIS, S.J. AND J. HALTIWANGER (1991), "Wage Dispersion Between and Within US Manufacturing Plants, 1963–1986", NBER Working Paper No. 3722, May.
- DELONG, J.B. AND L.E. SUMMERS (1991), "Equipment Investment and Economic Growth", *Quarterly Journal of Economics*, 106, pp. 445–502.
- DENNY, M. AND M. FUSS (1983), "The Effects of Factor Prices and Technological Change on the Occupational Demand for Labor: Evidence from Canadian Telecommunications", *The Journal of Human Resources*, Vol. XVII, No. 2, pp. 161–176.
- DOLLAR, D. (1992), "Outward–oriented Developing Economies Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976–1985", *Economic Development and Cultural Change*, Vol. 40, No.3, pp. 523–544.
- DUNNE, T. AND J.A. SCHMITZ, JR. (1992), "Wages, Employer Size–Wage Premia and Employment Structure: Their Relationship to Advanced–Technology Usage in US Manufacturing Establishments", Federal Reserve Bank of Minneapolis, processed.

- EDWARDS, S. (1997), "Openness, Productivity and Growth: What Do We Really Know?", NBER Working Paper No. 5978, March.
- FALLON, P.R. AND P.R.G. LAYARD (1975), "Capital–Skill Complementarity, Income Distribution, and Output Accounting", *Journal of Political Economy*, Vol. 83, No.2, April, pp. 279–301.
- FEENSTRA, R.C. AND G.H. HANSON (1995a), "Foreign Investment, Outsourcing and Relative Wages", NBER Working Paper No. 5121, May.
- Feenstra, R.C. and G.H. Hanson (1995b), "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras", NBER Working Paper No. 5122, May.
- FIELDS, G.S. AND G. YOO (1997), *Falling Labor Income Inequality in Korea's Economic Growth: Patterns and Underlying Causes*, manuscript prepared for the OECD Development Centre, Paris, January, processed.
- FINDLAY, R. (1978), "Relative Backwardness, Direct Foreign Investment and the Transfer of Technology: A Simple Dynamic Model", *Quarterly Journal of Economics*, Vol. XCII, No.1, pp. 1–16.
- FORTIN, N. M. AND T. LEMIEUX (1997), "Institutional Changes and Rising Wage Inequality: Is There a Linkage?" *Journal of Economic Perspectives*, Vol. 11, No.2, Spring, pp. 75–96.
- FREEMAN, R.B. AND L.F. KATZ (eds.) (1995), *Differences and Changes in Wage Structures*. National Bureau of Economic Research Comparative Labor Markets Series, University of Chicago Press, Chicago.
- GODFREY, M. (ed.) (1997), *Skill Development for International Competitiveness*, Edward Elgar, Cheltenham, UK.
- GOLDIN, C. AND L.F. KATZ (1996), "The Origins of Technology–Skill Complementarity", NBER Working Paper No. 5657, July.
- GREGORY, R. AND T. KARMEL (eds.) (1992), *The Australian Longitudinal Survey: Social and Economic Policy Research*, Centre for Economic Policy Research, Australian National University, Canberra.
- GRILICHES, Z. (1997), "Education, Human Capital and Growth: A Personal Perspective", *Journal of Labor Economics*, Vol. 15, No.1, Part 2, pp. S330–S344.
- GROSSMAN, G.M. AND E. HELPMAN (1991), *Innovation and Growth in the Global Economy*, MIT Press, Cambridge, MA.
- GROSSMAN, G.M. AND E. HELPMAN (1995), "Technology and Trade", Chapter 25 of *Handbook of International Economics*, Vol. III, edited by G. Grossman and K. Rogoff, Elsevier Science BV.
- HAMERMESH, D.S. (1993), *Labor Demand*, Princeton University Press, Princeton, NJ.
- HARRISON, A. (1995), "Openness and Growth: A Time–Series, Cross–Country Analysis for Developing Countries", NBER Working Paper No. 5221, August.
- HASKEL, J. (1996), "Small Firms, Contracting–Out, Computers and Wage Inequality: Evidence from UK Manufacturing", CEPR Discussion Paper No. 1490, October, London.
- HASKEL, J.E. AND M.J. SLAUGHTER (1998), "Does the Sector Bias of Skill–Biased Technical Change Explain Changing Wage Inequality?" NBER Working Paper No. 6565, May, Cambridge, MA.
- HOWITT, P. AND P. AGHION (1998), "Capital Accumulation and Innovation in Long–Run Growth", *Journal of Economic Growth*, Vol. 3, No.2, June, pp. 111–130.
- JOHNSON, G. (1970), "The Demand for Labor by Educational Category", *Southern Economic Journal*, 37, pp. 190–204.
- JUHN, C., K.M. MURPHY AND B. PIERCE (1993), "Wage Inequality and the Rise in Returns to Skills", *Journal of Political Economy*, Vol. 101, No.3, pp. 410–442.
- KATZ, L.F. AND K.M. MURPHY (1992), "Changes in Relative Wages, 1963–1987: Supply and Demand Factors", *Quarterly Journal of Economics*, Vol. CVII, No.1, pp. 35–78.
- KEEFE, J.H. (1991), "Numerically controlled machine tools and worker skills", *Industrial and Labor Relations Review*, Vol. 44, April, pp. 503–519.

- KILEY, M.T. (1997), "The Supply of Skilled Labor and Skill-Biased Technological Progress", Division of Research and Statistics, Federal Reserve Board, Washington, D.C., September, processed.
- KIM, D.-I. AND R.H. TOPEL (1995), "Labor Markets and Economic Growth: Lessons from Korea's Industrialization, 1970-1990", in Freeman and Katz, eds., *op. cit.*, pp. 227-64.
- LALL, S. AND G. WIGNARAJA (1997), "Skills and capabilities: Ghana's industrial competitiveness", in Martin Godfrey, ed., *op. cit.*, pp. 274-307.
- LAM, D. AND D. LEVISON (1992), "Declining inequality in schooling in Brazil and its effects on inequality in earnings", *Journal of Development Economics*, 37, pp. 199-225.
- LAWRENCE, R.Z. (1998), "Does a kick in the pants get you going or does it just hurt? The impact of international competition on technological change in US manufacturing", paper presented at NBER Conference on Globalization and Wages, Monterey, California, 27-28 February.
- LEVINE, R. AND D. RENELT (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions", *American Economic Review*, 84(4), pp. 942-963.
- LEVY, F. AND R.J. MURNANE (1996), "With What Skills Are Computers A Complement?" *American Economic Review*, 86, May, pp. 258-62.
- LINDBECK, A. AND D.J. SNOWER (1996), "Reorganization of Firms and Labor-Market Inequality", *American Economic Review*, Papers and Proceedings, Vol. 86, No.2, May, pp. 315- 321.
- LITTLE, I.M.D., D. MAZUMDAR AND J.M. PAGE, JR. (1987), *Small Manufacturing Enterprises: A Comparative Study of India and Other Economies*, Oxford University Press, New York.
- LOCKHEED, M.E., D.T. JAMISON AND L.I. LAU (1980), "Farmer education and farm efficiency: A survey", *Economic Development and Cultural Change*, Vol. 29, No.1, pp. 37-76.
- LOPEZ, R., V. THOMAS AND Y. WANG (1998), "Addressing the Education Puzzle: The Distribution of Education and Economic Reforms", Working Paper, World Bank, Washington, D.C. (processed).
- LUCAS, R.E. (1988), "On the mechanics of economic development", *Journal of Monetary Economics*, 22, pp. 3-42.
- LUCAS, R.E. (1990), "Why Doesn't Capital Flow from Rich to Poor Countries?" *American Economic Review*, Papers and Proceedings, LXXX, pp. 92-96.
- MACDONALD, J.M. (1994), "Does Import Competition Force Efficient Production?" *Review of Economics and Statistics*, Vol. LXXVI, No. 4, November, pp. 721-727.
- MACHIN, S. AND A. MANNING (1997), "Can supply create its own demand? Implications for rising skill differentials", *European Economic Review*, 41, pp. 507-516.
- MANKIW, N., D. ROMER AND D.N. WEIL (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, Vol. CVII, No. 2, May, pp. 407-437.
- McMAHON, W.W. (1998), "Education and Growth in East Asia", *Economics of Education Review*, Vol. 17, No.2, pp. 159-172.
- MILKMAN, R. AND C. PULLMAN (1991), "Technological Change in an Auto Assembly Plant", *Work and Occupations*, Vol. 18, No.2, May, pp. 123-147.
- MINCER, J. (1991), "Human Capital, Technology and the Wage Structure: What Do Time Series Show?", NBER Working Paper No. 3581, January.
- MINCER, J. (1995), "Economic Development, Growth of Human Capital and the Dynamics of the Wage Structure", *Journal of Economic Growth*, 1, March, pp. 29-48.
- MISHEL, L. AND A. BERNSTEIN (1994), *The State of Working America, 1994-95*, M.E. Sharpe, Armonk, N.Y. for the Economic Policy Institute.
- MISHEL, L., A. BERNSTEIN AND J. SCHMITT (1997), *The State of Working America, 1996-97*, M.E. Sharpe, Armonk, N.Y. for the Economic Policy Institute.

- MURNANE, R.J., J.B. WILLETT AND F. LEVY (1995), "The Growing Importance of Cognitive Skills in Wage Determination", *Review of Economics and Statistics*, Vol. LXXVII, No.2, May, pp. 251–266.
- NAFZIGER, E.W. AND D. TERRELL (1996), "Entrepreneurial Human Capital and the Long-Run Survival of Firms in India", *World Development*, Vol. 24, No.4, April, pp. 689–696.
- NELSON, R.R. (1994), "What Has been the Matter with Neo-Classical Growth Theory?" in SILVERBERG AND SOETE (eds.), *op. cit.*, pp. 290–324.
- NELSON, R.R. AND E.S. PHELPS (1966), "Investment in Humans, Technological Diffusion and Economic Growth", *American Economic Review*, Vol. LVI, No.2, May, pp. 69–75.
- NELSON, R.R. AND S. WINTER (1982), *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, MA.
- NELSON, R.R. AND H. PACK (1998), "The Asian Miracle and Modern Growth Theory", Policy Research Working Paper No. 1881, Development Research Group, The World Bank, February, Washington, D.C.
- OECD (1996), *Employment Outlook*, Paris, July.
- OECD (1998), *Education at a Glance — OECD Indicators 1998*, Paris.
- PARENTE, S.L. AND E.C. PRESCOTT (1994), "Barriers to Technology Adoption and Development", *Journal of Political Economy*, Vol. 102, No.2, pp. 298–321.
- PENN, R., A. GASTEEN, H. SCATTERGOOD AND J. SEWEL (1994), "Technical Change and the Division of Labour in Rochdale and Aberdeen", in Penn *et al.*, eds., *op. cit.*, chap. 5.
- PENN, R., M. ROSE AND J. RUBERY (eds.), (1994), *Skill and Occupational Change*, Oxford University Press, Oxford.
- PETSKA-JULIUSSEN, K. AND E. JULIUSSEN (1996), *The 8th Annual Computer Industry Almanac*, October, Florence, Kentucky.
- PISSARIDES, C.A. (1997), "Learning by Trading and the Returns to Human Capital in Developing Countries", *The World Bank Economic Review*, Vol. 11, No.1, pp. 17–32.
- POSTHUMA, A.C. (1995), "Japanese Techniques in Africa? Human Resources and Industrial Restructuring in Zimbabwe", *World Development*, Special Issue, Vol. 23, No. 1, pp. 103–116.
- PRAIS, S.J. (1995), *Productivity, Education and Training: An International Perspective*, N.I.E.S.R. Occasional Papers, No. XLVIII, Cambridge University Press, Cambridge.
- PRITCHETT, L. (1996), "Where Has All the Education Gone?" Policy Research Working Paper 1581, Poverty and Human Resources Division, Policy Research Department, World Bank, Washington, D.C.
- REVENGA, A. (1994), "Employment and wage effects of trade liberalization: The case of Mexican manufacturing", processed.
- ROBERTS, M. AND E. SKOUFIAS (1991), "Plant Characteristics and the Demand for Skilled and Unskilled Labor in the Colombian Manufacturing Sector", Pennsylvania State University, processed.
- ROBBINS, D.J. (1996), "Evidence on Trade and Wages in the Developing World", OECD Development Centre Technical Paper No. 119, December, Paris.
- RODRIK, D. (1997), *Has Globalization Gone Too Far?* Institute for International Economics, Washington, D.C.
- ROMER, P.M. (1990), "Human capital and growth: theory and evidence", Carnegie-Rochester Conference Series on Public Policy, 32, pp. 251–286.
- ROMER, P.M. (1993), "Idea gaps and object gaps in economic development", *Journal of Monetary Economics*, 32, pp. 513–542.
- ROSENBERG, N. AND L.E. BIRDZELL (1986), *How the West Grew Rich: The Economic Transformation of the Industrial World*, I.B. Tauris & Co.Ltd., London.
- RUMBERGER, R.W. (1981), "The Changing Skill Requirements of Jobs in the US Economy", *Industrial and Labor Relations Review*, Vol. 34, No. 4, July, pp. 578–590.

- RUSH, H. AND J.C. FERRAZ (1993), "Employment and skills in Brazil: The implications of new technologies and organizational techniques", *International Labour Review*, Vol. 132, No.1, pp. 75–93.
- SACHS, J.D. AND A. WARNER (1995), "Economic Reform and the Process of Global Integration", *Brookings Papers on Economic Activity*, 1, pp. 1–118.
- SCHERER, F.M. AND K. HUH (1992), "R&D Reactions to High–Technology Import Competition", *Review of Economics and Statistics*, Vol. LXXIV, No. 2, May, pp. 202–212.
- SCHULTZ, T.W. (1963), *The Economic Value of Education*, Columbia University Press, New York.
- SCHULTZ, T.W. (1975), "The Value of the Ability to Deal with Disequilibria", *Journal of Economic Literature*, 13, pp. 827–846.
- SILVERBERG, G. AND L. SOETE (eds.) (1994), *The Economics of Growth and Technical Change: Technologies, Nations, Agents*, Edward Elgar, Aldershot, UK.
- SLAUGHTER, M.J. (1997), "International Trade and Labor–Demand Elasticities", NBER Working Paper No. 6262, November, Cambridge, MA.
- SLAUGHTER, M.J. (1998), "International Trade and Labour–Market Outcomes: Results, Questions and Policy Options", *The Economic Journal*, 108, September, pp. 1452–1462.
- SPENNER, K.I. (1990), "Skill: Meanings, Methods and Measures", *Work and Occupations*, Vol. 17, No.4, November, pp. 399–421.
- STOKEY, N.L. (1991), "Human capital, product quality and growth", *Quarterly Journal of Economics*, Vol. CVI, No. 2, pp. 587–616.
- TAYLOR, J.E. AND A. YUNEZ–NAUDE (1999), *Education, Migration and Productivity: An Analytical Approach and Evidence from Rural Mexico*, OECD Development Centre, Paris.
- THE PROJECT GROUP FOR "RESEARCH ON PRIVATE ENTREPRENEURS IN CONTEMPORARY CHINA" (1995), "The Group Characteristics of the Owners of Private Businesses in China", *Social Sciences in China*, Summer, pp. 61–69.
- UNIDO (1995), *Industrial Development. Global Report 1995*, Oxford University Press, Oxford.
- VIJVERBERG, W.P.M. (1995), "Returns to Schooling in Non–Farm Self–Employment: An Econometric Case Study of Ghana", *World Development*, Vol. 23, No.7, pp. 1215–1227.
- WANG, J.–Y. (1990), "Growth, Technology Transfer and the Long–Run Theory of International Capital Movements", *Journal of International Economics*, 29, pp. 255–271.
- WANG, J.–Y. AND M. BLOMSTROM (1992), "Foreign investment and technology transfer: A simple model", *European Economic Review*, 36, pp. 137–155.
- WOLFF, E.N. (1996), "Technology and the Demand for Skills", *STI Review*, OECD, Paris, No. 18, pp. 95–123.
- WOOD, A. (1994), *North–South Trade, Employment and Inequality*, Clarendon, Oxford.
- WOOD, A. (1997), "Openness and Wage Inequality in Developing Countries: The Latin American Challenge to East Asian Conventional Wisdom", *The World Bank Economic Review*, Vol. 11, No.1, pp. 33–57.
- WOOD, A. (1998), "Globalisation and the Rise in Labour Market Inequalities", *The Economic Journal*, 108, September, pp. 1463–1482.
- WOOD, A. AND E. ANDERSON (1998), "Does Heckscher–Ohlin Theory Explain Why the Decline in Demand for Unskilled Labour in the North First Accelerated and Then Decelerated?" Institute of Development Studies, University of Sussex, 6 August, processed.
- WOOD, A. AND C. RIDAO–CANO (1999), "Skill, trade, and international inequality", *Oxford Economic Papers*, Vol. 51, No. 1, January, pp. 89–119.
- YOUNG, A. (1991), "Learning by doing and the dynamic effects of international trade", *Quarterly Journal of Economics*, Vol. CVI, No. 2, pp. 369–405.