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The fading productivity of schooling in East Asia

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The Fading Productivity of Schooling in East Asia

by

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The Fading Productivity of Schooling in East Asia

ABSTRACT

We compare changes in schooling output and in schooling input of six East Asian countries to derive a measure of productivity change. Our results question the impression that all is well with education in East Asia. First, we find that the cognitive achievement of pupils did not change substantially in 1980-94 (except for the Philippines, where it most likely declined). Hence schooling output largely remained flat or worsened. Second, we find that the relative price of schooling increased by more than would be warranted by zero productivity growth in schooling. Therefore, we conclude that schooling productivity has declined. The main reason for the fading productivity of schooling appears to be a decline in the pupil-teacher ratio.

JEL: I2

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I. Introduction and Summary

Most East Asian countries have achieved universal coverage of girls and boys in basic schooling. In addition, pupils from many East Asian countries have performed rather well in recent international comparisons of cognitive achievement. The impressive schooling record has led some observers to conclude that formal education played an important role in explaining the "East Asian miracle" (World Bank 1993). Mingat (1997: 714) concludes that East Asian countries have successfully attached high educational outcomes while keeping the burden of public finance "reasonable". However, not all is well with education in East Asia. We show that the productivity of schooling in a number of East Asian countries declined in 1980-1994.

Our assessment of schooling productivity is based on Baumol's cost-disease model (section II). This model can be used to derive a measure of the change in the productivity of schooling based on the change in the relative price of schooling, given that schooling output remains constant. We measure changes in schooling output as changes in the performance of pupils in internationally standardized tests of cognitive achievement in 1980 and in 1994 (section III). Notwithstanding minor improvements and deteriorations, we find that schooling output largely remained unchanged in Hong Kong, Japan, South Korea, Singapore, and Thailand, while it probably declined in the Philippines. With no significant improvement in schooling output in East Asia, changes in the

relative price of schooling can be used, as presumed by the model, to identify changes in the productivity of schooling.

We use public expenditures per pupil on primary and secondary education in 1980 and 1994 to derive a measure of the change in the price of schooling (section IV). Despite substantial quantitative differences across the six East Asian countries, we find that the price of schooling increased faster than total factor productivity in all economies, and it also increased faster than the price of other services with inherently low or zero productivity growth. Both findings imply that the productivity of schooling declined.

The main reason for the decline of schooling-productivity appears to be a decline in the pupil-teacher ratio (section V). More resources have been allocated to schooling in East Asian countries without a subsequent change in schooling output. Our results on the fading productivity of schooling in East Asia are similar to Hanushek's (1997) findings for the United States. They tend to confirm the positive theory of education expenditure by Pritchett and Filmer (1999), who claim that resource allocation in schooling does not follow a constrained output-maximizing rule. In their model of the schooling sector, resource allocation is mainly determined through rent seeking and not through competitive markets. Because the structure of public schools in the United States does not provide incentives to improve student performance or save on costs, it is not particularly surprising that these do not happen (Hanushek et al.

1994). With regard to incentives, public schools in East Asia may not be different.

II. Modeling Schooling Productivity

Schooling, like other services, is most likely to be a sector with stagnant productivity. The proverbial example of a stagnant-productivity service is a haircut, where the consumer is part of the product, the production is labor intensive, and the technology is tried and tested. In a way, schooling seems to share the same features. The combination of these features hinders productivity growth: the resources and the time required to produce a haircut or a unit of schooling output may not have changed that much over time, notwithstanding changes of fashion.

The cost-disease model suggested by Baumol (1967) was devised to explain the cost problems that will be encountered by any sector with little or zero productivity growth. The model describes an economy with two sectors, one with rising and the other with constant productivity. An application to the schooling sector is straightforward and was already envisaged in the paper by Baumol (1967). To keep the theoretical structure as simple as possible, a constant amount of labor (L) is assumed to be the only factor of production. The two sectors of the model are schooling (S), with constant productivity, and the rest of the economy (R) with exponential productivity growth. Output of the two

sectors can be described by two production functions as

$$(1) \quad Y_S = aL_S \quad \text{and}$$

$$(2) \quad Y_R = bL_R e^{r \cdot t},$$

where Y_i is the level of output of sector i in time t (t subscripts are omitted), a and b are constants, L_i is quantity of labor employed in sector i , and r is the exogenous rate of sectoral productivity growth that is assumed to be zero in the case of schooling. Wages per unit of labor (w) in the economy are determined in a competitive labor market and grow according to the sectoral rate of productivity growth:

$$(3) \quad w = c e^{r \cdot t},$$

where c is a constant.

Prices in the two sectors are assumed to be set in competitive markets where price (p) must equal marginal cost. With only one input, marginal cost is defined by the wage divided by the physical marginal product of labor (mpl). The physical marginal product is given by the derivative of the production function with respect to labor, hence the relative price of schooling follows as

$$(4) \quad p_S / p_R = (w / mpl_S) / (w / mpl_R) = (b / a) e^{r \cdot t},$$

which demonstrates that the relative price of the constant-productivity sector rises over time in proportion to the exogenous rate of sectoral productivity

growth r (Inman 1985). Thus, whenever the relative price of that sector rises by more than r , its productivity must have declined.

To use the model for an empirical analysis of changes in the productivity of schooling, we introduce two auxiliary assumptions. Assumption 1 is that schooling as well as all other service industries exhibit zero productivity growth. If so, an estimate of productivity growth in the non-service sector establishes a benchmark for the change in the relative price of schooling that would be compatible with an efficient allocation of resources. Assumption 2 is that comparing the change in the nominal price of schooling with changes in the prices of other services allows for an implicit assessment of changes in productivity between schooling and other services. Such a comparison would show how schooling performed relative to, say, government services or community, social, and personal services, which are likely to display stagnant or near-stagnant productivity.

Under assumption 1, the economy-wide rate of productivity growth, which we call the growth rate of total factor productivity (g_{TFP}), is given by

$$(5) \quad g_{TFP} = r \frac{Y_R}{Y} + r_S \frac{Y_S}{Y} \quad \text{and hence}$$

$$(6) \quad r = g_{TFP} / (Y_R / Y)$$

if productivity growth in services r_S (including schooling) is zero, with Y_S / Y

as the output share of services and Y_R / Y as the output share of the residual non-service sector. With the price level of economy-wide output (GDP) written as

$$(7) \quad p_{GDP} = p_S^{(Y_S / Y)} \cdot p_R^{(Y_R / Y)} ,$$

it follows that

$$(8) \quad \Delta p_S - \Delta p_{GDP} = \Delta p_S - \left(\frac{Y_S}{Y} \right) \Delta p_S - \left(\frac{Y_R}{Y} \right) \Delta p_R \quad \text{and hence}$$

$$(9) \quad \Delta p_S - \Delta p_R = \frac{\Delta p_S - \Delta p_{GDP}}{Y_R / Y} = r ,$$

where Δ indicates an annual rate of change.

Equation (9) clarifies that the true change in the relative price of schooling (and other services) will be underestimated if changes in the nominal price of schooling are simply deflated by a general price index such as the GDP deflator or the CPI deflator (Hanushek and Rivkin 1997). A GDP-deflated change in the price of schooling has to be divided by the output share of the residual non-service sector of the economy before it can be compared with the rate of productivity growth in the non-service sector. This benchmark reflects the expected rate of increase of schooling resources (labor input) that would prevail under conditions of efficiency since for any constant relation of sectoral output Y_S / Y_R it follows that

$$(10) \quad L_S = dL_R e^{r \cdot t} \quad \text{and hence}$$

$$(11) \quad \Delta L_S = r ,$$

where d equals the constant output ratio.¹

Alternatively, a GDP-deflated change in the price of schooling could be directly compared with the economy-wide growth rate of total factor productivity, since inserting (6) into (9) gives

$$(12) \quad \Delta p_S - \Delta p_{GDP} = g_{TFP} ,$$

which shows that changes in the GDP-deflated price of schooling should equal the growth rate of total factor productivity for an efficient allocation of schooling resources under assumption 1.

Under assumption 2, the model would be applied only to the service sector. In this interpretation, S would indicate schooling as before and R would indicate remaining other service sectors. Except for this change in scope, all equations could be used as before, with g_{TFP} as the weighted growth rate of total factor productivity of schooling and other services. If productivity is constant for all service industries ($r=0$), the price of schooling relative to other services

¹ To maintain the existence of a sector with constant productivity (schooling) along with a sector with positive productivity growth, the demand for its products (the demand for schooling) would have to be income elastic or price inelastic, because otherwise the output ratio of the constant-productivity sector would decline towards zero under conditions of efficiency.

should not change over time since equation (4) would read

$$(4') \quad p_S / p_R = (w / mpl_S) / (w / mpl_R) = (b / a) .$$

Our model results under assumption 1 and under assumption 2 depend on a fixed relation between schooling output and schooling input. If schooling productivity were not constant but rising, the economy-wide rate of productivity growth would exceed the increase in the GDP-deflated price of schooling. By contrast, if schooling productivity were declining, the GDP-deflated price of schooling should exceed the economy-wide rate of productivity growth. And if the increase in the relative price of schooling exceeds the increase in the relative price of other services, productivity growth in schooling would lag behind the typically low rate of productivity growth of other service sectors.

III. Calculating Changes in Schooling Output over Time

The main problem with an empirical estimation of the predicted effects lies with a measurement of schooling output over time. Measurement of output in service sectors is notoriously difficult because observed expenditure figures are difficult to disentangle into price and quality-adjusted quantity components. In this regard, measuring schooling output is easier because there are regular external measures of schooling output such as student achievement tests that do not rely on observed expenditures. However, the available measures of student

achievement for selected East Asian countries have to be transformed into a common format before they can be compared over time.

Consistent time-series data on the cognitive achievement of pupils in standardized tests are available only for the case of the United States. The National Assessment of Educational Progress (NAEP) began to monitor the performance of pupils aged 9, 13 and 17 years in mathematics and science in the early 1970s. The NAEP has used the same assessment content and the same administration procedures over time, so the reported average test scores of US pupils are intertemporally comparable.

Table 1 shows US test scores by age groups and subjects in 1977/78, 1982, and 1994. Our interpretation is that there has been no substantial change in the average performance of US pupils in 1980-1994. This interpretation is in line with Hanushek (1997: 186) who concludes on the basis of these data that "the overall trend in student performance has been flat or falling" from the early 1970s through 1994. As a benchmark for our further calculations, we assume a constant cognitive achievement of US pupils in 1980-1994.

In addition to the time series US evidence, test scores in various subjects are available for pupils of different age from a number of countries in selected years. The International Association for the Evaluation of Educational Achievement (IEA) has conducted a cross-country science study in 1983-84 and a cross-country mathematics studies in 1980-82, including selected East Asian

countries. The IEA's Third International Mathematics and Science Study (TIMSS) in 1994-95 integrated the two subjects. The studies differ with regard to the inclusion of subtests for pupils in the primary (age 10 or 3rd and 4th grade), middle (age 13 or 7th and 8th grade), and final (age 17) school years, and they also differ with regard to the inclusion of East Asian countries in the various subtests. Table A.1 in the appendix provides the available test score results for Hong Kong, Japan, the Philippines, Singapore, South Korea, and Thailand, in addition to results for OECD countries.

Based on these data, we attempt to estimate changes in the cognitive achievement of East Asian pupils in mathematics and science. Direct comparisons of the results of the early 1980s with the results of the mid-1990s are not possible because the design of test questions, the distribution of difficult and easy questions within a test, and the format in which test results are reported has changed. Nevertheless, we can calculate changes in the performance of pupils for each country over time subject to specific assumptions about the mean and the standard deviation of the reported test results. This is possible at least as a rough approximation because for each study, we know the performance of pupils from East Asian countries relative to the intertemporally constant performance of US pupils.

To make the different test results comparable over time, the underlying sample distributions and sample means have to be converted to a common scale.

We use alternative hypotheses to define such a common scale. Our hypotheses center around the idea that the performance of US pupils has remained constant and that the distribution of results among the relatively homogenous group of OECD countries should not have changed substantially between the early 1980s and the mid-1990s. To rescale the original TIMSS test scores, which are constructed under the assumption of a mean of 500 and a standard deviation of 100, we calculate an average sample distribution and an average mean *across all OECD countries* in the TIMSS-subtests. We then rescale the IEA II test scores using the same assumption of a constant sample mean and a constant sample distribution across OECD countries. To check for the robustness of our procedure, we compare three alternative hypotheses regarding the mean and the standard deviation of the reported cross-country test scores.

Our first hypothesis is that

H1: The mean of the OECD test scores and the standard deviation per mean of the OECD test scores are constant across all subtests.

To implement H1, we can transform the test scores of Table A.1 according to

$$(13) \quad TTS_t^i = \left(\frac{S_t^i}{\overline{mean}_t^{OECD}} - 1 \right) \cdot \frac{\overline{sdm}^{OECD}}{sdm_t^{OECD}} + 1 ,$$

where TTS_t^i is the transformed test score for country i in subtest t , S_t^i is the original test score for country i in subtest t , \overline{mean}_t^{OECD} is the mean of test

scores of the OECD countries in subtest t , $\overline{sdm_{TIMSS}^{OECD}}$ is the average standard deviation per mean across the OECD countries in the TIMSS subtests, and sdm_t^{OECD} is the actual standard deviation per mean across the OECD countries in subtest t .²

This transformation gives us a test score for each East Asian country which represents a sample distribution with the constant mean of the OECD countries and the constant standard deviation per mean across the OECD countries in all subtests. Hypothesis 1 is justified if the distribution of test scores across OECD countries did not change substantially over time.³ As noted above, we use the average standard deviation per mean across OECD countries of the TIMSS subtests as the common standard deviation among OECD countries which we apply to all subtests. That is, we present results as if the standard deviation per mean among OECD countries reported under the TIMSS test design would have also prevailed in all subtests conducted in the early 1980s.

Given the transformed test scores, the change in schooling output as measured by the change in the cognitive achievement of pupils can be calculated for each country according to

² The results derived on the basis of equation (13) are independent of the level of the mean which is chosen to be the same in all subtests.

³ Hanushek and Kim (1995) assume in one of their calculations that the mean and the standard deviation remains constant *for the sample of countries participating in the respective subtest*. This is a problematic assumption because different groups of countries participated in the different subtests.

$$(14) \quad ISO^i = \frac{\frac{1}{s} \sum_s \frac{1}{a} \sum_a \frac{TTS_{94,s,a}^i}{TTS_{94,s,a}^{US}}}{\frac{1}{s} \sum_s \frac{1}{a} \sum_a \frac{TTS_{80,s,a}^i}{TTS_{80,s,a}^{US}}} \cdot 100 ,$$

where ISO^i is an index of schooling output of country i in 1994 with base year 1980 set to 100, subject s is either equal to 1 (single measure for science or mathematics) or to 2 (combined science and mathematics measure), age group a is equal to 3 for the 1983 science study (with 1 = primary school years, 2 = middle school years, and 3 = final school years) and 2 for the other studies (given that there are no tests in the primary school years in the 1980 mathematics study and that no East Asian country participated in the TIMSS final-year study), and $TTS_{t,s,a}^i$ is the transformed test score of country i at time t in subject s and age group a .⁴ By construction, ISO allows for a comparison within a country over time, but it does not allow for a comparison of levels across countries because the rescaling of tests scores depends on ad hoc assumptions about the respective sample mean and sample distribution.

We present our estimates of changes in schooling output under H1 in Table 2. Column (1) lists changes in test scores in science, column (2) lists changes in

⁴ Missing data for subtest scores, as evident from Table A.1, are replaced by assuming that the test score of a country relative to the United States in a specific subtest is equal to the average score of that country relative to the United States in the other subtests for the given subject and year.

test scores in mathematics, and column (3) lists a simple average. Our figures suggest that the performance of Korean and Singaporean pupils (in science) slightly increased in 1980-1994, while the performance of pupils in Hong Kong, Japan and Thailand slightly decreased. The average performance of pupils from the Philippines in science seems to have deteriorated substantially. While the performance trend was similar in both science and mathematics in Hong Kong and Japan, Thai pupils seem to have improved their mathematical skills while their skills in science decreased.

To see how much our results depend on the specific assumptions made, we introduce two further hypotheses regarding the sample mean and the sample distribution of test scores.⁵ Under H2, which is probably less restrictive than H1, we assume that the US test score and the standard deviation of the OECD countries' test scores per US score remained constant across all subtests, while the OECD sample mean is now allowed to differ:

H2: The US test score and the standard deviation per US test score of the OECD test scores are constant across all subtests.⁶

This hypothesis directly takes into account that the performance of US pupils did not change significantly in 1980-1994 while leaving open the performance of pupils from other OECD countries. For our calculation of the transformed

⁵ For a more detailed discussion of the different hypotheses and of the properties of the *ISO* measure, see Gundlach et al. (1999).

test scores under H2, equation (13) now uses the US test score and the average standard deviation of OECD scores per US test score in the TIMSS subtests instead of the OECD mean and the average standard deviation per mean across the OECD countries as before. Hence our transformed test data under H2 imply that each subtest has the same US test score and the same standard deviation per US test score of the OECD countries, but different OECD means.⁶ Columns (4)-(6) of Table 2 show our estimates of changes in schooling output under H2. The results are almost identical to the results derived under H1. In Hong Kong, Japan, Singapore, South Korea, and Thailand, schooling output did not change by much in 1980-1994, but it deteriorated substantially in the Philippines.

Finally, we employ a third hypothesis to allow for an alternative sample distribution. Under H3, we assume that in addition to a constant US test score across subtests, the deviation of the test scores of the OECD countries from the US test score (as opposed to the standard deviation of the OECD countries) did not change across subtests:

H3: The US test score and the deviation of OECD test scores from the US test score are constant across all subtests.

We calculate the deviation of OECD test scores from the US test score by

$$(15) \quad dev_i^{US} = \sqrt{\frac{1}{n} \sum_n (U_i^i - U_i^{US})^2} ,$$

⁶ Results derived under H2 (and H3) are independent from the chosen level of the US test score applied to all subtests.

where dev_t^{US} is the deviation from the US test score in subtest t , n is the size of the OECD sample excluding the United States ($n=9$), and U_t^i are transformed test scores for OECD country i in subtest t with the same US test score across subtests ($U_t^i = S_t^i / S_t^{US}$).

Using equation (15) and the average deviation of OECD test scores from the US test score of the TIMSS subtests as the common standard deviation, we can again transform the East Asian test scores according to equation (13). Columns (7)-(9) of Table 2 show our estimates of changes in schooling output under H3. We find that the results derived under H3 do not differ substantially from our results derived under H1 and H2. Schooling output apparently did not change by much in the East Asian countries considered in 1980-1994 except for the Philippines, where it declined.

We interpret our findings under H1-H3 as suggesting that no East Asian country has achieved a major increase in schooling output in 1980-1994. If so, changes in the GDP-deflated price of schooling should largely reflect changes in the economy-wide rate of productivity growth (assumption 1) or changes in the price of other services (assumption 2), as outlined by the model of section II. The question is whether observed changes in the price of schooling are compatible with the model's theoretical base line of zero productivity growth in schooling.

IV. Measuring Changes in the Price of Schooling

We derive a measure of the price of schooling by using the definition that total expenditure equals price times quantity. Dividing total current expenditure on primary and secondary education by the number of pupils enrolled, which controls for quantity, we obtain the price of schooling for a given quality of schooling output as

$$(16) \quad p_s = EXPPUP_i^t = \frac{CUREXP_i^t \cdot (PERFIR_i^t + PERSEC_i^t)}{(PUPFIR_i^t + PUPSEC_i^t)},$$

where $EXPPUP_i^t$ is educational expenditure per pupil in country i at time t , $CUREXP_i^t$ is current educational expenditure, $PERFIR_i^t$ is the percentage of current expenditure spent at the first level of education, $PERSEC_i^t$ is the percentage of current expenditure spent at the second level of education, $PUPFIR_i^t$ is the number of pupils enrolled at the first level of education, and $PUPSEC_i^t$ is the number of pupils enrolled at the second level of education.

Data on schooling expenditure and pupils are taken from various issues of the UNESCO Statistical Yearbook (see Table A.2).⁷ The figures for several

⁷ In the UNESCO data, the identification of primary and secondary educational institutions is based on the International Standard Classification of Education (ISCED). According to ISCED, education at the first level (ISCED level 1) is education whose main function is to provide the basic elements of education (e.g. elementary schools, primary schools). Education at the second level (ISCED levels 2 and 3) provides general and/or specialized instruction as provided by middle schools, secondary schools, high schools, and vocational or technical institutions

countries had to be adjusted to ensure comparability of results over time. In the appendix, we list in detail all adjustments made. The appendix also includes all basic expenditure and enrollment data used for our calculations. Column (1) of Table 3 shows the average annual growth rate of the nominal price of schooling as computed by equation (16) in the six East Asian countries considered in 1980-1994. We find a substantial increase in the nominal price of schooling in all cases. Rates of change range from 6.1 percent in Japan to 18.0 percent in South Korea. These differences are likely to reflect differences in economy-wide inflation rates together with potential differences in the change of schooling productivity.

Our findings may overstate the true increase in the price of schooling if spending on more expensive secondary education increased relative to spending on primary education. Therefore, we recalculate changes in the price of schooling in 1980-1994 as if the shares of pupils in primary and in secondary education had remained constant at their 1980 level. Column (2) of Table 3 shows that for all countries, the difference relative to column (1) is less than 0.2 percentage points. Therefore, a shift in the structure of expenditure towards secondary education cannot account for the large increase in the nominal price

and is based on at least four years of previous instruction at the first level. In our analysis, we do not consider pre-primary education and education at the third level (e.g. universities).

of schooling in some East Asian countries.⁸

We employ three alternative deflators to derive a measure of the relative price of schooling which can be used to identify changes in schooling productivity, given that schooling output has remained constant. We use national accounts statistics provided by UN (var. iss.) to calculate (i) a GDP deflator, (ii) a deflator for producers of government services (PGS), and (iii) a deflator for community, social and personal services (CSPS). The GDP deflator (Table 3, column (3)) measures the economy-wide rate of inflation. The PGS deflator (column (4)) measures the increase of prices of public sector services, which includes the price of schooling. The CSPS deflator (column (5)) measures the increase of prices of privately provided services,⁹ which may be similar to

⁸ In the Philippines, no breakdown of schooling expenditure between the first and second level is available for 1994 data. However, the shift from first-level to second-level pupils was smaller in the Philippines than in any other country for which results are reported here. Hence it is unlikely that the small shift towards secondary education had a major impact on the change-in the price of schooling in the case of the Philippines.

⁹ In the System of National Accounts (SNA), "Community, social and personal services" equal that part of ISIC category 9 which is privately provided in a profit-oriented way. That is, economic activities of producers of government services, private non-profit services to households, and domestic services are subtracted from ISIC 9 to obtain only those services which are supplied by establishments whose activities are intended to be self-sustaining, whether through production for the market or for own use. ISIC category 9 does not include services such as wholesale and retail trade, communication and transportation, and financing, insurance, and real estate and business services, which all may be considered to experience at least modest productivity gains.

schooling in terms of their high labor intensity and their expected low rate of productivity growth. For every country in the sample, the two service deflators exceed the GDP deflator by more than half a percentage point; in some cases the difference exceeds two percentage points. These empirical facts are in line with the assumption of the cost-disease model of section II that productivity growth in services is below the economy-wide average.

As outlined in section II, one possibility to assess productivity change in schooling is to compare measures of total factor productivity growth (TFP growth) with the GDP-deflated increase in the price of schooling (see equation (12)). Using estimates of total factor productivity from a number of different sources that match the time period 1980-1994 as closely as possible (Table 4, column 1), we find that the increase in the GDP-deflated price of schooling exceeds the estimated TFP growth rates by an order of magnitude in all cases except for the Philippines (column 4). Given that schooling output fell in the Philippines and did not rise significantly on the other cases, this result is inconsistent with an efficient allocation of schooling resources in the six East Asian countries under consideration.

Another possibility to assess productivity change in schooling is to compare the increase in the price of schooling with the increase in the price of comparable services. This approach has the advantage that no estimates of total

factor productivity growth are needed, which are inherently unreliable.¹⁰ Given that official estimates of changes in services prices are reliable, we show the difference between the increase in the price of schooling and the averaged increase in the PGS- and the CSPA-deflator in 1980-1994 in column (5) of Table 4. Again except for the Philippines, all other East Asian countries experienced a substantial rise in the price of schooling relative to the price of other services.

Our main finding is that the structure of results across countries is basically the same under both measures of productivity change in schooling, despite admitted ambiguities about the reliability of estimates of TFP-growth and of changes in services prices. Our figures imply that it does not matter much whether we compare changes in the GDP-deflated price of schooling with the growth rate of TFP or whether we compare changes in the price of schooling with changes in other services prices. On both counts, there is a huge increase in the price of schooling which cannot be reconciled with an efficient allocation of schooling resources. The largest increases in the comparative price of schooling occurred in Korea and Thailand, followed by Hong Kong, Singapore, and Japan. The smallest increase occurred in the Philippines, but this is the country where schooling output seems to have declined substantially (see section III).

¹⁰ See, e.g., Gundlach et al. (1998) for the problems involved in calculating total factor productivity. For a critical survey of recent estimates of TFP growth in East Asia, see Felipe (1999).

Hence schooling productivity is fading in all East Asian countries considered.

V. Assessing the Decline of Schooling Productivity in East Asia

We summarize our results on changes in schooling output and changes in schooling input in six East Asian countries in Figure 1. On the vertical axis, we use an average of mathematics and science test results derived under H2 in section III as our measure of changes in schooling output. On the horizontal axis, we use the average of the PGS and the CSPA deflators as in section IV to calculate the relative price of schooling. Under an efficient allocation of resources, the expected correlation between changes in the relative price of schooling and changes in schooling output would result as an upward-sloping line through the point where *ISO* is equal to 100 and the change in the relative price of schooling is zero (no change in inputs and no change in output). Yet no such correlation emerges in Figure 1.

Recalling that the increase in the relative price of schooling mirrors an overproportionate increase in schooling resources, generously rising schooling expenditure apparently did not generate strong performance effects. At the same time, holding schooling expenditure at bay, as in the Philippines, seems to have generated devastating performance effects. To understand where the changes in schooling expenditure per pupil come from, we first note that total spending on teachers accounts for two thirds to more than 90 percent of total schooling

expenditure in all East Asian countries for which data is available. This figure reduces the possible impact of changes in spending on other educational inputs. Second, since teacher wages are usually constrained by the overall wage level in an economy, changes in the number of teachers employed emerge as the main determinant of changes in educational expenditure per pupil.

We use changes in the pupil-teacher ratio to measure changes in the number of teachers employed. Using data on teaching staff and pupils enrolled in primary and secondary education, Table 5 reports the pupil-teacher ratios in public schools in the six East Asian countries. Pupil-teacher ratios range from 43.5 in South Korea in 1980 to 15.8 in Japan in 1994. In all countries but the Philippines, the pupil-teacher ratio decreased in 1980-1994. Our disaggregated data show that the decline in the pupil-teacher ratio in five East Asian countries results from an increasing number of teachers on top of a decreasing number of pupils. Hence declining pupil-teacher ratios not only reflect demographic factors but a political decision to reallocate government resources towards the education sector. The strongest decline in the pupil-teacher ratio happened in South Korea. This is the country (except for Thailand) with the highest reported increase in relative expenditure per pupil.

South Korea is the only country for which intertemporally comparable data is available on the breakdown of schooling expenditure into further sub-categories. We focus on spending on teachers. Teacher salaries increased by an

average annual rate of 11.9 percent in 1980-1993 in nominal terms. In real terms, teacher salaries increased by less than 5 percent annually when calculated with the GDP deflator of Table 3. At the same time, real GNP per capita increased by an average annual rate of 8.2 percent (World Bank 1995: 163). That is, rising schooling expenditure in South Korea does not reflect disproportionately large increases in teacher salaries but rather the strong increase in the number of teachers employed. The rise in schooling expenditure would have been even larger had the teachers maintained their relative income position.

Taken together, our findings suggest that the productivity of public schooling in several East Asian countries is fading. In this respect, East Asia may not differ from the United States (Hanushek 1997). In both cases, the observed productivity decline of schooling seems to result from a government decision to increase the amount of schooling inputs without controlling for improved schooling output. While the performance of pupils has largely stayed constant (or even declined), the number of teachers per pupil has been increased. Except for the Philippines, the decline in the pupil-teacher ratio appears to be the most important single factor in explaining why the measured productivity of schooling is fading in East Asia.

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Appendix

- Test scores reported for various international tests of the cognitive achievement of pupils are presented in Table A.1. Data on schooling expenditure and on pupils enrolled used in our are presented in Table A.2, and the deflators in Table A.3. The following list reports definitions of variables and their sources. Adjustments and interpolations of the data used for individual countries are explained in detail where appropriate.

(1) Achievement Data (from Lee and Barro (1997) and IEA (1998))

- The 1980-82 mathematics study and the 1983-84 science study were conducted in 17 countries. The different TIMSS subtests were conducted for different sample sizes ranging from 21 countries to 39 countries. The 1980-82 mathematics study was conducted in the middle (pupils aged 13) and final school years. The 1983-84 science study includes three subtests for pupils in the primary (10), middle (13), and final school years. The TIMSS study was conducted in the primary, middle, and final school years. However, no East Asian country took part in the final-years test. For the TIMSS study, pupils in the primary school years are selected from the two grades with the largest proportions of 9-year-olds (third and fourth grades) and pupils in the middle school years are selected from the two grades with the largest proportions of 13-year-olds (seventh and eighth grades). Final school years always refers to pupils in their last year of secondary education.
- The data for the second IEA mathematics study and the second IEA science study

are taken from Lee and Barro (1997). They are reported in percent-correct format.

- The TIMSS data are taken from several publications by the IEA (1998). They are reported in proficiency scale, which is constructed to generate an international mean of 500 and a standard deviation of 100 over the range of 0 to 1000 for the countries participating in a test. For the Philippines, the characteristics of its school sample are not completely known.

(2) Data on Schooling Expenditure and Pupils Enrolled (from UNESCO, Statistical Yearbook, var. iss.)

- For Hong Kong, the ending year of the education data sample period is 1995 instead of 1994, so that the figures reported are average annual growth rates over a 15 year period. For Korea, the ending year of the education data sample period is 1993 instead of 1994 because of a structural break in Korean data in 1994, so that the figures reported are average annual growth rates over a 13 year period.

CUREXP: Current public expenditure on education (Table 4.1 of the 1998 Yearbook)

- For the Philippines, the 1994 figure is taken from 1995. For Japan, the 1994 figure is total expenditure on education in 1994 times current expenditure as percent of total expenditure (in the most recent year available).

PERFIR: Percentage of current educational expenditure spent at the first level of education (Table 4.2 of the 1998 Yearbook)

- For the Philippines, the 1994 percentage figure is the figure in the most recent year

available. For Singapore, the 1994 percentage figure is taken from 1995. For Thailand, the 1980 percentage figure is taken from 1981.

PERSEC: Percentage of current educational expenditure spent at the second level of education (Table 4.2 of the 1998 Yearbook)

- For the Philippines, the 1994 percentage figure is the figure in the most recent year available. For Singapore, the 1994 percentage figure is taken from 1995. For Thailand, the 1980 percentage figure is taken from 1981.

PUPFIR: Total pupils enrolled at the first level of education (Table 3.4 of the 1998 Yearbook)

PUPSEC: Total pupils enrolled at the second level of education (Table 3.7 of the 1998 Yearbook)

- For Singapore, the vocational part of the 1994 figure is full time enrollment only.

(3) Deflator Data (from United Nations, National Accounts Statistics, var. iss.)

- Deflators for a given year are calculated by dividing expenditure in current prices by expenditure in constant prices, after adjusting the constant-price data so as to reflect the most recent base year as a common base year. The GDP figures are taken from Tables 1.1 and 1.2 of the UN National Accounts Statistics. The PGS and CSPS figures are the categories of the SNA kind-of-activity classification called "Producers of government services" and "Community, social and personal services", taken from Tables 1.10 and 1.11.
- The reported deflator figures for Korea are average annual growth rates in 1980-

1993 instead of 1980-1994.

- PGS and CSPA data were not available for the sample period for Hong Kong.

Table A.1: Scores in International Student Achievement Tests

Year: Subject: Age/Grade:	IEA II ^a					TIMSS ^b							
	1980-82		1983-84			1994-95							
	Mathematics		Science			Mathematics		Science		Mathematics		Science	
	13	Final	10	13	Final	4th	3rd	4th	3rd	8th	7th	8th	7th
East Asia													
Hong Kong	49.9	73	46.7	54.7	62.9	587	524	533	482	588	564	522	495
Japan	63.5	68	64.2	67.3	51.4	597	538	574	522	605	571	571	531
Philippines	-	-	39.6	38.3	-	-	-	-	-	399	386	395	382
Singapore	-	-	46.7	55	62.6	625	552	547	488	643	601	607	545
South Korea	-	-	64.2	60.3	-	611	561	597	553	607	577	565	535
Thailand	42.7	31.3	-	55	-	490	444	473	433	522	495	525	493
OECD													
Australia	-	-	53.8	59.3	47.8	546	483	562	510	530	498	545	504
Belgium	52.8	47	-	-	-	-	-	-	-	545.5	532.5	510.5	485.5
Canada	50.9	41.6	57.1	62	40.8	532	469	549	490	527	494	531	499
France	53.5	-	-	-	-	-	-	-	-	538	492	498	451
Netherlands	58.1	-	-	66	-	577	493	557	499	541	516	560	517
New Zealand	46.4	49.8	-	-	-	499	440	531	473	508	472	525	481
Norway	-	-	52.9	59.7	49.8	502	421	530	450	503	461	527	483
Sweden	43.5	55.8	61.3	61.3	44.4	-	-	-	-	519	477	535	488
U.K.	48.8	49.4	48.8	55.7	63.7	516.5	457	543.5	491.5	502	469.5	534.5	490
U.S.A.	46	35.8	55	55	40.4	545	480	565	511	500	476	534	508

^aResults reported in percent-correct format. – ^bResults reported in proficiency scale.

Sources: Lee and Barro (1997); IEA II; IEA (1998); TIMSS.

Table A.2: Data on Schooling Expenditure and Pupils Enrolled

	CUREXP ^a		PERFIR ^b		PERSEC ^{b,c}		PUPFIR		PUPSEC	
	1980	1994	1980	1994	1980	1994	1980	1994	1980	1994
Hong Kong	3 036	29 852	33.7	21.4	35.7	35.0	540 260	467 718	468 975	473 817
Japan	9 416 591	17 200 449	38.2	37.0	34.6	41.8	11 826 573	8 612 106	9 557 563	9 878 568
Philippines	4 023	36 834	61.4	73.1	15.7	inc.	8 033 642	10 903 529	2 928 525	4 762 877
Singapore	587	2 486	35.8	25.7	41.1	34.6	291 722	251 097	187 532	210 473
South Korea	1 158 967	9 344 751	49.9	40.9	33.2	39.0	5 658 002	4 347 317	4 285 889	4 580 040
Thailand	15 867	108 485	55.1	51.0	28.3	21.5	7 392 563	6 291 945	1 919 967	3 382 755

^aIn million units of the local currency. – ^bIn percent. – ^cinc. indicates that the figure is included in PERFIR.

Source: UNESCO (var. iss.).

Table A.3: Deflators

	Base-year	GDP ^a		PGS ^a		CSPS ^a	
		1980	1994	1980	1994	1980	1994
Hong Kong	1990	0.457	1.397	n.a.	n.a.	n.a.	n.a.
Japan	1990	0.841	1.054	0.747	1.121	0.691	1.093
Philippines	1985	0.400	2.209	0.473	3.171	0.456	2.731
Singapore	1990	0.747	1.151	0.611	1.155	0.576	1.182
South Korea	1990	0.505	1.222	0.305	1.461	0.452	1.357
Thailand	1988	0.725	1.340	0.814	1.829	0.765	1.569

^aBase year = 1.

Source: UN (var. iss.).

Table 1: US Student Achievement by Subject and Age Group

Subject	Age Group	1977/78 ^a	1982	1994
Mathematics	9	219	219	231
	13	264	269	274
	17	300	299	306
Science	9	220	221	231
	13	247	250	257
	17	290	283	294

^aMathematics: 1978. Science: 1977.

Source: US Department of Education (1997: 86-88).

Table 2: Changes in Schooling Output, 1980-1994^a

	H1			H2			H3		
	Science (1)	Math (2)	Average (3)	Science (4)	Math (5)	Average (6)	Science. (7)	Math. (8)	Average (9)
Hong Kong	92.6	96.0	94.4	92.6	96.7	94.8	94.6	101.5	98.2
Japan	95.5	94.1	94.7	96.0	94.7	95.3	97.5	98.7	98.1
Philippines	78.6	n.a.	78.6	76.8	n.a.	76.8	78.3	n.a.	78.3
Singapore	101.7	n.a.	101.7	101.9	n.a.	101.9	104.5	n.a.	104.5
South Korea	101.9	n.a.	101.9	102.4	n.a.	102.4	102.2	n.a.	102.2
Thailand	88.6	103.1	95.7	88.1	102.8	95.3	90.5	101.0	95.7

^a1980=100.

Source: Based on Table A.1.

Table 3: The Nominal Price of Schooling and Various Deflators, 1980-1994^a

	Price of schooling Δp_S	Δp_S with constant enrollment shares ^b	GDP deflator Δp_{GDP}	Service deflators	
	(1)	(2)	(3)	PGS Δp_{PGS}	CSPS Δp_{CSPS}
Hong Kong ^c	15.4	15.3	8.3	10.6	15.3
Japan	6.1	6.1	1.6	2.9	6.1
Philippines	13.8	n.a.	13.0	14.6	n.a.
Singapore	9.2	9.0	3.1	4.7	9.0
South Korea ^d	18.0	18.1	7.0	12.8	18.1
Thailand	13.3	13.5	4.5	6.0	13.5

^aAverage annual rates of change, in percent. – ^bCalculated by assuming that the shares of primary and secondary pupils in total schooling enrollment remained constant at the 1980 level. – ^c1980-1995. Service deflators are calculated by adding the average difference between the GDP deflator and the respective service deflator of the other five countries to Hong Kong's GDP deflator. – ^d1980-1993.

Source: Based on Tables A.2 and A.3.

Table 4: Alternative Measures of the Change in Schooling Productivity, 1980-1994

	g_{TFP}^a	$\Delta p_S - \Delta p_{GDP}^b$	$\Delta p_{PGS, CSPS}^b$	Change in schooling productivity 1	Change in schooling productivity 2
	(1)	(2)	(3)	(4)=(1)-(2)	(5)=(3)- Δp_S
Hong Kong	1.7	7.1	10.2	-5.4	-5.2
Japan	0.9	4.5	3.1	-3.6	-3.0
Philippines	-0.8	0.8	14.1	-1.6	0.3
Singapore	2.2	6.1	5.0	-3.9	-4.2
South Korea	2.3	11.0	10.8	-8.7	-7.2
Thailand	2.0	8.8	5.7	-6.8	-7.6

^aHong Kong: 1981-1991 (Young 1995); Japan: 1970-1990 (Marti 1996); Philippines: 1987-1996 (Sarel 1997); Singapore: 1978-1996 (Sarel 1997); South Korea: average of 1984-1994 (Collins and Bosworth 1997) and 1980-1990 (Young 1995); Thailand: 1978-1996 (Sarel 1997). – ^bHong Kong: 1980-1995; South Korea: 1980-1993.

Source: Based on Table 3 and on sources in footnote a.

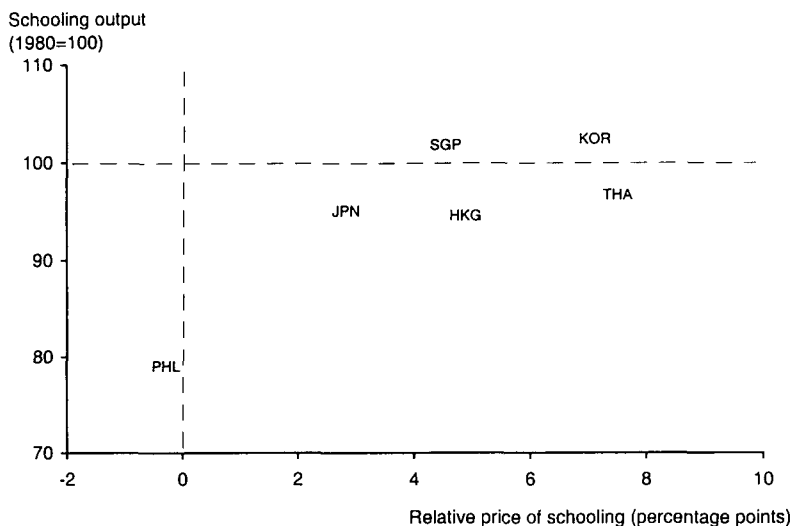
Table 5: Pupil-Teacher Ratios, 1980 and 1994

	Pupil-teacher ratio		Average annual rate of change ^b		
	1980	1994 ^a	Pupils	Teachers	PTR
	(1)	(2)	(3)	(4)	(3)-(4)
Hong Kong	29.8	21.8	-0.5	1.6	-2.1
Japan	20.9	15.8	-1.0	0.9	-1.9
Philippines	31.3	34.3	2.6	1.9	0.7
Singapore	25.5	21.4	-0.3	1.0	-1.2
South Korea	43.5	26.7	-0.8	3.0	-3.7
Thailand	n.a.	19.6	0.1	n.a.	n.a.

^aHong Kong: 1995; Thailand: 1992; South Korea: 1993. – ^bIn percent.

Source: UNESCO (var. iss.).

Figure 1: Changes in Schooling Output^a and in the Relative Price of Schooling^b, 1980-1994



HKG: Hong Kong; JPN: Japan; PHL: Philippines; SGP: Singapore; KOR: South Korea; THA: Thailand.

^aIndex of schooling output based on average mathematics and science test results derived under H2. – ^bAverage annual rate of change of the price of schooling minus the average annual rate of change of the average of the PGS and the CSPS deflators.

Source: Tables 2 and 4.