Education Journal《教育學報》, Vol. 35, No. 1, Summer 2007

Assessment of the Internal Efficiency of Macau's Basic Education: An Alternative Application of the Reconstructed Cohort Method

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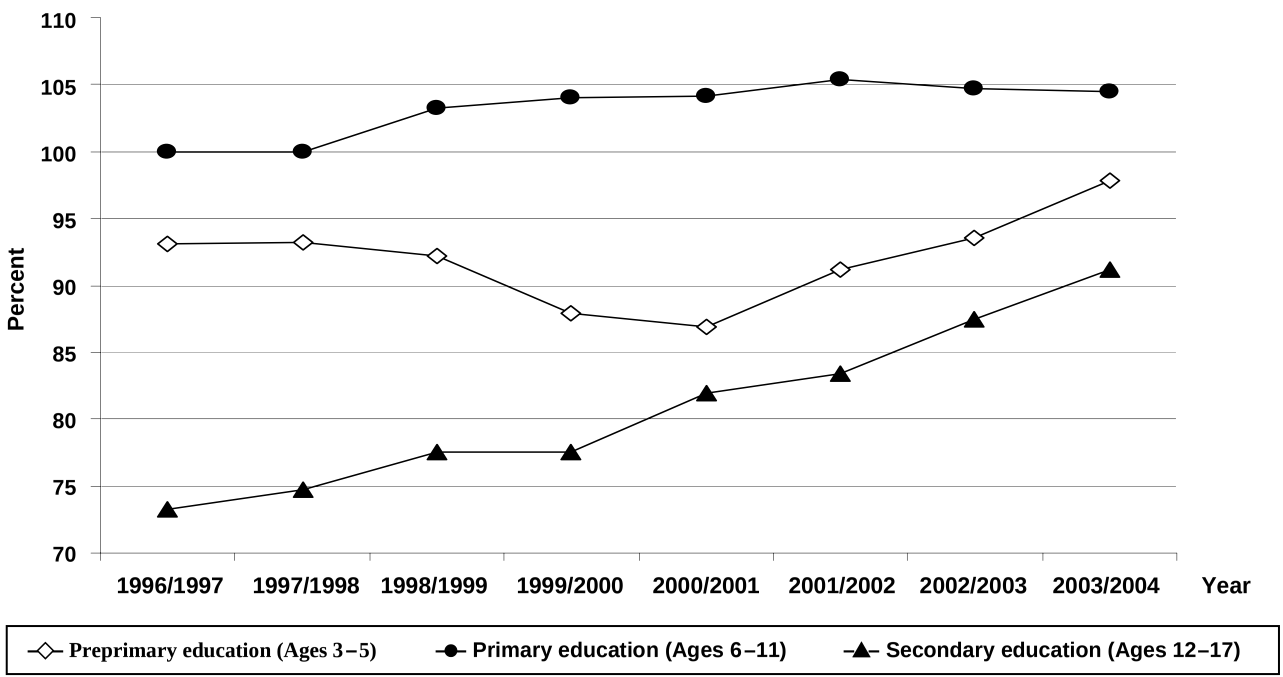
An assessment of internal efficiency allows policymakers and education administrators to understand how cost-effective the desired educational outputs, such as promotion and retention rates of students, are being produced from a given input. In Macau, where private school enrollment accounts for more than 90% of the total K–12 student enrollment, this study attempted to explore if a private-sector-dominated school system can be equally efficient in basic education. The internal efficiency was estimated for each educational cycle from 1996 to 2003 based on the reconstructed cohort method. The results of this study revealed that, on a seven-year average, the highest coefficient of efficiency was attained in preprimary education (99%), followed by primary education (90%), and then by upper secondary education (85%). Lower secondary education was found least efficient among four cycles, averaging only 79%. The years-input per preprimary, primary, lower and upper secondary graduate were 3.03, 6.67, 3.79, and 3.53 respectively. The wastage of educational resources was found worse in secondary education as the input-output ratios revealed that an additional 26% and 18% of the ideal resources were required to produce a lower and upper secondary graduate respectively.

The total student enrollment in Macau's basic education climbed from 91,768 in 1996 to 99,183 in 2002, and the number of school units also grew from 123 to 130 over the same time span. However, the basic education of Macau continued to be dominated by private schools as the proportion of students enrolled in the private sector remained fairly unchanged between 1996 and 2002, averaging 93.5% and 93.6% respectively. To facilitate free universal basic education, *Decreto-Lei n.º 29/95/M* (or Decree-Legislation No. 29/95/M) was implemented in 1995 to provide tuition subsidies for kindergartners (K3 students) and primary school (P1–P6) students in private schools integrated in the public school network (Government of Macau, 1995). The integration of private schools in the public school network was stupendous in Macau as the networked private schools then became more accountable to the government and to the public and the government finally has more control over the free-market basic education. Another subsidy scheme was introduced in 1997 to further free education for lower secondary (S1–S3) students enrolled in networked private schools (Government of Macau, 1997). As the number of private schools that voluntarily joined this public school network grew from 55 in 1996 to 86 in 2002, the proportion of Macau's student population receiving free basic education had jumped from 39% to 64% within seven years (Statistics and Census Service, 1998, 2004).

The increases in proportion of students receiving tuition subsidy and in number of private schools integrated in the public education network have helped improve access to basic education in Macau since 1996. As shown in Figure 1, the gross enrollment ratios of students in both primary and secondary education have continued to grow between 1996 and 2003. The gross enrollment ratios of preprimary, primary, and secondary school students had reached 97.8%, 104.5%, and 91.2%, respectively, in Macau in 2003. Although the overall participation of children in basic education has remained high, the society is still plagued with many problems associated with school dropout and grade repetition ("Opinions of Citizens," 2005). The limited systematic analyses of repetition and dropout in educational literature suggests that it is yet to make clear how severely the educational system's internal efficiency is undermined by these repetition and dropout problems in Macau. In addition, the impacts of the 1995 and 1997 decrees on the internal efficiency of Macau's basic education are yet to be understood. To assess the internal efficiency of Macau's basic education, the method adopted by UNESCO for evaluating the combined effects of repetition and dropout on a school system's internal efficiency in the

Figure 1: Gross Enrollment Ratio by Level of Education From 1996/1997 to 2003/2004



absence of individualized student information — the reconstructed cohort method — was alternatively applied in this study. The first part of this article is to introduce the methodological concepts of the reconstructed cohort method in internal efficiency assessments. The internal efficiency of Macau's basic education system is then estimated using such an assessment method.

Assessment Methods of Educational Internal Efficiency

Efficiency is a term conventionally used by economists to describe the optimal relationship between ends and means or between outputs and inputs (Wako, 1995, p. 26). In education, the term is adapted to represent how successful the desired output is being produced from a given input (Tan & Mingat, 1992, p. 50). Depending on types of outputs concerned, there are basically two aspects of educational efficiency: external efficiency and internal efficiency. External efficiency is used to address the relationship between educational inputs and outputs involving economic or social returns on investment in education as a whole. Educational outputs used in external efficiency studies include the rate of return, social equity, economic growth, and proportion of educated and skilled workforce (Tan & Mingat, 1992, p. 45). On the contrary, when educational inputs are related to outputs concerning internal goals of an education system, like student's achievement, promotion, dropout or retention rates, the term "internal efficiency" is applied (Tan & Mingat, 1992, p. 50). The cost-effectiveness of an education system often relies on the assessment of internal efficiency to know how well resources are being utilized to generate optimal educational outputs (Lockheed & Hanushek, 1994).

The importance of assessing internal efficiency in education was popularized in the World Conference on Education for All (EFA) in 1990. In an attempt to universalize primary education, UNESCO had conducted an EFA assessment of 167 countries' primary education from 1990 to 1998 based on 18 EFA core indicators, including a key internal efficiency indicator measuring the ratio of ideal to actual educational inputs on student cohorts — the coefficient of efficiency (UNESCO, 2000, p. 4). Since Macau did not participate in this EFA assessment in the 1990s, this study attempted to investigate how the internal efficiency of Macau's private-sector-dominated basic education measures up to other societies. As school choice and free-market education are much heated issues of societal debates in recent years, a study of the internal efficiency of Macau's basic education helps understand if a private-sector-dominated school system can be equally efficient in basic education. Moreover, by attesting effects of the government's subsidy policies on the internal efficiency of Macau's education system, it is hoped that this study can shed light on the possibility of adopting a similar measure in upper secondary education to improve the internal efficiency of Macau's school system.

To evaluate the internal efficiency of an education system, the pupil-year is a unit of measurement recently developed to represent educational inputs. A pupil-year is a non-monetary measure of educational inputs to retain one student in the system for one school year. Ideally, it takes only one pupil-year not only to keep a student in the school system but also to advance the student from a grade to the next. If a student completes a given educational cycle without repeating or dropping out, the number of pupil-years invested in that student should not exceed the number of prescribed grades in the cycle. Every time a student repeats a grade, twice the expenditure is required for the student to achieve one-year worth of education. By the same token, one or more years of educational expenditure could have been spent in vain if a student drops out before completing a degree (Wako, 1995). In this connection, when evaluating the severity of resource wastage in an educational cycle, inputs are frequently measured in terms of pupil-years, whereas the number of graduates from the given educational cycle is a synthetic indicator of outputs conventionally used in the assessment of a school system's internal efficiency (Wako, 1995).

Since the analyses of both educational inputs and outputs require tracking of students moving through an education system, the cohort method is a popular approach used in assessment studies of internal efficiency. A cohort in education, also known as a school cohort, is defined as a group of students entering the first grade of a given cycle in the same year but may not necessarily complete or exit the cycle at the same time due to individual's experience in promotion, repetition, or dropout (UNESCO, 1998a). By comparing the actual pupil-years an education system has invested in a school cohort within a given cycle against the ideal pupil-years supposedly spent for the cohort without repetition and dropout, internal efficiency can then be determined in terms of expenditure spent on repetitions and dropouts. There are three cohort methods commonly employed in internal efficiency analyses — true cohort, apparent cohort, and reconstructed cohort. Depending on the availability of data on a selected cohort, these methods are selected to calculate the internal efficiency under different circumstances.

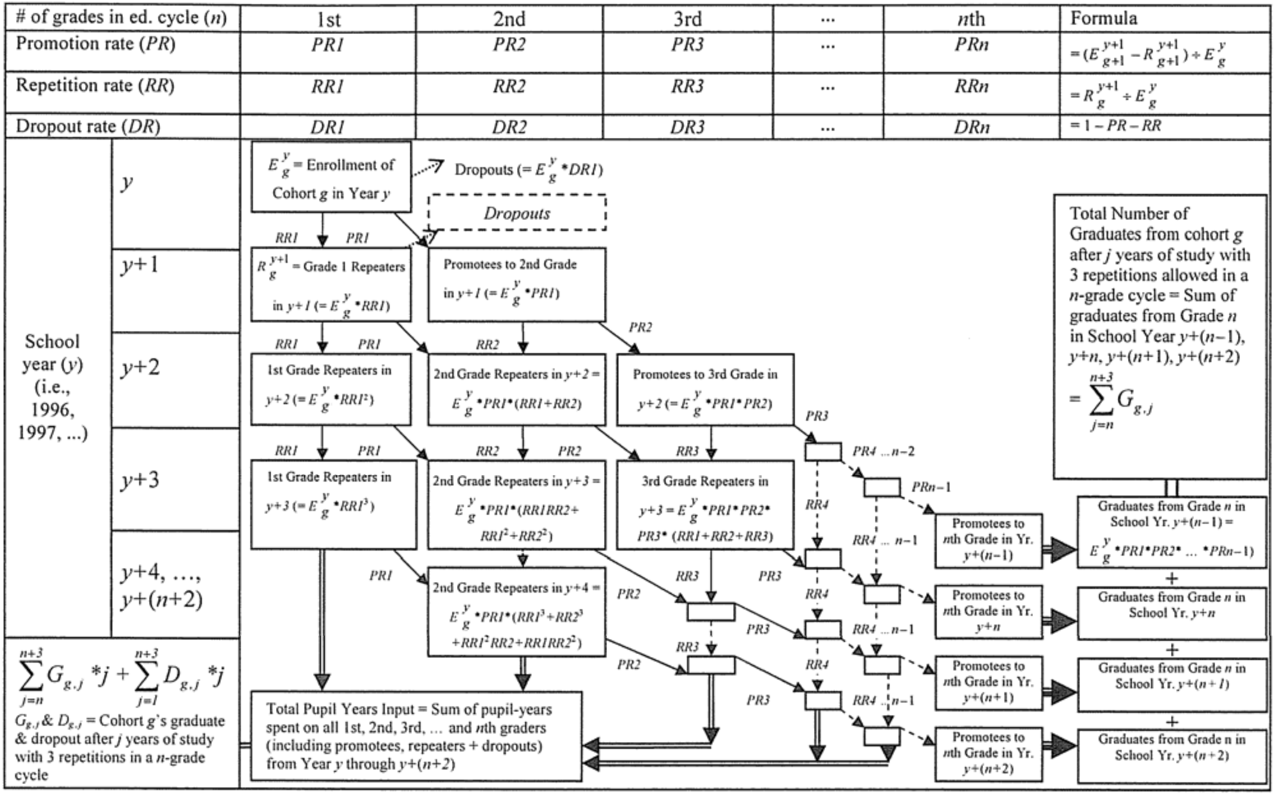
The true cohort method is the most precise and ideal method among the three. Complete promotion, repetition, and dropout information, obtained from either longitudinal tracking or retrospective study of existing school records of every student in the cohort moving in and out during the specified cycle, would yield an accurate account of wastage of resources on repeaters and dropouts in an education system (UNESCO, 1998b). However, this true cohort method is hardly ever used because it is often too hard to obtain or to access complete data. The second cohort method — the apparent cohort method — is applied when data on repetition are consistently missing. Because students are assumed to have advanced or else quitted, this method is applicable to systems wherein effect of repetition is neglected. Enrollment changes from one grade to the next between two successive years are believed to be the results of students dropping out of the educational cycle. Under the assumption of this model, impacts of repetition on an education system's internal efficiency are not considered and the wastage of educational resources is assumed only as a result of dropping out of students (UNESCO, 1998b). Therefore, the apparent cohort method is most appropriate for education systems warranting automatic promotion or lacking repetition data.

Different from the apparent cohort method, the reconstructed cohort method takes into consideration the impacts of both repetition and dropout when evaluating a school system's internal efficiency. It is especially useful in the assessment of an education system where the true cohort method cannot be applied because individualized student information is unavailable. The reconstructed cohort method is applicable as long as an education system does not warrant automatic promotion and data on enrollment and repetition by grade are available for two successive years (UNESCO, 1998b). This is, perhaps, why the reconstructed cohort method was selected and highly publicized by UNESCO in the assessment of 167 countries' internal efficiency in primary education (UNESCO, 2001, p. 21). Assuming that there is no double-promotion, no migration, and the per-level flow ratios of students remain unchanged no matter whether students progress via promotion or repetition, the reconstructed cohort method requires only enrollment and repeater data from two successive years to reconstruct a flow diagram of student flow ratios. The flow diagram can then be used to derive the total numbers of pupil-years spent and graduates produced. Given that cohort-specific internal efficiency can be easily calculated using only data from two successive years, this reconstructed cohort method provides an alternative means for making cohort comparisons (e.g., 1st graders of 2000 vs. 1st graders of 2001) even in the absence of a longitudinal tracking of individual student progress.

The Calculation of Indicators of Educational Internal Efficiency

Based on the fundamentals of the reconstructed cohort model, there are only three possibilities that students would experience when they move through an educational cycle: being promoted to the next grade, repeating the same grade, or dropping out. When the number of students promoted from grade g to the next (which equals to the number of grade $g + 1$ student enrollment minus the number of grade $g + 1$ repeaters) and the number of students repeating grade g in the subsequent year are compared against the grade g student enrollment in a given year, promotion rate (PR) and repetition rate (RR) can be arrived accordingly. Because promotion, repetition, and dropout rates should add up to 100%, the dropout rate (DR) is the residual of the promotion and repetition rates from 100% (Wako, 2003, pp. 23, 25, 26). Figure 2 recapitulates the general equations for calculating PR, RR, and DR in each grade (Wako, 2003, pp. 27–30). Using the PR, RR and DR established by grade, a flow diagram can be reconstructed to yield the number of pupil-years spent on only graduates as well as on the entire cohort. To help countries in the EFA assessment understand the use of reconstructed cohort method in estimating internal efficiency, UNESCO (1998b) has demonstrated how to use PR, RR, and DR to reconstruct a student flow diagram and to derive the total pupil-years and graduates through an example of a hypothetical cohort. Based on this example, the stepwise computations underlying the UNESCO's sample flow diagram are converted into corresponding formulas and summarized in Figure 2.

Figure 2: A Flow Diagram of Student Flow Ratios of Cohort *g* Using the Reconstructed Cohort Method



Source: Compiled from Wako (2003) and UNESCO (1998b).

Years-Input per Graduate

The pupil-years spent per graduate, more commonly termed the years-input per graduate (YIG), estimates the average number of (pupil-)years being invested in producing a graduate from the cohort (UNESCO, 1998c, 2003). Regardless of cohort size, the number of YIG achieved by a highly efficient school system would be close to the normal duration of study for a given educational cycle. The fewer the YIG, the higher the internal efficiency of an education system. The formula for arriving YIG for cohort *g* during the prescribed *n* years of study plus the number of repetition allowed (*k*) is expressed as follows (UNESCO, 1998c; 2003, p. 17):

$$YIG_g = \frac{\left\{\sum_{j=n}^{n+k} G_{g,j} * j\right\} + \left\{\sum_{j=1}^{n+k} D_{g,j} * j\right\}}{\sum_{j=n}^{n+k} G_{g,j}} \quad \cdots\cdots (1)$$

where YIG_g = Years-input per graduate from cohort *g*;
$G_{g,j}$ = graduates from cohort *g* after *j* years of a given educational cycle; and
$D_{g,j}$ = dropouts from cohort *g* after *j* years of a given educational cycle.

Coefficient of Efficiency

Different from YIG, coefficient of efficiency (CE) is a measure that relates the amount of pupil-years spent on only graduates to the total pupil-years spent on graduates, repeaters, and dropouts of cohort *g* in a period equivalent to the prescribed number of years of study plus the number of times a student is allowed to repeat. When the ideal number of pupil-years required for yielding the total number of graduates is expressed as a percentage of the actual number of pupil-years spent by the entire cohort to produce the same number of graduates, the impacts of repetition and dropout on the overall internal efficiency can be reflected (UNESCO, 1998d; 2003, p. 15). The closer the CE is to 100%, the smaller the undermining effects of repetition and dropout are on the system. For cohort *g* with *n* prescribed grades in the normal duration of study for a cycle, the number of graduates from the cohort in final grade n after j years of study ($G_{g,j}$) would ideally require $G_{g,j} * n$ pupil-years if the system disallows repetition (k). The actual input for this cohort g after j years of study is the sum of pupil-years spent in successive years of the given educational cycle on graduates and on dropouts, denoted as $G_{g,j} * j$ and $D_{g,j} * j$ respectively. The equation (UNESCO, 1998d; 2003, p. 15) is written as follows:

$$CE_g = \frac{\sum_{j=n}^{n+k} G_{g,j} * n}{\left\{\sum_{j=n}^{n+k} G_{g,j} * j\right\} + \left\{\sum_{j=1}^{n+k} D_{g,j} * j\right\}} * 100 \quad \text{.......................................} (2)$$

Input-Output Ratio

Computed exactly in the reverse of CE, input-output ratio (IOR) is a relative ratio of the actual expenditure on the entire student cohort throughout the given educational cycle to the ideal expenditure on only graduates from the cohort if there is no repeater and dropout. IOR can be directly calculated by dividing the total pupil-years used for the entire cohort (including graduates, repeaters, and dropouts) by the number of pupil-years used for graduates in a given cycle. But it is often more conveniently derived as the exact reciprocal of CE, so the IOR equation is most commonly written as IOR = 1/CE (UNESCO, 1998a; 2003, p. 15). If IOR is used in the assessment, the higher the value of IOR is exceeding one, the less productive the resources of education are being utilized to yield graduates (UNESCO, 1998a).

Limitations of the Reconstructed Cohort Method

All three indicators of internal efficiency are calculated based on promotion, repetition, and dropout data from two successive school years. Any errors in enrollment or repeater data will affect the estimates derived from these data. There are three primary sources of errors where student flow ratios could be distorted (UNESCO, 1998b): (1) the overreporting of enrollments and/or repeaters; (2) inaccurate or indistinct differentiation between new entrants and repeaters; and

(3) variation in data reporting between years. Any errors stemmed from any one of these sources will affect the accuracy of raw data used for the generation of internal efficiency indicators. Therefore, the findings of this study were data-, cohort-, or study-specific.

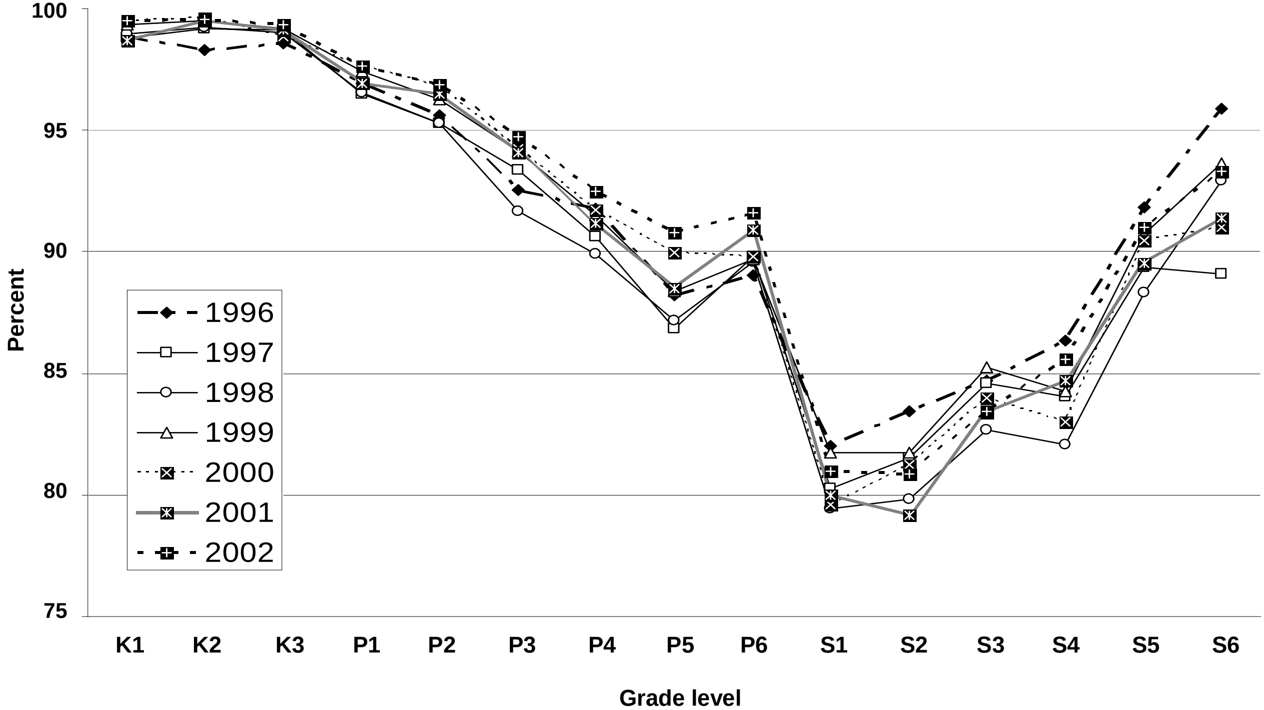
To minimize errors in the estimation of student flow ratios, particularly PR, data on enrollment, repetition, and promotion were gathered from the annual *Education Survey* of the government of Macau between 1996/1997 and 2002/2003 (Statistics and Census Service, 1998, 1999, 2000, 2001, 2002, 2003, 2004). Since the policy of free universal education was implemented in Macau in 1995, it is preferable to start the investigation from 1994 so as to compare the effect of the pre- and post-subsidy regulation. However, in this study, the years of 1996/1997 to 2002/2003 were chosen for two reasons: (1) a technical problem in the government's collection of 1994/1995 promotion and repetition data had, in turn, undermined the accuracy of both 1994/1995 and 1995/1996 data sets (Statistics and Census Service, 1997, p. 57); and (2) the use of data from successive years allowed variations in internal efficiency to be tracked on long-term basis and the year 2002/2003 was the latest set of data available at the time of data collection. In addition to yielding a more accurate account of the proportion of cohort students moving through each course of the three possibilities of promotion, repetition, and dropout, additional official information was taken into consideration in the study as an attempt to delineate the scope of the potential inconsistency associated with inter-annual data. It should also be noted that the number of repetition was limited to three in the construction of the flow diagram in this study. Although the maximum number of times a student is allowed to repeat a grade is not clearly regulated in Macau, it is assumed that repeaters, regardless of grade level, should take no more than three repetitions to move on to the next grade level.

Results of Internal Efficiency of Macau's Basic Education System

Patterns of Student Flow Ratios

Official promotion records along with enrollment and repeater data from two successive years were compiled to derive the PR, RR, and DR specific to each grade level. Figure 3 shows that the highest PR of every school year was consistently found in preprimary education whereas the

Figure 3: Promotion Rates of K1 Through S6 From 1996 to 2002



lowest was generally at the beginning of secondary education. Similar trends were observed across all seven years, indicating that PRs steadily decreased from preprimary (K) levels to near the end of primary education. Despite a brief rise from the fifth (P5) to the sixth (P6) grade, the PRs further plunged down at the first two secondary levels (S1 and S2), but gradually climbed back toward the peak at the end of secondary education. Table 1 reveals that all levels of Macau's basic education have achieved a minimum of 79% in PR between the school years of 1996/1997 and 2002/2003. On average, 10 out of 15 grade levels had been promoting more than 90% of students to the next grade in the seven-year span. Only P5, S1, S2, S3, and S4 were averaging 88.5%, 80.6%, 81.1%, 84.0%, and 84.3% respectively in PR from 1996 through 2002. The best PRs of preprimary and primary education were similarly found in the latter school years including 2000/2001 and 2002/2003. However, the highest PR of every secondary grade level, except S3, was attained in the earliest school year of 1996/1997.

The overall trend of RR was found exactly opposite to what was seen in the promotion analysis. Figure 4 shows that RRs have slowly but steadily increased from K levels all the way to P5. After a slight drop at P6, the RRs peaked at S1 and S2 and then gradually came down. Across all seven school years, S1 and S2 had been the grade levels wherein the highest RRs were obtained. Similar K1–S6 pattern of repetition was also noted year after year. On average, as indicated in Table 1, the RR was worst at S1 level (17%), followed by S2 (16.4%), S3 (13.5%), S4 (11.4%), and P5 (10.4%) respectively. But the RRs of the same grade level sometimes varied quite substantially in magnitude between years, notwithstanding the parallel K1–S6 patterns observed among years. The range of RRs was widest in S1, followed by S2, S4 and then S3 (Table 1). Not only was the range of RRs larger in secondary levels, the RRs of secondary levels were also escalating over time. Quite the opposite was seen in levels K2 through P5 as their RRs were found higher in earlier school years and lower in the latter years.

The pattern of K1–S6 DRs appeared less consistent from one school year to the next. The DRs of each school year fluctuated quite substantially across grades and each K1–S6 trend was completely unique. As shown in Figure 5, 1997/1998 was the school year wherein DRs were found the highest across grades except K2. Changes in DR were most evident in three intervals: from P6 to S1, from S3 to S4, and from S5 to S6. In contrast, changes among levels were less significant in

Table 1: Average and Range of Student Flow Ratios Between 1996 and 2002 by Grade Level

Grade	Promotion rate			Repetition rate			Dropout rate		
	M	Min.	Max.	*M*	Min.	Max.	*M*	Min.	Max.
K1	99.08	98.66	99.49	0.74	0.42	1.31	0.18	0.03	0.40
		(2001)	(2000)		(2000)	(2001)		(2001)	(1997)
K2	99.27	98.30	99.64	0.50	0.31	0.84	0.23	0.00	0.86
		(1996)	(2000)		(2002)	(1996)		(2000)	(1996)
K3	99.03	98.59	99.34	0.95	0.56	1.83	0.01	–0.42	0.31
		(1996)	(2002)		(1997)	(1996)		(1996)	(1997)
P1	97.09	96.48	97.66	2.61	2.16	3.17	0.30	0.08	0.84
		(1997)	(2000)		(2000)	(1998)		(2001)	(1997)
P2	96.08	95.26	96.87	3.58	3.10	4.59	0.33	0.02	1.41
		(1998)	(2002)		(2002)	(1998)		(2000)	(1997)
P3	93.53	91.64	94.71	6.01	5.14	7.70	0.46	0.07	1.47
		(1998)	(2002)		(2002)	(1998)		(1999)	(1997)
P4	91.30	89.89	92.51	7.99	6.92	9.44	0.71	0.32	1.79
		(1998)	(2002)		(2002)	(1998)		(2000)	(1997)

P5	88.54	86.86	90.77	10.38	8.64	12.11	1.07	0.50	2.62
		(1997)	(2002)		(2002)	(1998)		(2000)	(1997)
P6	90.06	89.01	91.59	8.44	7.58	9.09	1.51	0.63	2.59
		(1996)	(2002)		(1997)	(2000)		(2002)	(1997)
S1	80.58	79.45	82.02	17.03	13.39	20.16	2.39	–1.92	6.37
		(1998)	(1996)		(1997)	(1999)		(1999)	(1997)
S2	81.11	79.16	83.44	16.41	12.95	19.02	2.47	0.79	4.46
		(2001)	(1996)		(1996)	(2001)		(1999)	(1997)
S3	84.00	82.68	85.24	13.48	9.79	15.01	2.52	0.84	5.6
		(1998)	(1999)		(1997)	(2001)		(1999)	(1997)
S4	84.28	82.07	86.37	11.38	8.20	13.62	4.34	2.39	7.09
		(1998)	(1996)		(1996)	(2000)		(1999)	(1997)
S5	90.18	88.34	91.83	7.00	4.78	8.57	2.81	0.85	4.61
		(1998)	(1996)		(1996)	(2001)		(2002)	(1997)
S6	92.46	89.07	95.89	3.20	1.46	4.60	4.34	2.49	9.10
		(1997)	(1996)		(1996)	(1998)		(1998)	(1997)

Note: The number in parenthesis is the year wherein maximum or minimum is found.

Figure 4: Repetition Rates of K1 Through S6 From 1996 to 2002

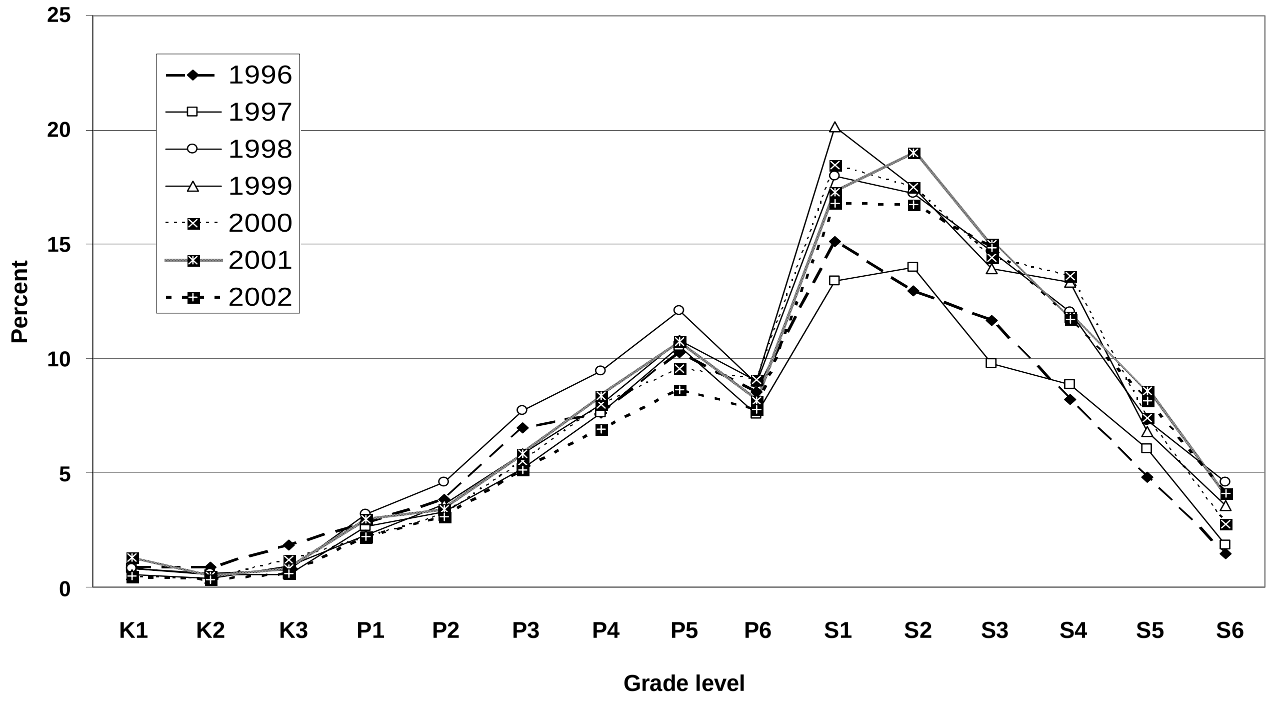
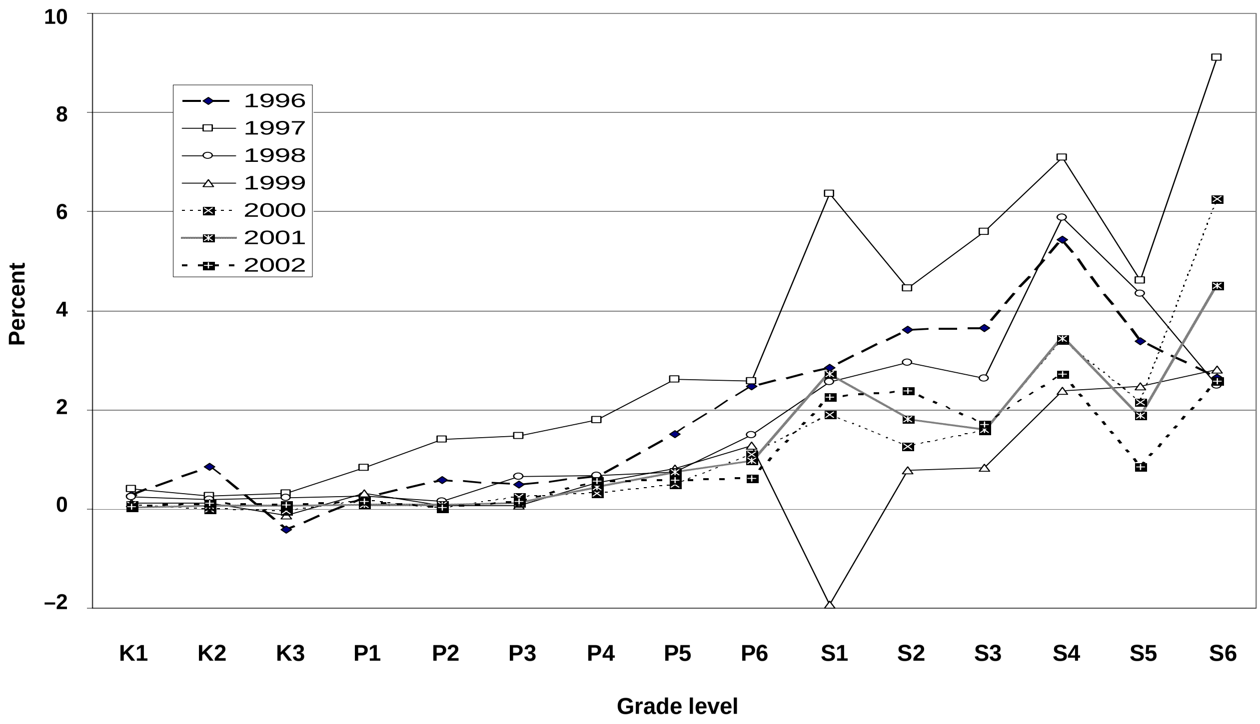


Figure 5: Dropout Rates of K1 Through S6 From 1996 to 2002



grades prior to P5. As presented in Table 1, approximately one-third of all DRs had exceeded 2% and these high DRs were commonly found in secondary levels. The average DR was highest in S4 and S6, estimating 4.34% apiece, followed by S5, S3, S2 and then S1. In fact, the last grade level of the basic educational cycle, S6, was the level where the worst DR was observed in four out of seven years. The highest DR of the remaining three school years was similarly observed in level S4. Another noticeable finding was that there had been four occasions wherein negative DRs were seen: S1 in 1999, K3 in 1996, 1999 and 2000.

Indicators of Internal Efficiency

Using the reconstructed cohort method exhibited in Figure 2, one hypothetical scheme of student flow had been reconstructed for each educational cycle to yield the YIG every year. Table 2 shows the average number of pupil-years spent per preprimary, primary, lower and upper secondary school graduate between 1996 and 2002. The average number of pupil-years for a preschooler to graduate from preprimary education ranged between 3.02 and 3.04 in the seven-year span. The years-input per preschool graduate were found highest in 1996 and 1997 (averaging 3.04 apiece), and lowest in 1999, 2000, and 2002 (all estimated at 3.02). In general, the numbers of years-input per primary school graduate also declined over time. The cohort of 1997's primary school students was found to have the largest number of pupil-years

Table 2: YIG by Level of Education From 1996 to 2002

Year	Preprimary education	Primary education	Lower secondary education	Upper secondary education
1996	3.04	6.78	3.76	3.40
1997	3.04	6.94	3.90	3.74
1998	3.03	6.74	3.87	3.55
1999	3.02	6.61	3.67	3.46
2000	3.02	6.55	3.76	3.60
2001	3.03	6.58	3.81	3.53
2002	3.02	6.48	3.77	3.41
7-year average	3.03	6.67	3.79	3.53

invested per primary graduate (6.94), followed by the cohort of 1996, 1998, 1999, 2001, 2000 and then 2002. Similarly, the largest pupil-years spent on a lower secondary and on an upper secondary graduate were found in 1997, averaging 3.90 and 3.74 respectively. But the cohort of 1999's lower secondary students took the fewest years to graduate (3.67), whereas the smallest number of pupil-years spent per upper secondary graduate was observed in 1996, averaging only 3.40. Although variations in YIG were smaller in lower secondary education, the number of years invested to advance a lower secondary student to the next educational cycle was consistently larger than what was spent per upper secondary graduate in each and every year between 1996 and 2002.

The CEs by level of education between 1996 and 2002 are summarized in Table 3. The highest CEs were found in preprimary education, ranging between 99.38% and 98.57%, followed by primary education, upper secondary education, and then lower secondary education across the years. Compared to the soaring CEs estimated for preprimary education, the CEs of primary education never exceeded 92.59%. Lower secondary education was found to have the lowest CEs, all in the range of 77–82%, whereas the CEs of upper secondary education were slightly higher in the range of 80–88%. Generally speaking, the CEs of preprimary education grew slowly from the lowest in 1996 and reached a plateau after 1999. The CEs of primary education temporarily dropped from 88.47% in 1996 to 86.44% in 1997, and then steadily grew to reach new high (92.59%) in 2002. Both lower and upper secondary education was similarly found least efficient in 1997.

Table 3: CE by Level of Education From 1996 to 2002

Year	Preprimary education	Primary education	Lower secondary education	Upper secondary education
1996	98.57	88.47	79.69	88.35
1997	98.74	86.44	77.00	80.31
1998	98.85	89.03	77.60	84.45
1999	99.38	90.72	81.69	86.72
2000	99.35	91.63	79.78	83.34
2001	99.02	91.19	78.76	84.95
2002	99.37	92.59	79.52	87.87
7-year average	99.04	90.01	79.15	85.14

But lower secondary education was found most efficient in 1999, whereas the highest CE of upper secondary education was seen in 1996.

Table 4 reveals that the highest IOR of primary, lower and upper secondary education has been commonly found in 1997. The IORs of all seven cohorts of kindergartners were found identical at 1.01. The IORs of primary education fluctuated between 1.16 and 1.08 but were generally receding over time, from 1.13 in 1996 down to 1.08 in 2002. The IORs obtained for lower secondary education ranged between 1.22 and 1.30, and the highest and the lowest ratios were found in 1997 and 1999 respectively. The lowest IOR of upper secondary education was observed in 1996 at 1.13. But upper secondary education's IORs were generally declining from 1.25 in 1997 to 1.14 in 2002.

Table 4: IOR by Level of Education

Year	Preprimary education	Primary education	Lower secondary education	Upper secondary education
1996	1.01	1.13	1.25	1.13
1997	1.01	1.16	1.30	1.25
1998	1.01	1.12	1.29	1.18
1999	1.01	1.10	1.22	1.15
2000	1.01	1.09	1.25	1.20
2001	1.01	1.10	1.27	1.18
2002	1.01	1.08	1.26	1.14
7-year average	1.01	1.11	1.26	1.18

Discussion and Conclusions

Important Characteristics of Macau's Student Flow Ratios

The analysis of student flow ratios between 1996/1997 and 2002/2003 school years has revealed several important characteristics of Macau's basic education system. First of all, the repetition rate of Macau's preprimary and primary schoolchildren generally grew as grade level increased all the way up to the 5th grade every year. The RR of P6 students, however, was consistently found lower than that of P5 students year after year. As students in the private sector continued to exceed 93% of the total student enrollment between 1996 and 2002, the lower

RR of P6 students may be related to processes underlying the transition of P6 students from primary to lower secondary schools. Schools offering basic education compete against each other in the free market and private schools are free to set their admission policies and enrollment quota. In the absence of both central placement system and standardized examination for admission to secondary education, admission tests are administered directly by schools. A graduating P6 student who attends a school that offers only primary education or wishes to attend a different school at secondary level must apply for a lower secondary school of the student's choice and take the corresponding admission test required by that school. As variations in curriculum across schools have been great, a P6 student deemed failing by the primary school the student is attending could possibly be considered advanceable by a lower secondary school if the student passes the admission test of that school. It is unsure whether the acceptance of a student to a private lower secondary school is contingent upon test score, grade completion, or a combination of the two, but it would be reasonable to assume that private schools' decisions on whom to admit at this P6−S1 transition may have played an important role in the extent of RR found in the last grade of primary education.

Secondly, among the entire educational span from preprimary to secondary education, the most prominent changes observed in student flow ratios were the fall in promotion and rise in repetition between P6 and S1. A comparison of student flow ratios between these two levels revealed that a seven-year average of 10% plunge in PR along with an approximately 9% upsurge in repeaters had resulted in only a 1% increase in dropouts (Table 1). These drastic inter-level changes were seemingly a manifestation of inconsistent admission policies and curriculum standards across schools. As graduates of primary schools entered secondary education, more students seemed to have difficulties passing Grade S1. This might be partially explained by the availability of primary and secondary schools in Macau. There were nearly 70 schools that deliver education for primary schoolchildren, but almost half do not offer any education beyond Grade P6. Among 40+ schools that offer secondary education, about four-fifths are actually kindergarten through secondary (K–S) or primary through secondary (P–S) schools. In other words, many P6 graduates are likely to attend a K–S or a P–S school that they are not accustomed to when they move on to the S1 level. The intensity of competition could be higher and the process of adjustment could be longer as the influx of new students into schools might be the largest at the S1 level. In this connection, an S1 student might have failed the grade because the student had found the new school curricula too challenging or the new classmates too competitive. Fortunately, many S1 students who failed to make the promotion chose to stay in the educational system by repeating the grade. On average, only 2.4% of S1 students decided to drop out of schools completely.

Thirdly, the proportion of dropouts continued to climb throughout secondary grade levels except S5. Based on the seven-year average, S4 and S6 students tended to drop out of schools more frequently than others. It is very likely that some upper secondary students in Macau have left schools for two reasons. First, some S4−S6 students could have dropped out due to inaffordability. Free education is provided for K3−S3 students enrolled in both public and private schools that joined in the free education network. As students advance to upper secondary education, some may have found school education no longer affordable and eventually dropped out. Second, educational levels beyond S3 are not considered compulsory. As a result, sophomores, juniors, and seniors of secondary schools could have left schools to join the labor force once they become eligible to work at the age of 16. These two factors together could help explain why DRs were higher in levels S4 through S6 each year.

The problem of student retention was less severe in Grades S1 through S3. The expansion of subsidy coverage from Grades P6 to S3 legislated in 1997 (Government of Macau, 1995) might have been an important contributing factor. The quitting of S1, S2, and S3 students was found worst in the school year of 1997/1998 but gradually improved since the subsidy statute of 1997 has taken effect. It is rather arcane that the impact of the decree on the retention of S1−S6 students, in particular of lower secondary students, was latent. The gross enrollment ratios of secondary school students, as displayed in Figure 1, seemed to resonate more implicitly with the legislation instead. Unless there was an external factor that was strong enough to cause a drastic increase in dropout in 1997 but unaccounted for in this study, the peaking of DR in the 1997/1998 school year across grade levels (except K2) might be better explained by possible overestimations of the actual DRs. As DR is calculated as a residual of PR and RR, an under-estimation of either PR or RR can result in an overestimation of DR.

The overreporting of dropouts often arises from the underreporting of repeaters due to incorrect distinction between new entrants and repeaters or the yearly variation in the coverage of the data (UNESCO, 1998b). Vice versa, an overestimation of repeaters and/or enrollees can lead to an underestimation of dropouts. Instances of negative DRs found in the study suggested that the overreporting of repeaters or enrollees or both could possibly exist, at least in 1997. Other than the accuracy of repeater and enrollment data, a negative DR estimated for a grade *g* in year *y* could also result from a significant inflow of new *g* + 1 entrants to the education system in the subsequent year (Wako, 2003, p. 28). Taking the 1996/1997 DR of K3 as an example, the negative value implied that there might be more new 1st grade entrants to the system in the subsequent school year, 1997/1998, than the number of K3 students in 1996/1997. As three out of four negative DRs found in the study had all been that of level K3, the possibility of a significant influx of P1 students to the basic education system of Macau could not and should not be overlooked.

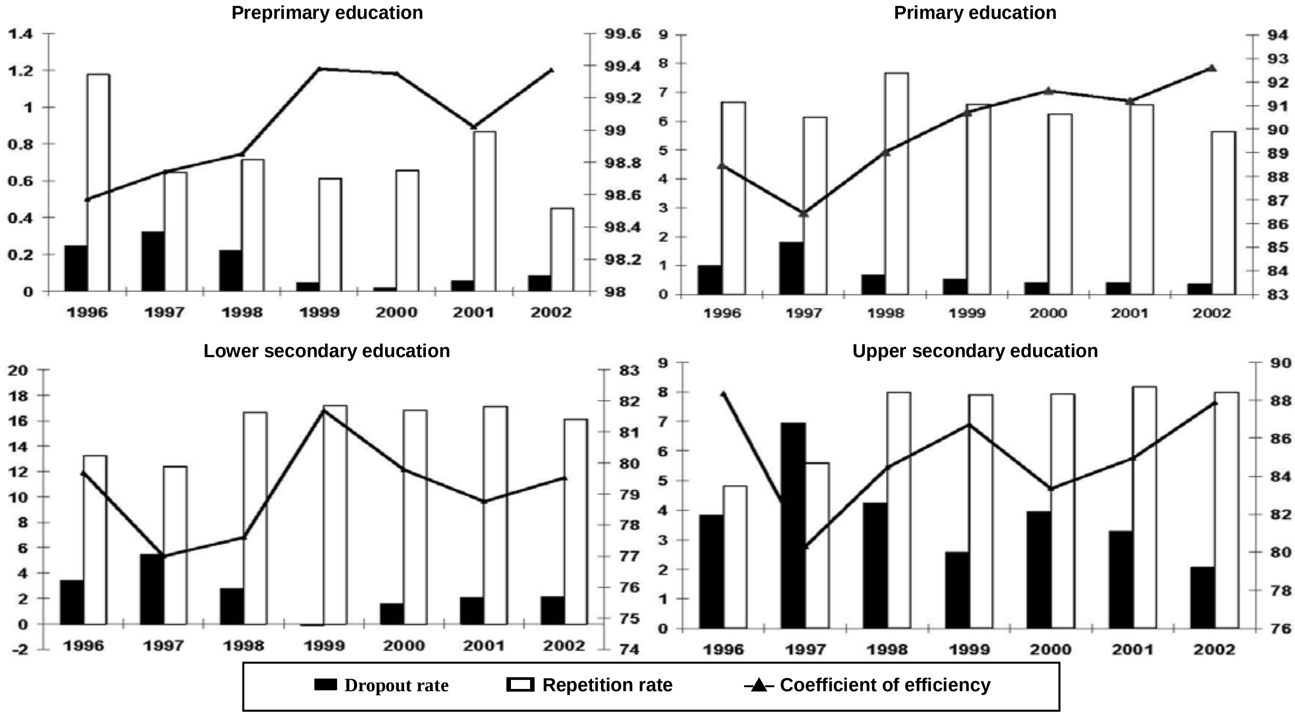
Contributing Factors to the Internal Efficiency

The wastage problem appeared to be more evident in the post-preprimary educational cycles. For an ultimate cohort of primary schoolchildren, the system is to invest no more than six pupil-years per graduate. However, Table 2 reveals that it has taken as many as 6.94 pupil-years to yield a graduate in primary education, and even the most efficient cohort of primary schoolchildren has spent 6.48 pupil-years. The YIG for primary education were higher in 1996/1997, 1997/1998, and 1998/1999 as opposed to the latter years. The small declines in years-input seen in recent years were possibly due to the increases of P1–P6 students being promptly promoted to the next grade level. These input declines also echoed with the progressive improvement of P1–P6 student cohorts in CE over the seven-year span. The CEs were seen to ascend from more than 88% in 1996 to almost 93% in 2002 in spite of a temporary drop to 86% in 1997. These improvements in efficiency might be more easily understood and conveniently conveyed in terms of IOR. Table 4 shows that the effort invested by the system in primary education has been 1.13 times and 1.08 times of the ideal scenario in 1996 and 2002 respectively. In other words, the wastage of educational resources on repeaters and dropouts became 5% less for the most recent cohort of primary school students than for the earliest cohort.

The impacts of *Decreto-Lei n.º 29/95/M* and *Decreto-Lei n.º 34/97/M* seemed to reflect most directly in the CE of primary education. Figure 6 illustrates that the efficiency of primary education has increased as the proportion of dropout has decreased. As basic education became more affordable, primary schoolchildren were more inclined to stay in the system. Fewer P1–P6 students were dropping out, so more efforts could then be diverted to promote P1–P6 students, either directly or through repetition, to the next educational cycle. Therefore, much of the efficiency improvement in primary education were contributed by the decrease in dropouts across years and also by the expansion of free education coverage. Comparing with the efficiency of 52 countries' primary education in the EFA assessment in 1998, the CE of Macau's primary education found in the same year (89.03%) would rank in the second quartile and was better than the median value (88%) among countries in East Asia and Pacific (UNESCO, 2000, p. 35). In addition to the government's provision of the free basic education for K3–P6 students enrolled in the networked public and private schools since 1996, the relatively high efficiency of Macau's primary education might also be attributed to the continuous decreases in student-teacher ratio and class size within the same period. The impacts of student-teacher ratio and class size on the efficiency of Macau's basic education were, however, inconclusive since the efficiency of secondary education generally increased as student-teacher ratio and class size increased, not decreased.

The CE was the lowest in lower secondary education among all four educational cycles, averaging only 79%. The efficiency of the system was found below 80% in advancing lower secondary students to the next educational cycle in six out of seven years. In a three-year cycle of lower secondary education, it took as few as 3.67 and as many as 3.90 pupil-years to produce a lower secondary graduate between 1996 and 2002. The wastage problem was more evident at S1 and S2 levels because about 17% of S1 students and 16% of S2 students were found repeating Grades S1 and S2 respectively. Nearly half of the schools providing education for P1–P6 students do not offer any grade levels beyond P6 in Macau. Student mobility is considerable at the transition from primary to secondary education. Therefore, the increase of S1 and S2 repeaters was very likely a result of the need of secondary school new entrants for

Figure 6: The Relationship Between Efficiency, Repetition and Dropout Rates From 1996 to 2002 by Level of Education



more time to adjust to the new school environment or curriculum standards. The IOR of lower secondary education further confirmed that the system was wasting as little as 0.22 but as much as 0.3 times of an ideal amount of educational resources to yield a lower secondary graduate. Unlike preprimary and primary education wherein internal efficiency continued to improve over the years, none of the indicators of internal efficiency obtained for lower secondary education showed consistent patterns over time. As indicators of internal efficiency of lower secondary education were comparable in extent before and after the 1997 statute was in effect, the impacts exerted by the expansion of free education coverage on lower secondary students were, however, uncertain.

Comparatively speaking, the benefits bestowed by the decree of 1997 were stronger upon the gross enrollment ratio of 15- to 17-year olds in upper secondary schools (Education and Youth Affairs Department, n.d.). The impacts of the expansion of free education from P6 to S3 in 1997 was, however, less evident on the internal efficiency of upper secondary education. The use of educational resources on upper secondary students was found at least 80% efficient across the years. The highest CE of upper secondary education (88%) obtained in 1996 was markedly higher than the highest CE of lower secondary education (82%) found in 1999. The consistently higher CEs of upper secondary education showed that the system was more cost-effective at upper secondary than lower secondary levels. It took the system between 3.40 and 3.74 pupil-years per upper secondary graduate in the three-year cycle.

In spite of the small overall S4–S6 student enrollment possibly brought on by the non-inclusion of S4–S6 in the provision of free education, the percentage of promoted students grew progressively with grade levels in upper secondary education. This implied that upper secondary students were more likely to move promptly to the next grade level as long as they stayed in schools. Although fewer were repeating grades S4–S6 compared to S1–S3, the problem of student retention appeared worst at S4–S6 levels (Figure 6). Possibly due to inaffordability, work or other reasons, about 3–4% of upper secondary students were dropping out of schools. With only a few exceptions, the proportions of S4–S6 dropouts were noticeably shrinking since 1997 as more upper secondary students were taking the alternative route of repeating when they failed to advance. Overall, the IORs revealed that the system still spent 1.13 to 1.25 times of the ideal amount of educational resources to produce an upper secondary graduate. But the generally improving efficiency of upper secondary education suggested that the system has, indeed, been utilizing fewer and fewer resources to yield an upper secondary graduate over time.

Conclusions

According to UNESCO's (2004) *EFA Global Monitoring Report 2005*, retention and degree completion of primary school students have remained a major challenge in many areas of the world (p. 1). The assessment results of this study revealed that the system of Macau was fairly efficient in the use of educational resources to produce graduates of basic education between 1996 and 2002. The consistently high CEs of preprimary and primary education, averaging 99% and 90% respectively, suggested that Macau has made significant efforts to reduce the number of repeaters and dropouts in preprimary and primary schools (Figure 6). The completion rate of primary schoolchildren in Macau has by far exceeded that of many developing societies. The high efficiency of Macau's preprimary and primary education could very likely be attributed to the government's provision of the free basic education for K3−P6 students enrolled in the networked public and private schools since 1996.

All three indicators of internal efficiency found in the study showed that the system was less efficient in secondary education, especially in lower secondary education. In general, as displayed in Figure 6, the larger magnitude of repetition as opposed to that of dropout suggested that repetition appeared to have a greater impact on the efficiency of Macau's basic education than dropout. The mostly double-digit RRs of Grades P5 and S1 through S4 revealed that the wastage of educational resources on repeaters were most severe when students moved from one educational cycle to the next. In addition, the dropout rates were worse at S4−S6 levels, and in 1997 the impact of S4−S6's dropout was found even greater than that of repetition. The IORs implied that the presence of a large number of lower secondary repeaters and upper secondary dropouts combined had required the system to put in, on average, an additional 26% and 18% of resources to produce a lower and upper secondary school graduate respectively.

The impacts of public resources wasted on repetition and dropout in secondary education must not be overlooked and should be given the priority in improving the efficiency. Even though a possible extension of free basic education from lower to upper secondary education has been heatedly discussed among the public and policymakers and may soon be underway, expanding the coverage alone may not be enough to solve the problem of resources wastage in secondary education in Macau. As the expansion of free education coverage may help retain more students in the system, repetition is still a problem to solve. Establishing level-appropriate and subject-specific curriculum standards, implementing intra- or inter-school tutorial programs, and strengthening the collaboration between schools and between educational cycles are all alternatives yet to be trialed and understood for their benefits to the reduction of repetitions. Further studies are needed to investigate not only the feasibilities of alternative measures to reduce repetition and dropout but also the underlying causes of repetition and dropout. Only by understanding how severely each factor is undermining Macau's basic education and how feasible a resolution mechanism is in retaining students, the internal efficiency of Macau's basic education can be truly enhanced in the near future.

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