



**Aggregate Shocks and How Parents Protect  
the Human Capital Accumulation Process:  
An Empirical Study of Indonesia**

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We exploit differences in Indonesian education expenditures in response to the Asian Financial Crisis (AFC) to document human capital investment behavior. Indonesians from rich and poor households adopted different types of strategies to cope with high inflation levels and volatile currency exchange rates. While we find that consumption levels changed little, education expenditures fell and the cost of education rose disproportionately higher. As a consequence, tradeoffs had to be made in the human capital investment of children aged 6 – 14. At the extensive margin, children were still able to receive some form of education, be it formal or informal. But the extent to which parents from different income levels were still able to maintain the educational quality attained by their children is questionable. To attempt to understand the elusive concept of quality of educational outcomes, we use the EBANAS national achievement test scores for transition to a higher level of schooling. Our finding is that the aggregate shock caused some children to self-select themselves out of transition to the next stage despite passing their tests.

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## **1. Introduction**

Parents make sacrifices for their children. They work two jobs, save for the future and try to send their children to good schools. What parents do to invest in their children becomes even more challenging in developing countries. These countries are characterized as having lower income levels, incomplete credit markets, higher risk and practically non-existent safety nets. These particular features of low income settings create a scenario that may severely limit children from achieving their full potential. Yet against all odds, literacy rates are increasing and children have more years of schooling than their parents.

In this paper we aim to document how even with this type of low income setting in a country parents can still choose to invest in their children. Taking the scenario of Indonesia when the population suffered through the Asian Financial Crisis (AFC), we examine how families made schooling decisions for their children. The AFC enables us to compare the behavioral changes of high income and low income families in response to an exogenous shock and over a short period of time. Available data provides us with the opportunity to examine not just whether parents sent their children to school but also the extent to which they invested in the quality of their education.

Using an intra-household allocation approach to trace mechanisms of behavior, we examine changes in prices, household consumption and financial investment in education. These changes are studied in terms of distributions within the household unit. Holding the quality of education constant, we study how the aggregate shock affected real consumption and investment. Regardless of extremely high levels of inflation and volatility in currency exchange rates, we find that children aged 6 – 14 managed to still get an education. Parents from high and low income groups reallocated their household budgets, moved their children to more affordable schools and chose alternative methods of schooling – doing what they could to protect their children’s future. However, it is not necessarily only the poorest households who fared badly in protecting the human capital accumulation process.

This paper contributes to the question of the relationship between family income and human capital. In the literature, Card (1999, 2001) argues for the importance of short term credit constraints in affecting child development. However, Carneiro and Heckman (2003) question the long term consequences of credit constraints for an adolescent's college education. In addition, Card and Krueger (1992) find evidence that parental income or education do not affect state-level rates of return to education, holding constant school quality measures.

In terms of developing countries, unpredictable income flows become a greater threat because consumption smoothing behavior may include reduced education investments (Jacoby and Skoufias, 1997; Cameron and Worswick, 2001). Particularly for Indonesia, Sparrow (2006), studied the Asian Financial Crisis as an income shock. He found that state intervention protected enrollment flows and it seemed to relieve pressure on household investments in education. But Banerjee and Duflo (2008) find that developing country households living on Purchasing Power Parity (PPP) US\$2 - \$10 a day tend to spend more on education per child over time regardless of unpredictability in income flows. This spending is partly in terms of more years of schooling and partly in better quality.

For us, we posit that parents regardless of the risky environment that they live in will still invest in their children. We further extend Sparrow's work by shifting the focus from enrollment flows to household investment and the quality of educational outcomes. We find that quality is a questionable issue. This is because risk mitigation in this environment depends on family income and this exacerbates human capital inequalities within a developing country. Rich families compared to poor families have a larger portfolio of choice in maximizing their investments. As a consequence, there may be disadvantaged children who were forced to substitute low quality schooling for high quality schooling in the short term and could not recover to ex-ante quality levels in the long term. Also within this environment there are political and judicial processes that affect this human capital accumulation; such processes are recognized by Card and Krueger (1992).

To document these changes in household behavior, we use the RAND Corporation Indonesia Family Life Surveys (IFLS2 - 1997 and IFLS3 - 2000). The AFC began at the end of 1997 and continued until the Indonesian foreign exchange rates stabilized in the beginning of 2000. Using households in the same community and the pair-wise matching of schools ex-ante and ex-post the AFC, we study education expenditures of children aged 6 – 14. We use construct our own deflator to calculate the price of education. There are 4,983 observations in IFLS2 and 9,735 observations in IFLS3.

The rest of the paper is organized in the following way. Section 2 provides a description of the AFC in Indonesia. Section 3 describes the human capital accumulation process as a production function in the context of the Indonesian education system. In Section 4 we document patterns of change to prices, consumption and education expenditures. Given these changes we analyze the within-household allocation behavior for the protection of human capital and the inadvertent tradeoffs. The approach that we use in our analysis is non-parametric estimation. This is because we choose not to be heroic and impose strong, arbitrary assumptions about what happens *within* the family. Section 5 covers our conclusions on household choices made by the rich and the poor. While both types of households made sacrifices for their children's future, there is divergence in terms of long term human capital outcomes.

## 2. AFC Aggregate Shock

The AFC occurred at the end of 1997 with effects in the financial markets felt until the beginning of 2000. It had interrupted a thirty year period of rapid growth in East and South East Asia. In Indonesia, real per capita GDP rose four-fold between 1965 and 1995 with an annual growth rate averaging 4.5% until the 1990s when it rose to almost 5.5% (World Bank, 1997). The poverty headcount rate declined from over 40% in 1976 to just under 18% by 1996. Primary school enrollment rates rose from 75% in 1970 to universal enrollment by 1995 and secondary enrollment rates from 13% to 55% over the same period (World Bank, 1997). The total fertility rate fell from 5.6 in 1971 to 2.8 in 1997<sup>1</sup>. Total estimated population in 2008 is 227 million<sup>2</sup>.

In April 1997, the financial crisis began to be felt in the Southeast Asian region, although the major impact did not hit Indonesia until December 1997 and January 1998. Real GDP declined 13% in 1998, stayed constant in 1999 and finally began growing in 2000 by 4.5%. Macroeconomic data from BPS shows that the decline in GDP in 1998 hit investment levels very hard. Real gross domestic fixed investment fell in 1998 by 35.5%. For the household sector, much of the impact was due to rapid and large swings in prices, which may have resulted from extreme exchange rate volatility. Figure 1 captures the movement of the monthly US Dollar (USD) to Rupiah (IDR) exchange rate over this period. The CPI more or less doubled in this period for food, housing, clothing and health. But the direction of the relationship between prices and currency depreciation is uncertain as it is endogenously determined. Our goal is to document the household response to the shock and how this affected the human capital accumulation process. We do not attempt to analyze the macroeconomic changes and whether these changes were directly transmitted to households via labor market changes. Furthermore, we are fully cognizant of the fact that more than 70% of Indonesian labor market behavior cannot be observed because it is operating in the informal sector (Arifianto, 2006).

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<sup>1</sup> Indonesia Central Bureau of Statistics et al. (*Badan Pusat Statistik*, BPS) 1998

<sup>2</sup> *Proyeksi Penduduk 2000 – 2025*, BPS 2005

### **3. The Indonesian Education System and Human Capital Accumulation**

After achieving independence, Indonesia established an education policy focusing on literacy programs defined as the ability to read and write - to recognize letters, to read simple sentences, and to write his/her own name and address. The language in use is *Bahasa Indonesia* which is also used to unify 824 ethnic groups who tend to use their own dialects. Within the scope of this paper, it is found that from 1990 to 2000 the government focused on achieving Nine Years Compulsory Basic Education. The amount of funds committed to this program hovered at around 2.8% of GDP over the ten year period (World Bank). Relative to its South East Asian country neighbors, this expenditure is considered to be an underinvestment.

Within this time period, there was also a trend of the central government to increase local content in the national curriculum. In 1994 a key piece of education reform was introduced. Yulalelawati (2000) wrote: "First, it extends basic education from six years to nine years of schooling at the primary and lower secondary schools. Second, it delegates from central government to regional offices the design of the local curriculum content (LCC). Third, it allows teachers to have a more flexible adjustment of the national curriculum to the local situations and contexts. Fourth, the head-teachers are given more options to select supplementary textbooks for their schools; fifth, local hetero-cultural preservation and development are highly encouraged. Moreover, the teaching of English at the primary schools is now permitted, particularly for schools in the tourism and urban areas".

Table 2 shows the organizational structure of the school system in Indonesia. The school system is divided into two streams, namely the Islamic stream under the Ministry of Religious Affairs (public and private), and the secular stream under the Ministry of National Education (public and private<sup>3</sup>). Islamic schools have an alternative curriculum that is a mix of skill acquisition and the study of the Koran (Dhofier, 1999). There are also Christian and Buddhist schools. The extent to which the emphasis is on skills or religion depends on whether the education provider is public or private. Contrary to

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<sup>3</sup> MONE classifies a private school into three types: subsidized, aided or fully private



practices in many other countries, the public sector provides higher quality education than the private sector (Lanjouw, Pradhan, Saadah, Sayed and Sparrow, 2001; Newhouse and Beegle, 2005). This is because children who do not qualify to enter public schools will resort to attending private schools, making it a case of adverse selection. Preschool at the lowest level is not a requirement for entry to the elementary level. However, the government makes every effort to encourage parents to send their children into preschool education before entering elementary schools.

The education system is financed in broad terms by four sources: 1) funds from general government revenue 2) government revenues earmarked for education 3) tuition and other fees 4) voluntary contributions. In terms of the first two sources, this refers to central and regional government where by constitutional law, the central government should fund 20% of the total funding required each year. Revenues earmarked for education include foreign aid assistance. The third source of funding comes from the household and this varies based on the number of children being sent to school at the same time. The fourth source includes gifts from individuals, communities, charitable and religious bodies, domestic or foreign, whether in cash, kind or services; endowments, commercial or private loans; and the schools' own efforts to raise funds (Daroelman, 1971). Based on World Bank records (2007), the general split of funding sources for the education system is 1) central government, 20% 2) regional / local government, 20% and 3) other sources including parents' contributions, 60%.

Since the end of the dictatorial Suharto regime and the introduction of regional autonomy laws UU 22/1999 and UU 25/1999 that complements the 1994 education reform, there is an increasing trend of schooling provision by religious associations and non-governmental organizations. These private providers of education retain the option to adjust the curriculum to a greater extent to meet local indigenous needs. These include a curriculum covering local agricultural farming methods, environmental education and local culture - traditional arts and languages / dialects (Ibrahim, 1998).

For this paper we focus on basic education consisting of elementary school / *sekolah dasar* / *SD* (ages 6 – 12 in the observed data) and junior secondary school / *SMP* (ages 13 – 14 in the observed data). These grades of schooling provide a compulsory curriculum of *Bahasa Indonesia* and Mathematics. Other courses taught include Religion, *Pancasila*, Moral Education, Social Sciences, Natural Sciences, Sports and Health, Special Skills, Art, Regional Languages and courses termed as Local Content. The ratio between the national and local curriculum content is 80-20. However, in terms of the political economy of decentralization and implementation it is not clear whether this ratio is maintained.

At the end of each school level children sit for the compulsory EBTANAS national achievement test<sup>4</sup>. It is a requirement that children sit for this test to enable them to progress to the next level. EBTANAS is considered to be a proxy for child ability and it is a standardized test designed by the Ministry of National Education. This test enables quality comparisons to be made across schools in the country. However a caveat is that education reform resulting in standardization only started in the mid-1990s and may not have been fully implemented by the end of the decade.

Using this description of the Indonesian education system, we set up the human capital accumulation process to document investment behavior. In broad terms using the definition originating from Becker (1964), human capital is defined as a set of skills that is directly useful in the production process. In particular, human capital increases a worker's productivity in all tasks, though possibly differentially in different tasks and situations, be it in the formal or informal labor market. Using Becker's view, although the role of human capital in the production process is complex, there is in general a sense of a uni-dimensional object, such as the stock of knowledge of skills and this stock is directly part of the production function.

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<sup>4</sup> Since 2002, EBTANAS has been replaced by the UAN (*Ujian Akhir Nasional*) and the latest incarnation is UN (*Ujian Nasional*)

In the context of the Indonesian education system, investment behavior entails credit constrained parents deciding whether to finance their children's education and the mechanics of how their children receive an education. Children can attend formal schooling or informal schooling – religious schooling, home schooling apprenticeships, on-the-job training or a combination of methods. Within one school day, children can spend half their time in school and the other half of the time working with livestock, learning local animal husbandry. As such there is a variety of schooling methods available to parents and their children and in part this arises from decentralization in education policy.

Consequently the formal school is no longer the exclusive source for skill formation. This is to such an extent that there is a growing body of empirical studies concerning the simultaneous nature of labor and schooling decisions in developing countries (Cameron and Worswick, 2001). As noted by Heckman and Lochner (1999), informal and non-institutional sources of learning should be recognized as well as source of skill building. This then raises questions concerning the veracity of using only formal schooling enrollment and attendance measures to determine educational outcomes.

The choices made concerning the mode(s) of skill formation affect the household cost profile over the schooling period. This has implications for whether the children grow up to receive wages as skilled or unskilled labor and in general, the accrued benefits of education. By weighing up the upfront costs and delayed benefits of human capital accumulation, parents can arrive at an optimal investment strategy.

The EBTANAS achievement test scores are used to capture transitions from one school level to another. We use measures of language, mathematics, science, social studies and moral studies. In the context of Indonesia, language skill stands out. This is because *Bahasa Indonesia* the unifying language of the country is a requirement for a worker to function optimally in the formal labor market.

## **4. Changes in Prices, Consumption and Education Expenditures in the Household**

### *4.1 Price Indices*

To document changes in prices in response to the aggregate shock, we first refer to the *Badan Pusat Statistik* (BPS) SUSENAS household surveys and BPS price data to capture responses to price changes. We use the SUSENAS data in broad terms to get an idea about the magnitude of change. But this data does not form the underlying basis for our detailed analysis. This is because the baseline quantities for urban areas are from 1996 and for rural areas from 1993. In addition the SUSENAS data is more detailed in terms of food prices and this can possibly lead to an overstatement of food shares.

With reference to work done by Levinsohn, Friedman and Berry (1999), at the aggregate level SUSENAS and their estimates capture 184 products and the price changes from January 1997 through October 1998. These changes are estimated across provinces and will mask changes at the disaggregated community level. This helps us to understand the general movement of prices even though further price data until beginning 2000 is not available. This is then further aggregated into the following product groups 1) foodstuff 2) prepared food 3) housing 4) clothing 5) health services 6) transportation and 7) education & recreation. Table 1 captures the price changes of these product groups. The average price increase for foodstuff is 112.8% and for housing is 107.7%. The price increase for education & recreation are lower at 73.1%. In comparison to these estimates, BPS using procedures that are different from SUSENAS (in Table 2) reported that overall the consumer price index for the country doubled over the period of the AFC. Given these estimates from two different sources, it would be reasonable to state that prices increased to between 110% and 130%. We disregard the estimate for education & recreation because we are unable to disentangle the two types of goods. Consequently we take another approach for studying education prices which we will detail later. For us at this juncture, price aggregates for the food and housing product groups are sufficient to help us understand how consumption changed albeit at the province level. Levinsohn et al, also find that these parameters for consumption are statistically significant.

Our unit of analysis for expenditures is the household. Hence our definition-in-use for the household follows the BPS and RAND Corporation definition: a household is defined as being a group of people where the members reside in the same dwelling and share food from the same cooking pot. We proceed to document household consumption first using expenditure shares and how this changed ex-ante and ex-post. Consumption is used instead of income because the latter suffers from measurement error in a country where about 70% of the economy is in the informal sector. In addition there is more detailed and reliable data related to consumption in IFLS. However it is acknowledged that expenditures even when reported in terms of prices and quantities cannot fully provide information on the quality of goods unless inference is made. Table 3 details these spending shares in 1997 and 2000. We split expenditures by food, non-food, education and housing. From 1997 to 2000, it is observed that share on food increased from 49% to 51% while non-food items fell from 35% to 34%. Education shares were maintained at 5%. Housing shares that includes rental and self-ownership fell from 11% to 9%. For all these shares, there is only a shift in the mean but the exception is education where there is a change in higher moments. There is a positive skewness of the education share distribution which has increased from 1.58 to 2.73 and kurtosis has increased from 11.34 to 14.73. Given these noticeable changes to the distributions, we disaggregate educational expenditures for further investigation.

Starting first in nominal terms to determine direction and the magnitude of change, children aged 6 – 14 reported an average increase of 161% from 1997 to 2000 for aggregate spending on basic education. Expenditures included one time registration fees for each new school year; monthly scheduled fees that included parents' contributions to the school (BP3) and school fees for private schools (SPP); annual exam fees for the EBTANAS test that enables progression to the next school grade; books and writing supplies; uniforms and sports equipment; pocket money for food and room boarding if the child resided part-time near the school; and special courses. All these detailed expenditures showed a marked increase as well.

These expenditure increases in nominal terms contradict the stylized fact that an economic crisis causing currency devaluation will depress consumer spending. Within an open economy, spending can instead be maintained or increased in terms of a local currency if consumers substitute from imported goods to locally produced goods. Still despite this, the first main issue that needs to be highlighted is the type of price deflator that should be used to capture the real cost of living. The second main issue is to determine whether education can be disentangled into its real cost and quality components and if yes, how it was affected by the aggregate shock. We address this next.

The official BPS measure of consumer prices in Indonesia consists of a modified Laspeyres formula. The base year is 1996 and there are between 249 – 253 items in the basket. Prices of some commodities and services are controlled because of changes in government policy such as rice, gasoline and public transportation tariff but the others reflect the monthly movement of demand and supply of goods and services or the market mechanism in retail trade. Coverage is urban, based on 43 cities which bias the calculation. In addition the weights assigned are only updated every five years. This means that adjustments were not made due to the exceptional circumstances of the AFC. The urban bias is carried over to IFLS which sampled 34 out of the BPS reported 43 cities. Ways to address these issues include using a combined Tornquist price index which has a hedonic component with a spatial price index<sup>5</sup> for a geographically diverse area such as Indonesia that covers over 1.9 million km<sup>2</sup>.

The Tornquist index is constructed using consumption shares from the 1996 and 1999 SUSENAS household surveys. In principle, by considering consumption shares from both periods, the Tornquist index allows for the fact that households will substitute away from expensive items towards cheaper ones as relative prices change. This substitution will mitigate the welfare impact of price changes that should in principle be accounted for in a cost of living index. In addition it is also necessary to adjust for spatial price differences. The spatial deflator constructed is the ratio of the location (province, urban/area) poverty line (in December 2000 prices) to the Jakarta poverty line. Thus, it

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<sup>5</sup> We follow the same approach as the RAND Corporation

converts the local December 2000 values into Jakarta December 2000 values. Using these two price indices, real consumption changes can be calculated. However a different price deflator is required to assess the price of education. This is because we have defined education as being an investment good which will entail decision making that is different from consumption goods. Decision making with respect to investment includes a measurement of cost and benefit flows over time. This price deflator increases the accuracy of measuring investment over a longer period of time. This is as opposed to the Tornquist-spatial deflator which captures shorter term living standard or welfare changes.

#### *4.2 Investment in Human Capital and the Sample Selection Problem*

In order to capture investment behavior, we construct our own price deflator for education using the wages of primary and junior secondary school teachers in 1997 and 2000. This is information available in IFLS. Wages are used because changes over time are caused by the price effect and not quality effect. Using pair-wise matching of schools in 1997 and 2000, our deflator then consists of the same schools with teachers in the education production process for the same given community<sup>6</sup>. This deflator then enables us to hold school quality constant ex-ante ex-post and to isolate the pure income effect of education.

Using the Tornquist - spatial price index for consumption, contrary to changes in consumption measured at the provincial level, there is very little change in real terms at the household level. See Figure 2. This strongly infers that households were able to substitute between different types of goods in order to mitigate the welfare impact of the aggregate shock. It appears that in-kind transfers and self-production played a crucial role in smoothing consumption during this period of low consumption and high marginal utility. This is consistent with what is observed in the data. The highest proportion of the household budget is assigned to food hovering at around 50%. But within this food category, there was substitution between rice and what Indonesians perceive as lower quality food staples such as corn, sago, cassava, tapioca and yams. In terms of food

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<sup>6</sup> Our identifying assumption is to match on schools and unfortunately not on teachers because we are unable to identify who the teachers are ex-ante and ex-post.

production dry paddy yields increased by 5.4% cumulatively from 1997 to 2000<sup>7</sup> which strongly implies food security was ensured during this period of crisis. In addition, from an income perspective, primarily farm households enjoyed income growth from a diversified crop portfolio during the aggregate shock<sup>8</sup>. This increase in income would have helped agricultural households to cope with high inflation levels and maintain a certain level of consumption. However the same inference cannot be made for households with landless labor.

Using our self-constructed price deflator, we find that the price of education increased by 126% between 1997 and 2000. We proceed to look at how expenditures on education changed in response to this spike in costs. Starting with aggregate figures, average real education expenditures for children aged 6 – 14 fell by only 1% between 1997 and 2000. In deriving this average, we exclude the child's pocket money for food and boarding. This is because regardless of parental investment in the skill formation process, a child will consume food and shelter. See Figures 3 and 4. This aggregate figure of 1% is a seemingly negligible hit compared to how teacher wages spiked.

But it starts to become a different story when these changes are analyzed using an intra-household allocation approach. In terms of total education expenditures as a share of consumption, there are noticeable reductions for all households and particularly for the lower end of the distribution. These share reductions are found in two steps. First we use our self-constructed price deflator for calculating the price of education. Second we use this figure and divide it by real consumption derived from the Tornquist and spatial deflator. See Table 6. Our estimates show that on average in 1997, households allocated 2% of their budget to education. But in 2000, this slice of the pie fell to 0.9%. This situation was exacerbated for up to the 10<sup>th</sup> percentile where the share allocated to education fell to zero in 2000.

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<sup>7</sup> BPS and the US Agency for International Development, 2002

<sup>8</sup> The World Bank, Washington DC and the Center for Agro-Socioeconomic Research, Indonesia, 2000



In Table 8 we disaggregate the figures and look at spending patterns. Spending on monthly scheduled fees increased by 37%, books and writing supplies increased by 8% and transportation increased by 42% in 2000. In contrast, average spending on exam fees, uniform and sports and special courses decreased by 26%, 23% and 38% respectively in 2000. It appears that households could compress certain expenses related to the intensive margin and could not for other expenses at the extensive margin.

When these estimates are compared against these estimates which only use the Tornquist-spatial deflator, the latter finds a status quo for education shares at 5%. This is because unfortunately, this deflator is not able to detect responses to changes in education prices. This difference in estimates is a substantial 3% points at the mean. This means that our self constructed price deflator is starting to sketch a picture of how households compromised on education while valiantly and successfully protecting consumption. This implies that short run welfare between 1997 and 2000 was a priority compared to long run human capital investment.

Upon further investigation, we find a non-negligible percentage of households reporting zero education expenditures ex-ante ex-post. See Table 7. The individual expenses with the highest percentage of zeroes are registration fees, exam fees and transport. But ex-post, the highest percentage point differences are registration fees, monthly scheduled fees and uniform & sports. What is faced here is a sample selection problem. The data for these expenditures has a censored distribution where values in a certain range are transformed or reported as zero. As such we do not know the true population density by only referring to the sample density. We address this problem by un-censoring the distribution. Observations can then be made by comparing the shapes and shifts of the censored and un-censored distributions.

This approach is taken with registration fees, monthly scheduled fees and uniform & sports which have the highest percentage of zeroes reported. See Figure 5 which is a kernel density for registration fees. There is a peak for 1997 and 2000 where most values are clustered around zero. This does not imply that this is the true density. In Figure 6, the

distribution from Figure 5 is un-censored. The selection problem can be seen where the un-censored distribution in 2000 compared to 1997 has shifted further to the left. This may be interpreted as a worsening of household behavior in registering their children in school. Or the state has stepped in to subsidize households for registration. The kernel density for monthly scheduled fees is in Figure 7. Again the highest density is around the zero value. This does not provide us with enough information. But by looking next at Figure 8, it is seen that the shape of the distribution has changed from a tall peak in 1997 to a flattening out in 2000. There is greater variability in the pattern of monthly fees paid across households. For uniform and sports, there is hardly any change in the shape of the distribution with a slight shift to the left in 2000.

Despite reporting zero payment of registration fees for 65% of households in 1997 and 75% in 2000, there was still payment for other aspects of schooling. In particular, there was still payment for monthly scheduled fees. Why would households not pay registration fees and not enroll their children in school and yet pay monthly scheduled fees? Unobserved, qualitative household differences in behavior is in operation here. In the next section, we dissect this behavior in terms of the portfolios of choice available and the choices made.

#### *4.3 Public, Private and Alternative Schools*

We start by looking at the school choices available to households. Table 9 tells us that in 1997, 87% of children were in public schools and 13% of children were in private school. In contrast in 2000, 69% of children in public schools and a higher percentage at 24% of children were in private schools. The remaining 7% were in a third type of school, alternative schooling. This was not observed in 1997. In the IFLS surveys in both years, households were asked to write down the type of schooling received if the other closed ended school type options did not apply. We determined these written descriptions to be alternative and informal ways of learning. We add this alternative method into the portfolio of school choice because we would like to avoid having a fundamental misconception about how skills are formed. As argued by Heckman and Lochner (2000),

non-institutional sources of skill formation like families, neighborhoods and firms are as important as the formal school system in producing skills.

In terms of the urban-rural split, in 1997 60% of children from rural households went to public school and 40% went to private school. For urban children, the reverse pattern occurred; 40% went to public school and 60% went to private school. While for rural households the public-private school split remained the same in 2000, there were changes for children from urban households. In 2000, 33% of these urban children were in public school; 46% were in private school and 21% were in a third type being alternative school. 49% of these alternative schools in the observed data were located in Java which is more urbanized than the other islands. Because of this noticeable change in the public – private schooling mix, we study expenditure flows to each school type to understand where parents chose to make their financial investment as a reaction to the aggregate shock.

The measure that is used to study school type and its affordability is monthly scheduled fees consisting of BPP and SP3. These fees play a substantial role in a school's cost structure<sup>9</sup> and arguably in how parents make investment decisions. Looking at our estimates in Table 10, on average the payment of monthly scheduled fees is higher in private school than in public school. In both 1997 and 2000, private school monthly scheduled fees were at least double of public school monthly scheduled fees. Combined with Figure 6 where a high degree of variability is observed in the un-censored distribution, it is strongly inferred that parents use this expense as the main consideration in how they cope. Table 8 provides support for this inference. In 1997 and 2000, this expense takes up the highest share of total education expenditures. While there were adjustments between the other expenses in terms of increases and decreases in shares ex-ante ex-post, monthly scheduled fees rose substantially in shares from 26.43% in 1997 to 35.68% in 2000. This can be inferred as parents being able to compress most of the expenses but not being able to compress further monthly scheduled fees. To a lesser extent, they were also not able to further compress books, writing supplies, uniform and

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<sup>9</sup> Monthly scheduled fees are used to cover a school's operating costs. Private schools are more dependent on these fees than public schools that receive up to 40% of financing from central and local government. See page 7 of this paper for information on sources of financing

sports. These three expenses remained as the largest slices in total education expenditures.

With respect to the urban-rural split, urban households spent more on monthly scheduled fees than their rural counterparts in both 1997 and 2000. Based on empirical studies by Newhouse and Beegle (2005), Strauss et al (2004) and Serrato and Melnick (1995), the benefit received from paying higher monthly scheduled fees differ by public and private school. The differences are in terms of schooling inputs. Based on their studies of SMP level schools (junior secondary), in public schools textbooks appear to be more easily and teachers have higher educational qualifications. In private schools, these studies found that there is a lower student-teacher ratio. For analytical tractability, we assume that despite the different schooling inputs parents could purchase a given level of school quality based on their incomes. It is also assumed that the school quality varies with the ability of the children in a complementary manner.

When we consider monthly scheduled fees in terms of the relationship between education spending and the consumption distribution, we find that this is expense is the main response mechanism for the aggregate shock. In Figures 9 and 10, from the 78<sup>th</sup> to the 99<sup>th</sup> percentile of the consumption distribution, households spent more for their children's education in 2000 compared to 1997. In contrast poor and middle class households did not have sufficient resources to have the same behavior as the rich. Up to the 77<sup>th</sup> percentile, total education expenditures were lower in 2000 compared to 1997. The situation for the poorest of the poor at the 5<sup>th</sup> percentile was worse with education spending falling to zero in 2000. On the basis of these figures, it is strongly inferred that despite all households reducing the share of budget allocated to education spending, adjustments around monthly scheduled fees resulted in divergence between children's schooling.

We study this divergence further by using Table 10. The rich increased spending on monthly fees as a share from 26% to 32% between 1997 and 2000. This is as opposed to the poor who increased the share from 26% to 29%. Rich households had the financial

option of spending even more on monthly scheduled fees to not only cope with the shock but to be better off. This option occurred in one of two ways. The top 1% reinforced spending on an elite public school and paid the higher BPP demanded by the school. Or they spent on a lower quality and more easily available private school that depended on the SP3 to keep it operational. The 78<sup>th</sup> – 98<sup>th</sup> percentile behaved in a similar manner but only to the extent of maintaining spending in real terms. The implication is that the rich could use the public and private school mix as an investment strategy where they could determine which school type gave them a better payoff. But the poor and middle class households did not have the luxury of such a strategy to meet the cost demands of the schools. Nonetheless the poor had a different portfolio of school choice. 7% of the sample coming from the lower end of the consumption distribution attended alternative schools that did not have the characteristics of public or private schools. As such these households could choose between relatively more expensive public and private schools and a new and more affordable, though untested option that arose after the aggregate shock.

Given these descriptive statistics, the portfolio of choices available to the different household can be summarized. In our estimates in Table 11, higher income households chose private schools and lower income households chose public schools in 1997. Then after the aggregate shock, the preferred choice remained the same for higher income households. However lower income households chose between public and private schools.

#### *4.4. Likelihood of Switching School Type*

By constructing a pseudo-panel and assuming a unitary household model (Becker, 1965), we run a logistic regression to study the probability of switching school type because of the shock. In Table 12, we look at the probability of parents given certain characteristic switching their children from public to private school. These characteristics are log of consumption, discrete changes from rural to urban, no shock to shock and poor to rich. The coefficients for consumption, urban, shock and being rich are positive for increasing the probability of switching. All these results are significant at the 1% level. However for

the interaction of being urban and experiencing the shock, the coefficient becomes negative. The magnitude of the interaction slightly reduces the positive size of the two individual coefficients. This result is statistically significant at the 10% level.

From these findings it is inferred that given the larger portfolio of school type available to urban households and depending on consumption levels, these households had various ways to change behavior. It is posited that in these areas, parents regardless of income could look for market driven solutions to protecting their children's human capital.

Given these different investment strategies, households can vary the amount of school quality that they can afford to purchase. They can choose to substitute between low quality and high quality schools. This is not unlike their strategy for substituting between different types of quality goods for consumption. In the next section, we study whether this substitution has negatively affected children in terms of educational outcomes. We aim to determine the tradeoffs made and which children were compromised.

#### *4.4 Quality of Educational Outcomes*

Based on the observed data, there are EBTANAS test scores for children who on the basis of their scores have qualified to transition from the SD (primary school) level to the SMP (junior secondary school) level. This means that in 1997, we have test scores for children who were at the SMP level. This level of schooling consists of three years. As such there are score records for students in the first, second or third year in this level. For a student in the first year of SMP in 1997, his / her test score is from 1996. For a student in the second year, the score is from 1995. For the third year, the score is from 1994. The same sequence applies to 2000 for the first, second and third school years being 1999, 1998 and 1997 respectively. Given this logical sequence in the data, we are unable to compare the type of school a child has attended and how the child performed in the tests. This is because we first have the child's test scores and then the type of school that the child has moved to. However we can use EBTANAS to study which type of children succeeded or failed to transition and relate this to the aggregate shock.

We use this measure of transition instead of years of schooling because entry into the Indonesian formal labor market is primarily determined by completion of successive educational levels<sup>10</sup>. As such we argue that the level of schooling instead of years of schooling is a more valid measure of human capital accumulation.

We find that there are qualified children who have transitioned to the SMP level and qualified children who did not make the transition. This type of schooling behavior was also observed by Suryadarma, Suryahadi and Sumarto (2006). They investigate the causes of low SMP enrollment despite near universal SD attendance. They find that attrition during the transition between SD and SMP is the main cause.

All qualified children in 1997 made the transition to SMP. This is as opposed to 11.3% of qualified children in 2000 that did not start SMP. Of this 11.3%, half of these children came from Java. This is an unexpected finding because on average Javanese households have higher incomes than the Outer Islands and there is a higher availability of schools.

We proceed to study the characteristics of these children who fell through the cracks. We investigate this by comparing total test scores of transitioned and non-transitioned children in 2000 with children in 1997. Then we remove the test-scores of non-transitioned children in 2000 to determine the net difference. See Figures 11 and 12. Children who transitioned in 2000 as a sample on their own had better test scores than a sample containing both transitioned and non-transitioned children. In Figure 12 where the sample of student scores in 2000 are restricted to only qualified and transitioned students, there is a greater distance between the two lines for higher income households. This is as compared to the distance observed in Figure 11. It is inferred that richer children are pulling further ahead than poor children in terms of academic performance.

The children who did not start SMP came from households that allocated a lower share of the total household budget to education compared to transitioned children. Of this sample of children, 52% were in alternative schools in 2000. It is unknown whether alternative

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<sup>10</sup> The level after SMP is SMA or senior secondary school for minimum entry into the formal labor market

schooling is a temporary solution chosen by households to cope with the aggregate shock. These children may have over time then resumed study in the formal school system. But this has serious implications for them in terms of catching up with their peers.

We also look at test scores reported by schools. This is to give us an idea of whether the improvement in EBTANAS is a trend that is occurring regardless of the shock. In IFLS, a random sample of 25 student test scores for Bahasa Indonesia and Mathematics was selected from each school. See Tables 13 and 14. Because a random sample is used, it is posited that the scores reflect school quality with little selection bias coming from student ability. We find the same trend of higher scores. Public schools scored higher than private schools in both years. However for Bahasa Indonesia the rate of increase 1997 – 2000 for private school (8%) was higher than for public school (5%). An unusual finding was for Math where the rate of increase 1997 – 2000 for public school was 35%. This is as compared to a paltry 0.5% rate of increase for private school. It appears that this improvement is a trend and the self-selection of students may help to reinforce this trend.

## **5. Conclusions**

Using an intra-household allocation approach, we examined changes to prices, consumption and education in attempt to see how the human capital accumulation process may have been interrupted by the aggregate shock. While we do not find noticeable changes to real consumption levels, we do find a fall in real education expenditures when we use our own deflator. It is strongly inferred that then the quality of schooling was somehow compromised. However this deterioration was not from a lack of trying as parents from rich and poor households used various strategies to keep the human capital accumulation process going – substituting between public and private school, dividing educational production between a school environment and self-learning and others. Or in other terms, the formal school is no longer the exclusive source of skill formation.

To some extent, the state was able to step in to provide some form of subsidy but arguably much of the fiscal burden was still on parents. This burden extended beyond the



poorest households up to the 77th percentile in the income distribution. This finding contradicts the assertion that only the poor face the full impact of an aggregate shock. It is unexpected that even the middle class could not withstand the shock. Only rich households from the 78th – 99th percentile were able to come out of this period relatively unscathed with their children's educational process uninterrupted. To some extent, rich households and undoubtedly some were outliers in the income distribution could even reinforce their human capital investment.

This raises disturbing questions about the human capital inequalities that can arise in relation to an aggregate shock. The rich further improve their long term socio-economic position from increased human capital accumulation while the poor and middle class fall back. The children of the poor simply disappear from the formal school system and it is unknown whether this is just a temporary phenomenon. The poorest of the poor are in an even worse position with a zero chance of surviving the shock. This can arguably be compounded in a country like Indonesia that is relatively income unequal. In 1999, the Gini coefficient for Indonesia was 0.32 (Booth, 2000). While the effects of the aggregate shock washed away relatively quickly at the macroeconomic level, we argue that given the empirics on family background and intergenerational mobility (Becker and Tomes, 1964; Bowles, Gintis and Osborne, 2001), such associated effects can be negative in the long term for Indonesian children.

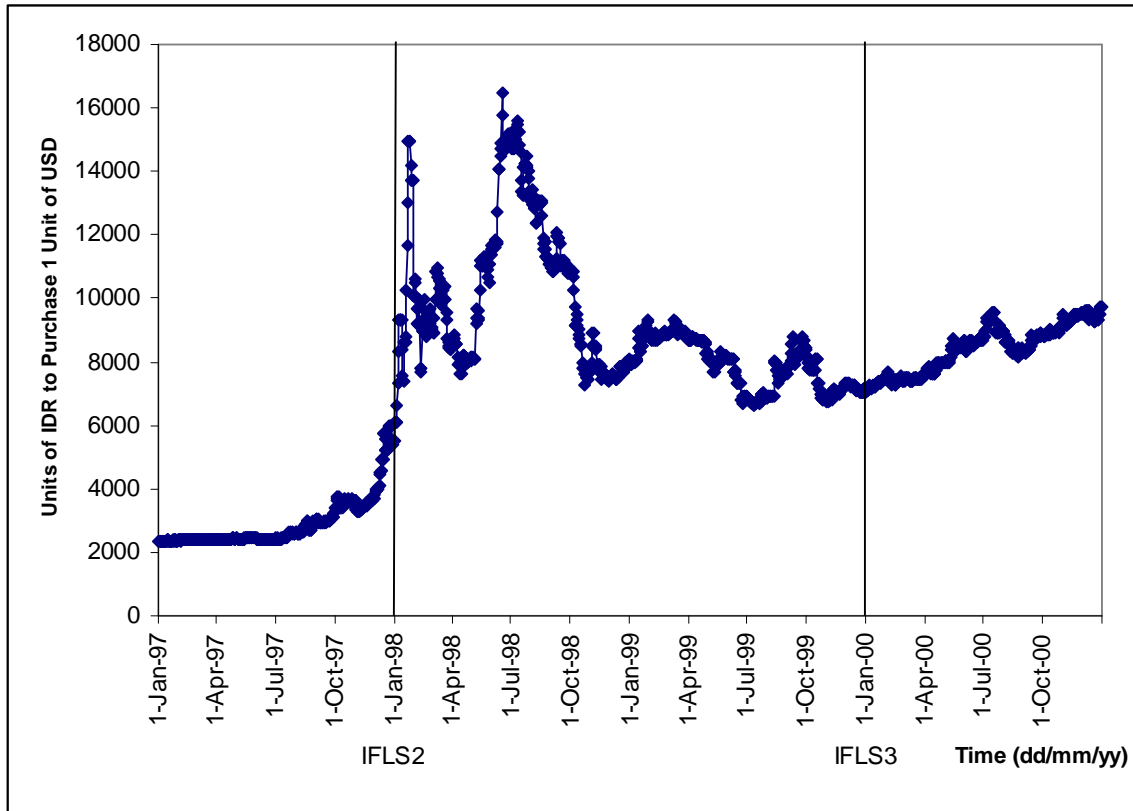
When we translate Indonesian parents' human capital investment into purchasing power parity terms (see Figure 13), the extent to which they protected their children's education is very admirable. Given that PPP is measured in terms of how much it would take to purchase education in the US domestic market and that education is clearly far more expensive in the US than in Indonesia, despite the aggregate shock parents spent more. This provides support to Banerjee and Duflo (2008) who provide an economic perspective on what the middle class looks like in developing countries. The caveat is that at the disaggregated level, rich parents could afford to spend more; this masked the deterioration suffered by poor households. Nonetheless perhaps parents in developing countries are more alike parents in developed countries than we are used to thinking.

Perhaps we all have middle class values. Perhaps we all have the same aspirations for our children's future regardless of whether we are American or Indonesian.

## Appendix 1

Figure 1

US Dollar (USD) to Rupiah (IDR) Interbank Rates (January 1997 – December 2000)



Source: Oanda Forex Currency Trading Archives [www.oanda.com](http://www.oanda.com)

Notes: IFLS2 captures observations of individual, household and community behavior for the full year of 1997. IFLS3 captures observations of the behavior of individuals, households and communities with the same characteristics in 1997 for the full year of 2000. IFLS3 includes a balanced panel element which we do not use in this paper. We prefer to use all information available to capture changes to behavior across distributions.

Table 1 The Indonesian Education System

School Age	Higher Education	Islamic S3 Program	S3 Program	Specialist 2 Program			
		Islamic S2 Program	S2 Program	Specialist 1 Program			
		Islamic S1 Program	S1 Program	D4 Program	D3 Program	D2 Program	D1 Program
	Middle Education	Islamic Sen. Sec. School	Senior General Sec. School				Senior Vocational Sec. School
		Islamic Jun. Sec. School	Junior Sec. School				
	Basic Education	Islamic Elementary School	Elementary School				
Preschool	Islamic Preschool	Kindergarten					

Table 2 Price Changes by Product Groups (Levinsohn, Friedman and Berry, 2001)

Product Heterogeneity					
Product Aggregate	Number of Individual Products	Average Price Increases	Std. Dev. of Price Increases	Minimum Price Increase	Maximum Price Increase
Foodstuff	262	112.8%	80.5%	-68.3%	612%
Prepared Foods	72	78.4%	41.6%	0.04%	169%
Housing	105	107.7%	76.4%	0.4%	499%
Clothing	94	80.3%	46.4%	-0.04%	214%
Health Services	38	85.8%	51.2%	0.0%	263%
Transportation	48	77.3%	84.1%	-0.13%	482%
Education & Recreation	43	73.1%	71.5%	-9.70%	310%

Note from Authors: Price increases are from January 1997 through October 1998. Average price increases are computed as the average across all provinces reporting price data for a given good.

Table 3 Consumer Price Index (*Badan Pusat Statistik, BPS*)

Item	1997	1998	1999	2000	2001
General Index	111.83	198.64	202.45	221.37	249.15
Food and Food Services	120.54	263.22	249.54	259.53	290.74
Prepared Food, Beverages, Tobacco	108.88	211.58	219.20	243.49	278.75
Housing	107.84	159.03	166.77	183.61	208.57
Clothing	110.58	219.71	233.21	256.98	277.90
Pharmaceutical Products & Medical Services	114.18	212.54	220.37	241.46	262.99
Education, Recreation & Sports	117.27	161.84	170.44	200.28	224.12
Transportation & Communication	105.24	163.70	172.20	194.00	221.47

Table 4

Expenditure Shares in the Household Consumption Budget in 1997					
Expenditure Type	Mean of Share	Median of Share	Std. Dev. of Share	Skewness	Kurtosis
Food	0.49	0.49	0.17	-0.19	2.49
Non Food	0.35	0.34	0.13	0.59	3.84
Education	0.05	0.02	0.06	1.58	11.34
Housing	0.11	0.09	0.08	1.93	5.80

Expenditure Shares in the Household Consumption Budget in 2000					
Expenditure Type	Mean of Share	Median of Share	Std. Dev. of Share	Skewness	Kurtosis
Food	0.52	0.53	0.18	-0.32	2.61
Non Food	0.34	0.32	0.13	0.81	4.13
Education	0.05	0.02	0.07	2.73	14.73
Housing	0.09	0.07	0.07	1.72	6.71

Note: The Tornquist-spatial price deflator is used for the above calculations

Table 5

Expenditure Shares in the Household Consumption Budget in 1997					
Expenditure Type	Mean of Share	Median of Share	Std. Dev. of Share	Skewness	Kurtosis
Education	0.02	0.01	0.02	2.53	13.48
Expenditure Shares in the Household Consumption Budget in 2000					
Expenditure Type	Mean of Share	Median of Share	Std. Dev. of Share	Skewness	Kurtosis
Education	0.09	0.01	0.01	3.71	27.92

Note: Education / Total Consumption = Our self constructed price deflator is used to calculate the price of education (numerator) and the RAND Corporation Tornquist-spatial deflator is used to calculate the price of consumption

Figure 2

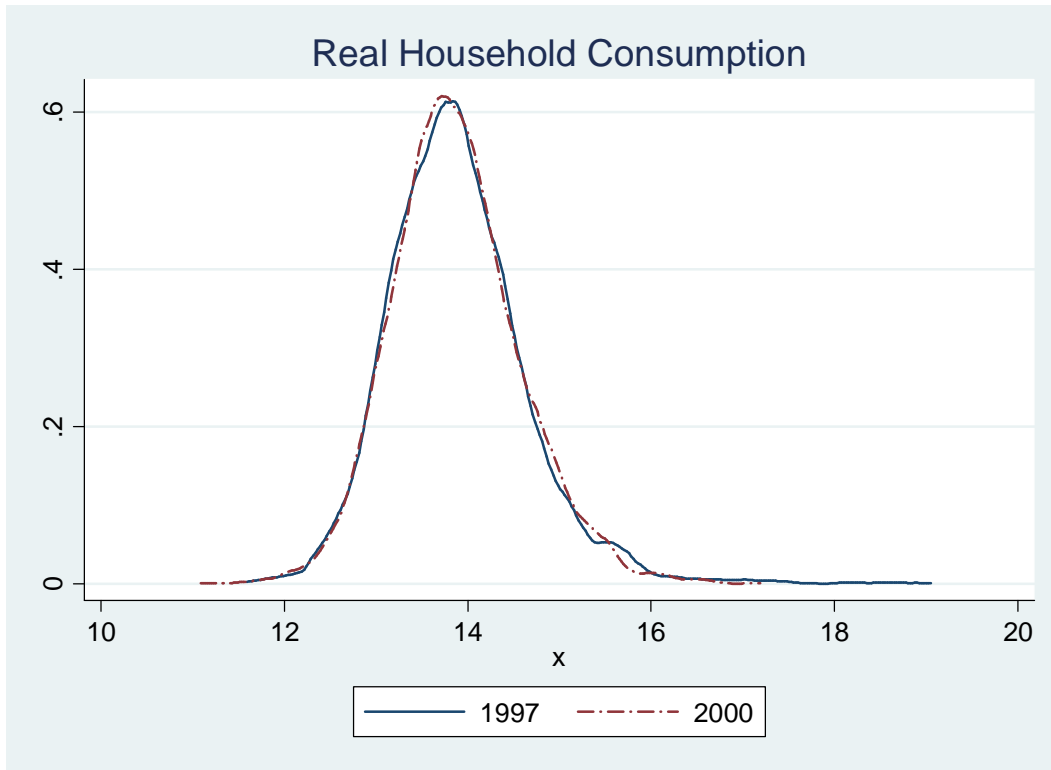


Figure 3 Including Food & Boarding

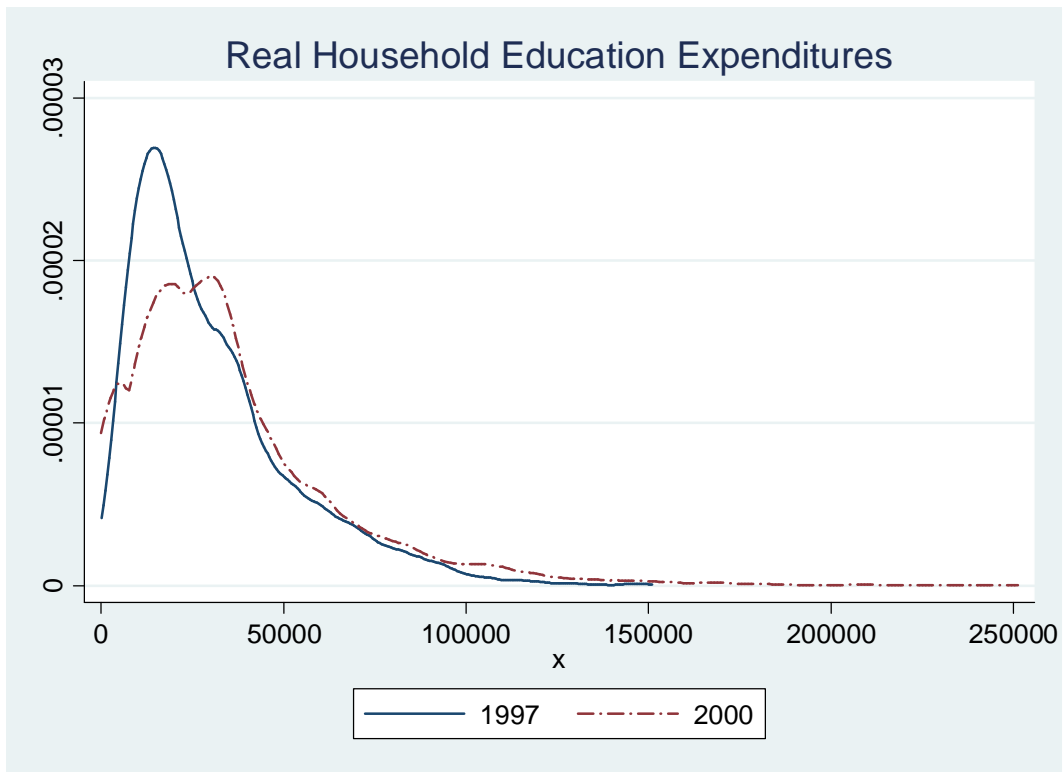


Figure 4 Excluding Food & Boarding

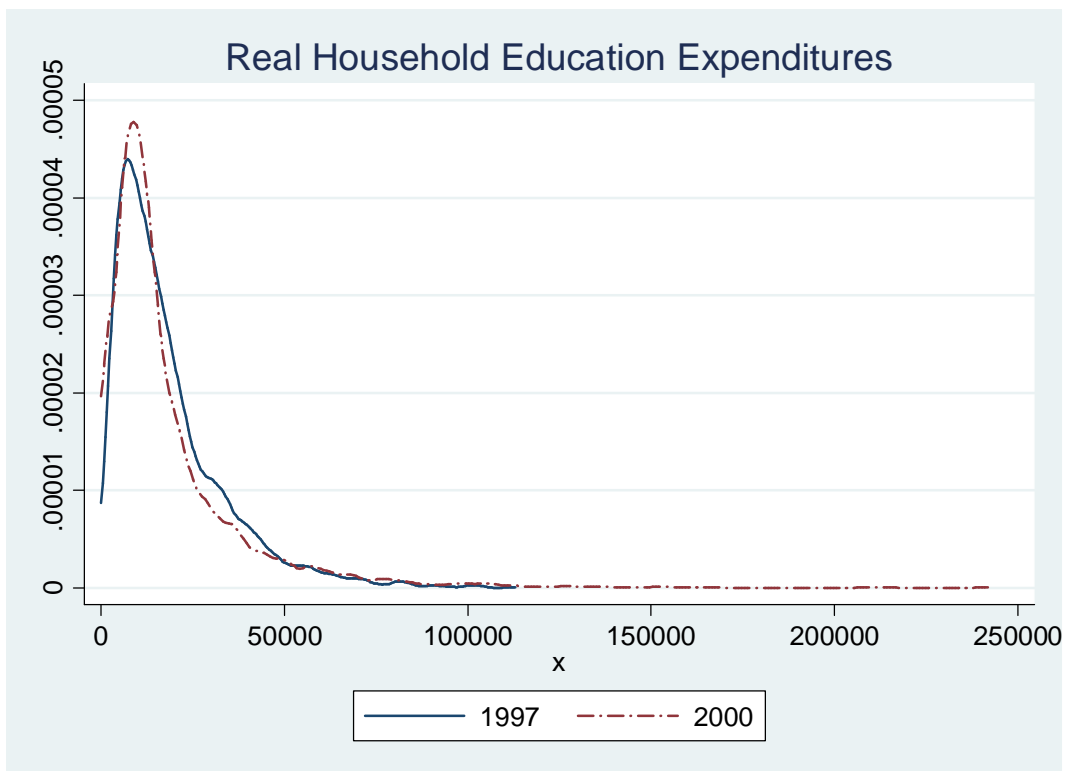




Table 6

Education Share of Consumption		
Percentiles	1997	2000
1%	.0010821	0
5%	.0031679	0
10%	.0048068	.0013036
25%	.0087786	.0034503
50%	.0155789	.0068979
75%	.0267025	.0121225
90%	.0425725	.0201385
95%	.0560173	.0273828
99%	.0929551	.0501189
Mean	.0208188	.009582
SD	.0185708	.0103655
Skewness	2.531584	3.714054
Kurtosis	13.48898	27.92117
Observations	4,956	10,147

Note: Education / Total Consumption = Our self constructed price deflator is used to calculate the price of education (numerator) and the RAND Corporation Tornquist-spatial deflator is used to calculate the price of consumption

Table 7

Percentage of Households Reporting Zero Expenditure by Expenditure Type			
Expenditure Type	1997	2000	% Point Difference
Registration Fees	65%	75%	+10
Monthly Scheduled Fees	9%	17%	+9
Exam Fees	67%	60%	-7
Books & Writing Supplies	3%	8%	+5
Uniform & Sports	30%	41%	+11
Transport	92%	91%	-1

Table 8

Household Education Expenditures Within Reallocation (By Expenditure Type) and Between Allocation (By Year)						
Expenditure Type	Average in 1997 (Rupiah Real Terms)	Average in 2000 (Rupiah Real Terms)	Difference in Averages	Share of Total Education Expenditures in 1997	Share of Total Education Expenditures in 2000	Difference in Shares (% Points)
Registration Fees	2.008,71	1.292,79	-35,64%	10,86%	7,06%	-3,80%
Monthly	4.888,59	6.531,64				
Scheduled Fees			33,61%	26,43%	35,68%	9,24%
Exam Fees	324,75	386,14	18,90%	1,76%	2,11%	0,35%
Books & Writing	5.783,57	5.320,68				
Supplies			-8,00%	31,27%	29,06%	-2,21%
Uniform &	4.225,05	3.169,50				
Sports			-24,98%	22,85%	17,31%	-5,53%
Transport	875,98	1.167,43	33,27%	4,74%	6,38%	1,64%
Special Courses	363,74	350,31	-3,69%	1,97%	1,91%	-0,05%
Others	22,75	89,55	293,63%	0,12%	0,49%	0,37%
Total	18.493,14	18.308,04	-1%	100%	100%	

Figure 5

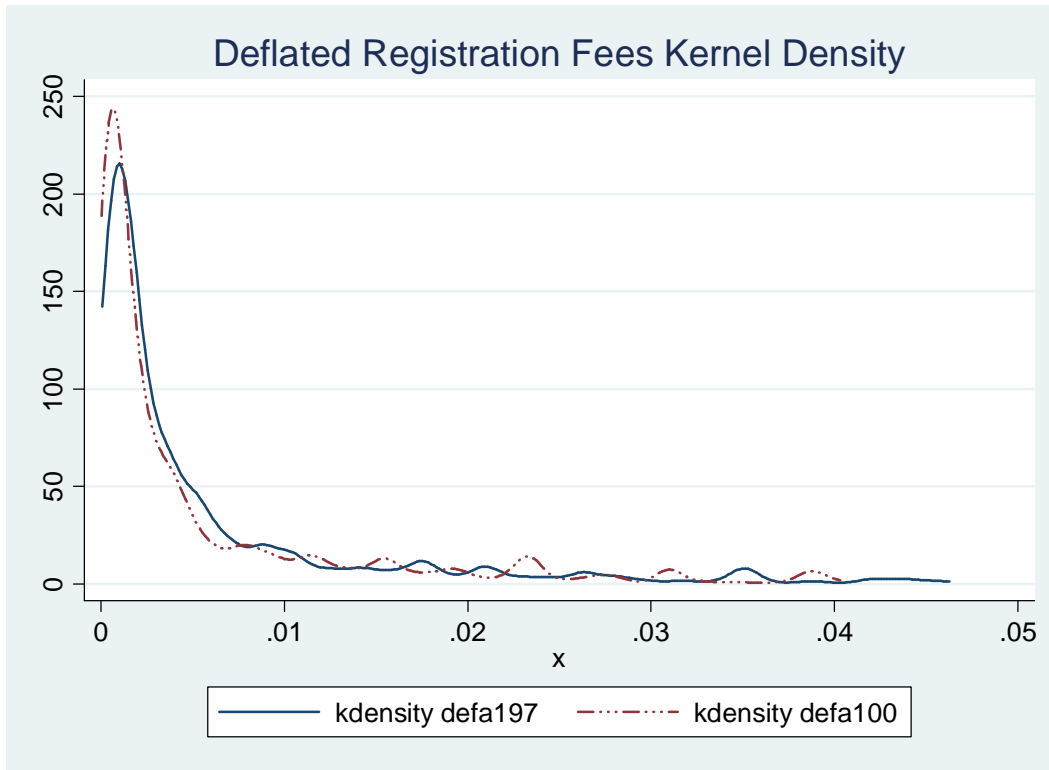


Figure 6

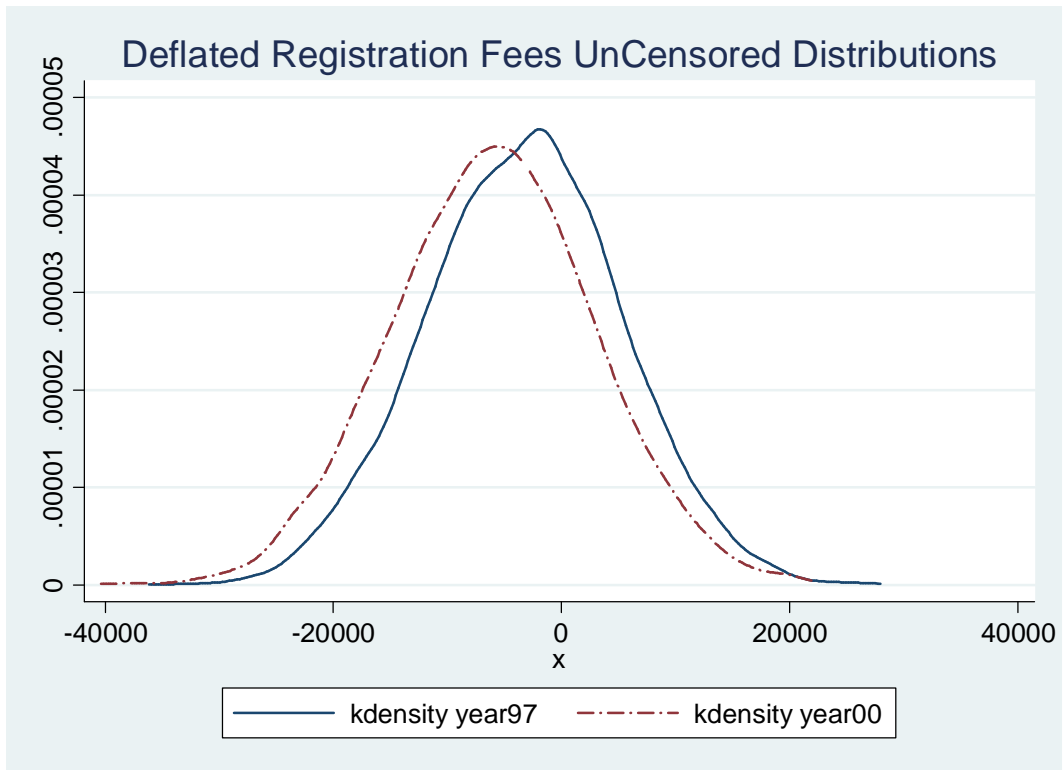


Figure 7

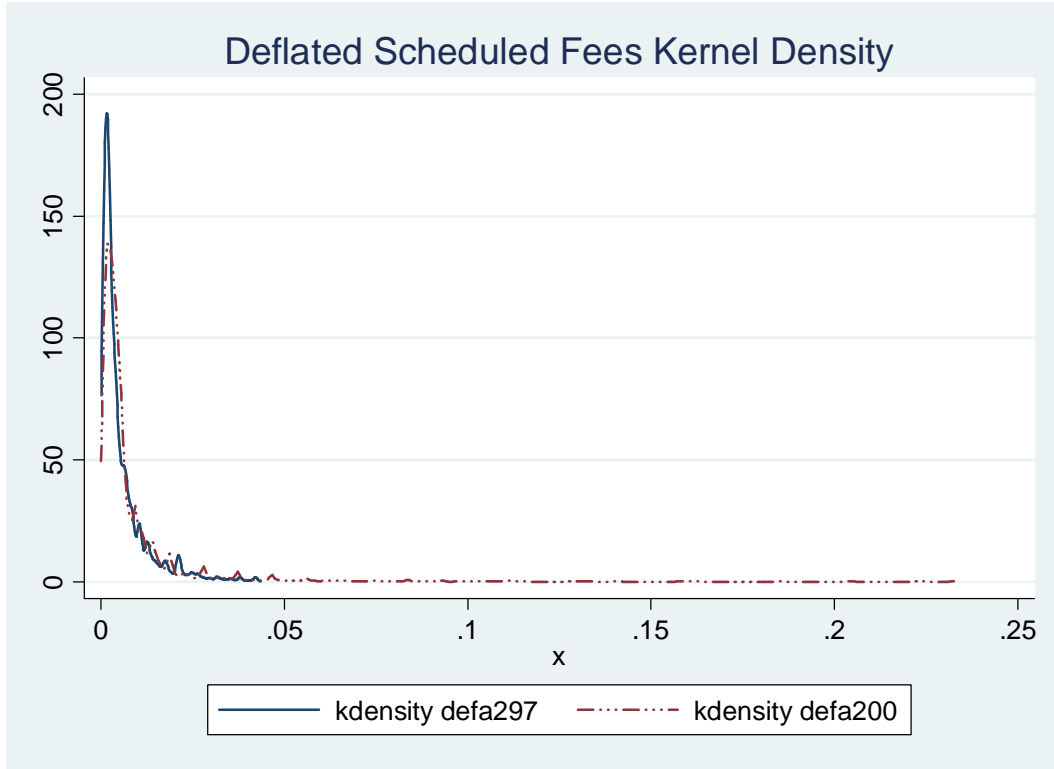


Figure 8

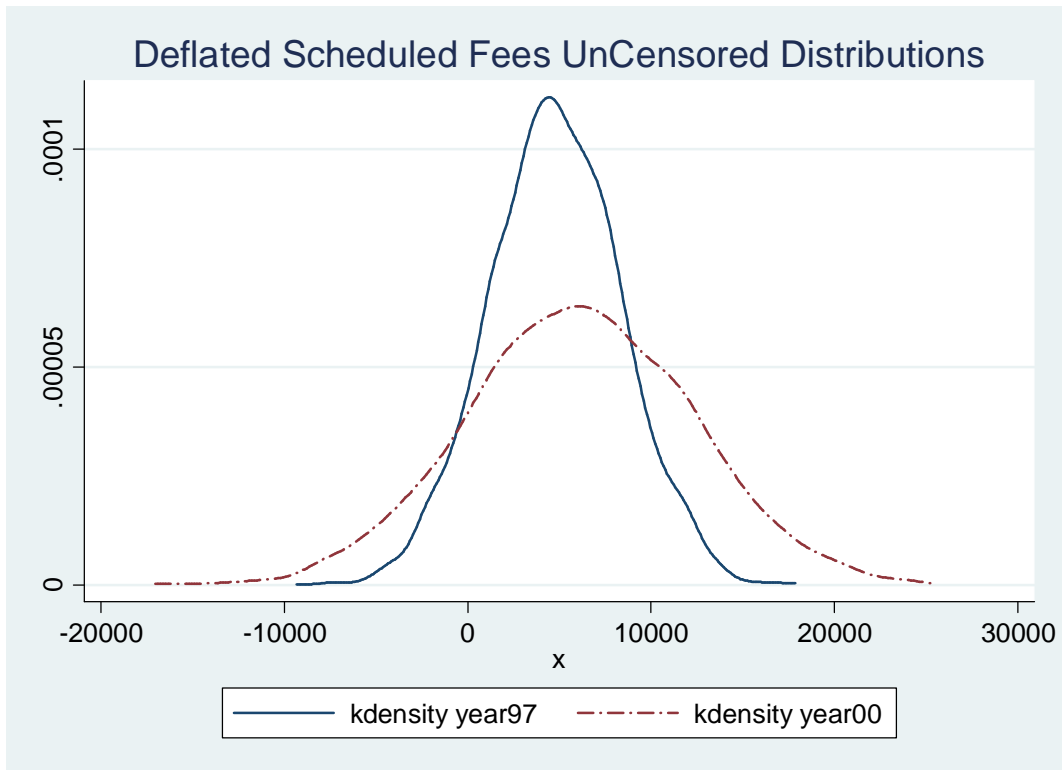


Table 9

Number of Children Attending Different Types of Schools				
School Type	1997	Percentage	2000	Percentage
Public	4,343	87%	7,111	69%
Private	639	13%	2,474	24%
Alternative	0		732	7%
Total Children	4,982		10,317	

Table 10

Monthly Scheduled Fee Payments By School Type in 1997 (Rupiah Real Terms)					
School Type	Obs	Mean	Std. Dev.	Min	Max
Public	4,343	11,853.08	15,216.63	0	120,000
Private	639	28,179.66	27,413.53	0	124,000
Alternative	0				
Total Schools	4,982				

Monthly Scheduled Fee Payments By School Type in 2000 (Rupiah Real Terms)					
School Type	Obs	Mean	Std. Dev.	Min	Max
Public	7,111	32,700.09	57,541.78	0	1,200,000
Private	2,474	75,915.32	134,711	0	1,500,000
Alternative	732	18,281.25	18,776.67	0	180,000
Total Schools	10,317				

Figures 9 and 10

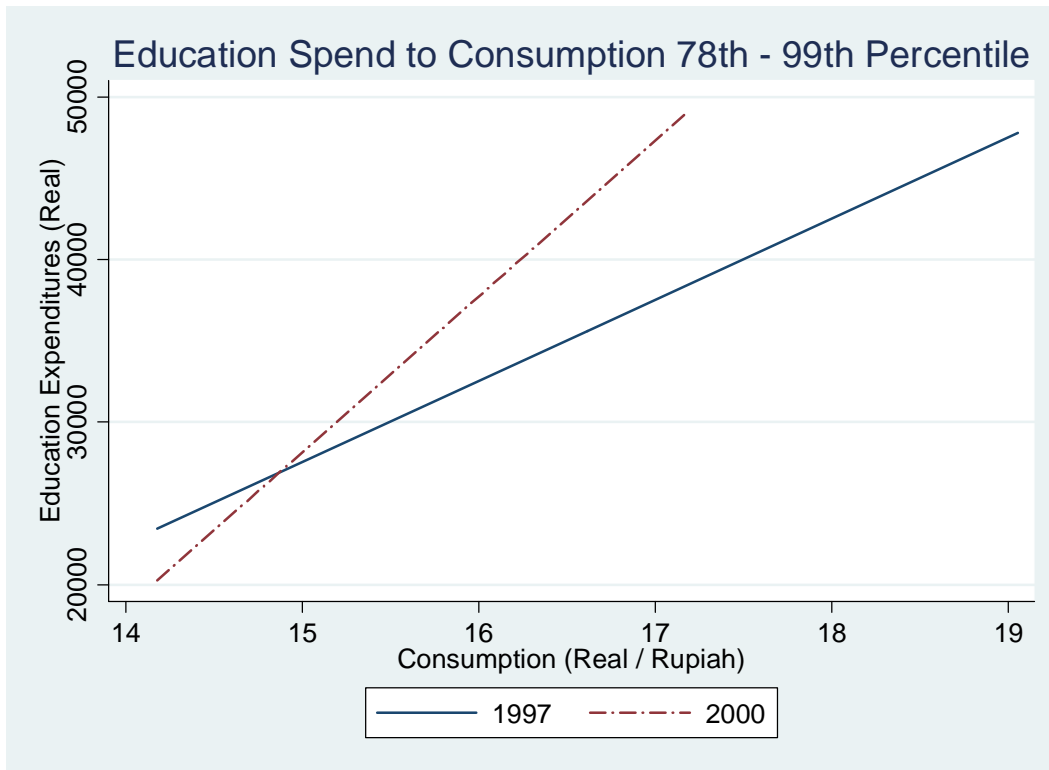
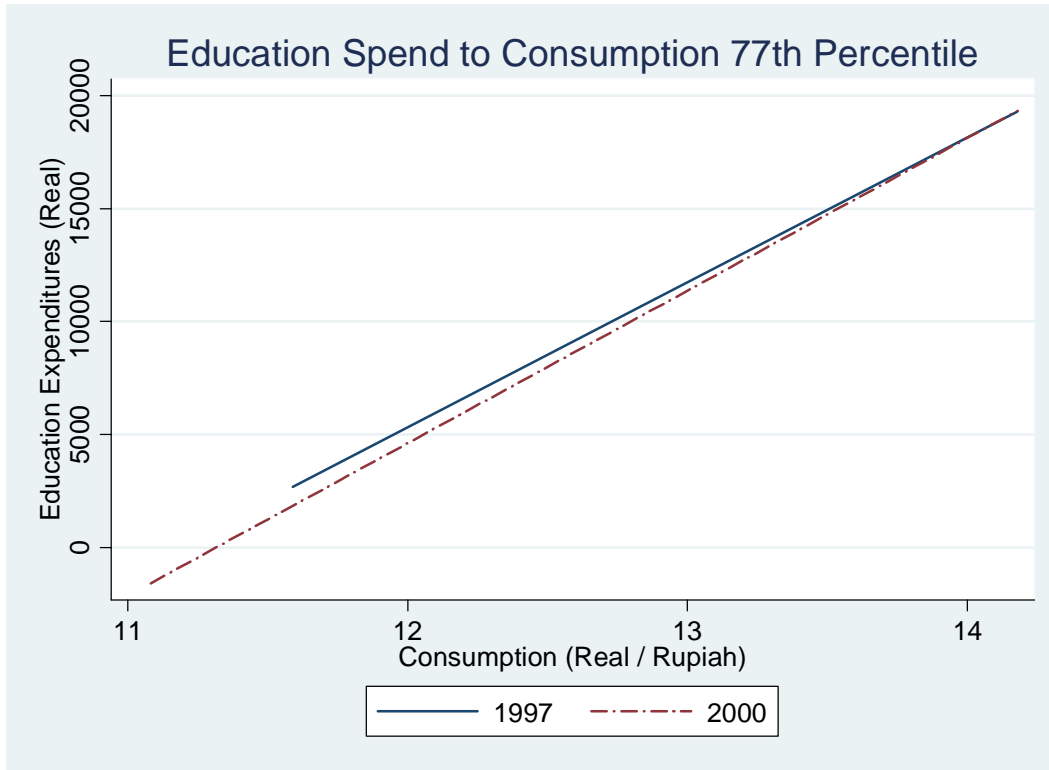


Table 10

Monthly Scheduled Fees As A Share of Education Expenditures By Consumption Level 1997					
Consumption	Obs	Mean	Std. Dev.	Min	Max
Rich	1512	.2621965	.2070387	0	1
Poor	3466	.2595681	.2147581	0	1

Monthly Scheduled Fees As A Share of Education Expenditures By Consumption Level 2000					
Consumption	Obs	Mean	Std. Dev.	Min	Max
Rich	2847	.3218496	.2274418	0	1
Poor	6733	.2897803	.2125616	0	1

Table 11

Portfolio of School Choice & Household Investment Flows 1997					
School Type: Public					
	Obs	Mean	SD	Min	Max
Ln Consumption	4325	13.85404	.720827	11.5891	18.5786
Education Share on Consumption	4324	.0200873	.0181512	0	.1660655
School Type: Private					
	Obs	Mean	SD	Min	Max
Ln Consumption	632	14.08536	.8446361	12.21525	19.0535
Education Share on Consumption	632	.0258231	.0205482	.0000859	.2138403
School Type: Alternative					
	Obs	Mean	SD	Min	Max
Ln Consumption	0				
Education Share on Consumption	0				

Portfolio of School Choice & Household Investment Flows 2000					
School Type: Public					
	Obs	Mean	SD	Min	Max
Ln Consumption	7101	13.8459	.6738632	11.08223	16.59057
Education Share on Consumption	7044	.0093212	.0098126	0	.1352383
School Type: Private					
	Obs	Mean	SD	Min	Max
Ln Consumption	2453	14.01828	.7501154	11.62768	17.19083
Education Share on Consumption	2406	.0110163	.0125631	0	.1332729
School Type: Alternative					
	Obs	Mean	SD	Min	Max
Ln Consumption	722	13.58959	.6265172	11.70211	15.78469
Education Share on Consumption	694	.007272	.0057871	0	.0459945

Table 12

Logistic Regression for Households						
Dependent Variable = School Type (0 = Public 1 = Private)						
	Coef.	SE	z	p> z	[95% Conf. Interval]	
Consumption	.195548	.0455442	4.29	0.000	.1062831	.284813
Urban	.7534709	.0880572	8.56	0.000	.580882	.9260598
Shock	1.058436	.0735641	14.39	0.000	.9142534	1.202619
Interaction of Urban with Shock	-.2726864	.0997299	-2.73	0.006	-.4681535	-.0772194
Rich	.1813438	.0685621	2.64	0.008	.0469645	.3157231
Constant	-5.096256	.6191897	-8.23	0.000	-6.309846	-3.882666

Number of Observations = 14514

Log Likelihood = -7167.3361

LR chi2(5) = 689.95

Prob > chi2 = 0.000

Pseudo R<sup>2</sup> = 0.0459

Marginal Effects at the Mean After Ordered Logit							
y = Pr(dla41) (predict)							
= .1974022							
	dy/dx	SE	z	p> z	[95% Conf. Interval]		x
Consumption	.0309816	.00721	4.30	0.000	.016855	.045108	13.8881
Urban	.1255687	.01515	8.29	0.000	.095881	.155256	.386248
Shock	.151794	.00918	16.53	0.000	.1338	.169788	.658468
Interaction of Urban with Shock	-.0413804	.01441	-2.87	0.004	-.069618	-.013143	.241835
Rich	.0293387	.01132	2.59	0.010	.007151	.051527	.30791



Figure 11

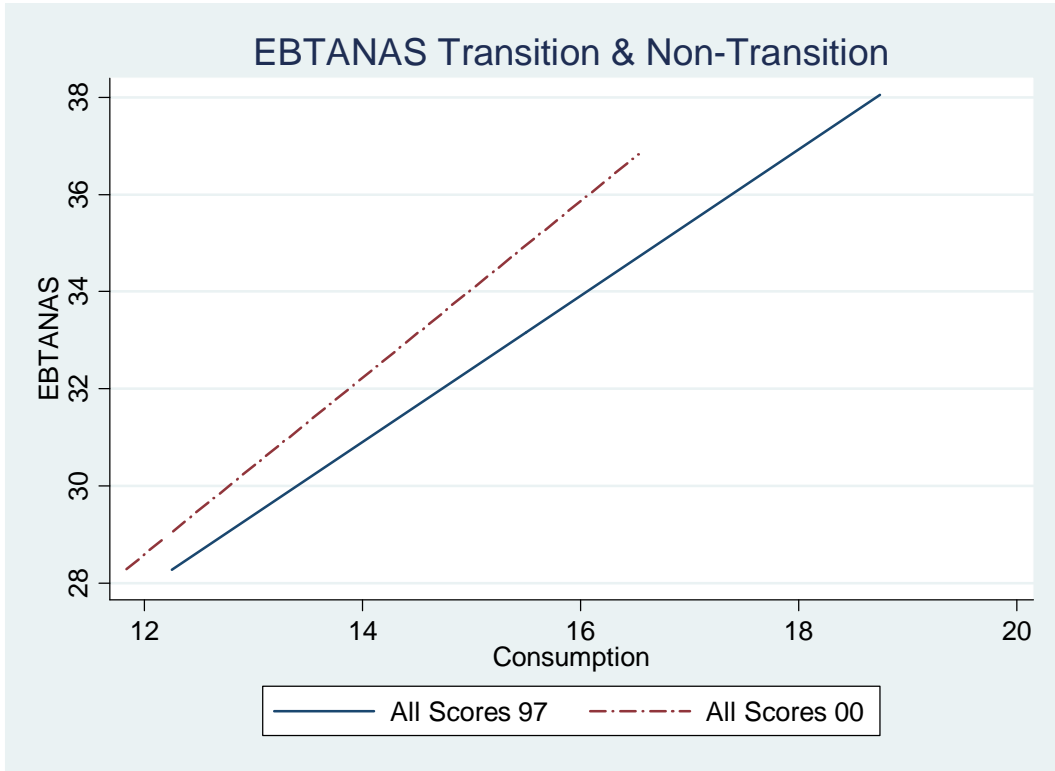


Figure 12

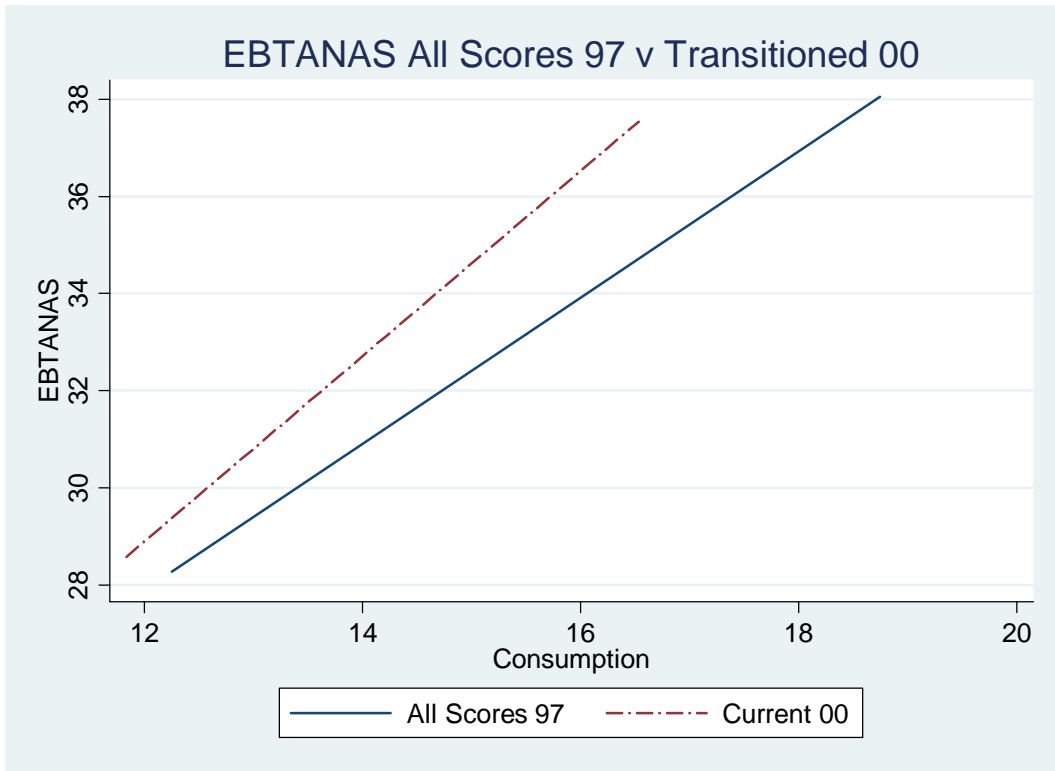


Table 13

School Reported EBTANAS Bahasa Indonesia 1997 (Random sample of 25 student scores in school building / complex)					
	Number of Schools Observed	Mean of 25 student scores	SD	Min	Max
Public	2527	7.115363	.4351555	4.2656	8.9404
Private	790	6.67903	.2628215	5.7228	8.31

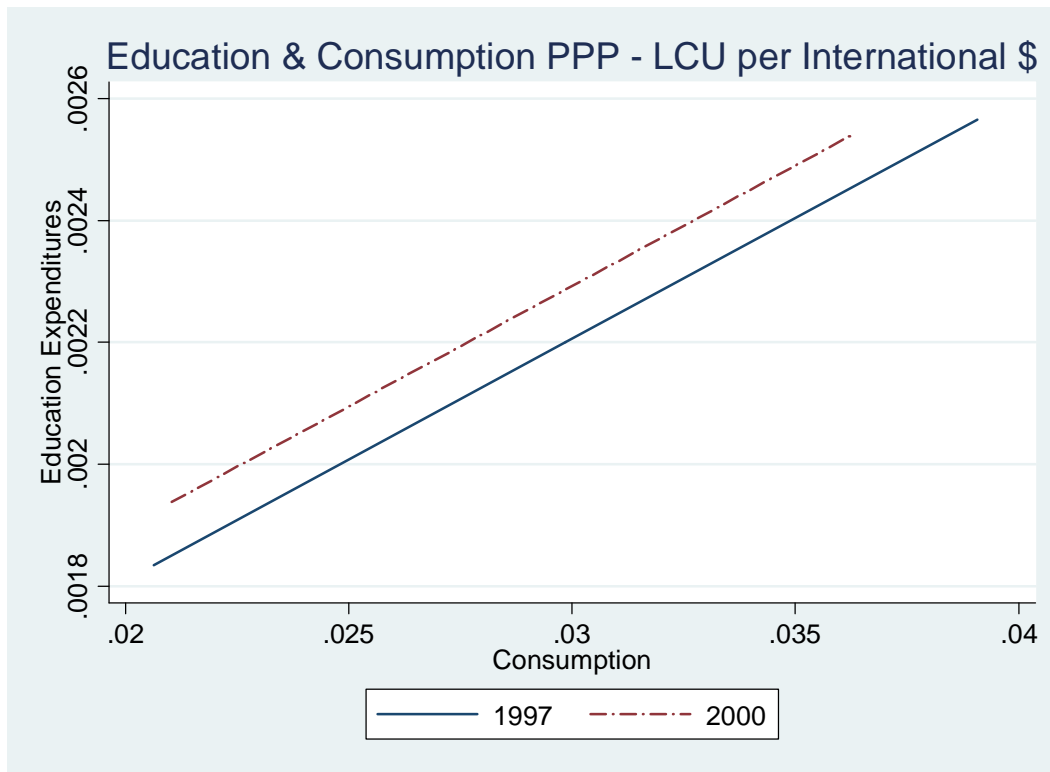
School Reported EBTANAS Bahasa Indonesia 2000 (Random sample of 25 student scores in school building / complex)					
	Number of Schools Observed	Mean of 25 student scores	SD	Min	Max
Public	2535	7.519691	.5218106	4.676	8.712
Private	792	7.219729	.3513688	3.984	8.72

Table 14

School Reported EBTANAS Math 1997 (Random sample of 25 student scores in school building / complex)					
	Number of Schools Observed	Mean of 25 student scores	SD	Min	Max
Public	2523	5.733533	.6713488	2.5936	8.9072
Private	790	7.350196	.6138299	3.178	8.7844

School Reported EBTANAS Math 2000 (Random sample of 25 student scores in school building / complex)					
	Number of Schools Observed	Mean of 25 student scores	SD	Min	Max
Public	2533	7.784071	.9066379	2.1452	11.89
Private	792	7.398837	.5892589	3.6	9.01

Figure 13



Note:

PPP – LCU per International \$: Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. Source: International Comparison Program.

## Appendix 2 the Censored Normal Distribution (Greene, 2007)

We remove the assumption of normality for the distributions of interest. This is to enable the analysis of a dependent variable that is a zero for a non-negligible proportion of the observations.

To analyze this distribution, a new random variable  $y$  is defined as being transformed from the original  $y^*$ , by

$$\begin{aligned} y &= 0 \text{ if } y^* \leq 0 \\ y &= y^* \text{ if } y^* > 0 \end{aligned}$$

The distribution that applies if  $y^* \sim N[\mu, \sigma^2]$  is  $\text{Prob}(y=0) = \text{Prob}(y^* \leq 0) = \Phi(-\mu/\sigma) = 1 - \Phi(\mu/\sigma)$  and if  $y^* > 0$ , then  $y$  has the density of  $y^*$

For our case where  $y = 0$  and the censoring is of the lower part of the distribution, the mean simplifies to

$$\begin{aligned} E[y|a=0] &= \Phi(\mu/\sigma)(\mu + \sigma\lambda) \\ \text{where } \lambda &\text{ is the Inverse Mills' Ratio, } \lambda = \frac{\phi(\mu/\sigma)}{1 - \Phi(\mu/\sigma)} \end{aligned}$$

We then proceed to derive two simultaneous equations to compute for the un-censored distribution mean and standard deviation.  $\alpha$  is the proportion of zeroes of  $y$  in the distribution and it is transformed by the Inverse Mills' Ratio

$$\begin{aligned} \alpha &= -\mu/\sigma \dots (1) \\ \bar{y} &= \mu + \sigma(\lambda(\alpha)) \dots (2) \end{aligned}$$

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