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A Comparative Analysis of the Accuracy of the United Nations' Population Projections for Six Southeast Asian Countries

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Abstract

This report analyzes the accuracy of the United Nations' population forecasts in the past, based on six Southeast Asian countries: Indonesia, Malaysia, Singapore, Philippines, Thailand, and Vietnam. The study uses available projected and estimated age-structured data published by the UN from 1950 onwards. An exploratory data analysis has been carried out to examine the accuracy of the UN forecasts. The study reveals that there is heterogeneity in the accuracy of the UN projections for different countries and the errors are age specific. For example, large errors in forecasts of age structures have been found for both the younger (0-4 years) and the older (70 years and over) cohorts for each country. However, the magnitude of errors becomes narrow with a shorter projection horizon. The analysis also shows that gradual improvement in the accuracy of projections occurs over time. The heterogeneity in error is due to the wrong assumptions made in various past projections; thus, the decomposition of the total errors provides us with interesting scenarios about the base (population) error as well as the change error (or unknown error). It has been found that, generally, the base error and the total error have consistently been decreasing over time. On the other hand, the change error does not follow any particular increasing or decreasing path. Until recently, much was unknown about the causes of the change error in forecasting; the determinants are very important to demographers in order to improve the overall accuracy of population forecasting. In short, the main findings are: i) age-specific errors are inconsistent in sign; ii) there has been a gradual improvement in the accuracy of forecasts; and iii) this increase in accuracy is due to improvements in jump-off errors, not to the forecasts of change. Finally, the present study identifies some reasonable causes of errors and makes policy suggestions.

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Introduction

Forecasting is very important for demographic and economic analyses at the global, regional, and national levels. In particular, it is a part of our decision-making process and, therefore, the forecaster's principal aim is to produce the most accurate forecasts possible. However, the task is not easy and perhaps has never been so, as there is a greater likelihood of uncertainty involved in forecasting and it is more so in the case of population forecasting. The whole process of forecasting is complex because the future population size and structure depend on changes of many social, economic and technological factors.

In this paper we concentrate on population forecasting, which is primarily determined on the basis of base-year population and three other prime components of population change: fertility, mortality and migration. Some common demographic terminology used throughout the text needs further clarification at the beginning. For example, the terms "forecast" and "projection" have similar meanings. When examining the accuracy of data, some authors use the term "observed" and other use "estimated" in relation to data. This indicates the estimate of observed data. The word "uncertainty" indicates the degree of forecast error or forecast inaccuracy. In other words, uncertainty refers to the future, whereas a forecast or projection error refers to the past (Keilman 1990). By accuracy we mean how close the forecast output becomes to the actual value of the variable being forecast.

The United Nations' forecasts are thought to be a reliable source of information and are used for a variety of global, regional and national planning purposes. In some countries this may be the only source of information. Demographers often guess at the uncertainly relating to population forecasting and argue on this particular issue. Questions may arise: How accurate is one's forecast? How big is the gap between forecast and the actual value? Is it big enough for any particular cohort? What are possible sources of forecast errors? What can the forecaster do to maintain or gain credibility? These are supposed to be the common questions. The assessment or evaluation of forecast errors is very important for the future assessment of population. Keilman (1990) classified the following sources of errors:

a) *Errors in projection input data*: the base-year population structure may be based on incorrect census coverage or age-sex misreporting or undercounting. During enumeration some people may not be included as a result of "difficult to trace" or "refusal to interview" or persons were unintentionally omitted during data processing. All of these comprise coverage errors in the census.

b) *Incorrect specification of forecast parameters*: supposed life expectancy is expected to rise at the same rate observed in the last 20 years, but instead, in reality it will increase at twice that rate. This may also happen for other assumptions.

c) *Unexpected events*: such as the outbreak of war, the impact of HIV/AIDS or other epidemics, natural disaster such as floods, cyclones and famine, economic boom, and the urgency of skill migration, etc.

d) *Randomness in parameters*: stochastic fluctuations in the estimated number of births, deaths and migrants are not taken into account in projection methods. Fortunately, experience shows that such errors are found to be small in general.

e) *Inaccurate projection model specification*: if in any case one of the three components fertility, mortality and migration is omitted from the projection model, then there is the possibility of bearing a forecast error.

In particular, the present study will concentrate on the issues of errors made due to (a) and (b) above. In addition, it reveals that in general, the common sources of errors for developing countries are:

a) Wrong assumptions made for the components (fertility, mortality and migration) of projections, and

b) The inaccurate and unreliable input data (base-year population).

When dealing with historical data, the evaluation of accuracy is very important in demography. Time horizon in population forecasting can greatly affect forecast accuracy and uncertainty (Ahlburg and Lutz 1998). There is general consensus among demographers that population forecasting is fairly accurate for short intervals, usually 5 to 10 years (Heilig 1996; Campbell 1996). Therefore, the shorter the interval, the more accurate is the forecast. This is attributable to the demographic momentum and the relative stability of reproductive behavior and mortality. On the other hand, long-range forecasting is much more problematic and more dependent on experts' assessment and uncertainty.

The scenario of future age structure of population completely depends on the reproductive behavior of generations not yet born and their socioeconomic, demographic, cultural and political situations. In addition, the data on migration are not available in some developing countries; this certainly affects the estimation of the base population. If the base-year population is not accurate, then forecasting might not go in the right direction. Future change in fertility, mortality and migration are also based on the experts' assumptions. Wrong assumptions may provide bigger magnitudes of error. The more the deviation, the farther we are from the reality and, thus, forecasters always try to minimize the total error.

The projection is based on a traditional cohort-component model with a low, medium and high "variant." These variants are the result of assumptions on future trends in fertility, mortality and migration. This method is normally used by the United Nations for estimating and projecting the world population. The UN medium variant is widely used as a best-guess projection of future demographic trends. When the projection horizon is longer, the range between high and low variants will grow accordingly. Differences in the degree of uncertainty between the components of population change may be reflected in the gap between corresponding variables in the high and low variants, which may be set based on the analysis of past forecasts (Cruijsen and Keilman 1992).

Although the UN has pursued the noble task of forecasting the age structures of the populations of its member countries since the 1950s, very little systematic investigation has been carried out with regard to the accuracy of the past UN forecasts. This important issue has not received the attention it deserves so far. Moreover, most of the studies focused on developed countries. For example, a survey carried out by Long (1992) in industrialized countries shows that of the 30 countries surveyed, only eight systematically studied forecast errors. Long (1992) emphasized the effects of the components fertility, mortality and migration on population projections for industrialized countries. Inoue and Yu (1979) investigated the errors in total population size of six rounds of the UN projections, with base years from 1950-1970 and observed data for the period 1950-1975. They found a consistent overestimation of the projected growth rate in developing countries after 1960, which was largely explained by the rapid slowdown of population growth in China. They also concluded that errors in the base-year population and in the growth rate of the population immediately preceding the starting year were important determinants of errors in the projected population size of developing countries. Keyfitz (1981) analyzed 1,100 projections made during the period 1939-1968 of various countries including the UN medium variants. The results indicate that populations in slowly growing countries can be estimated more precisely than populations in countries which are growing faster. One of the main findings of Keyfitz's study is that relatively short-term (up to 10 to 20 years) forecasts tell us something about population, but beyond this limit (projection horizon) population forecasting becomes less reliable. Lutz (1991) concludes that projections made for 30 to 40 years can be fairly reliable, but beyond this range projections become less credible. Keilman (1990) is far less optimistic and indicates that forecasts beyond a 15-year period have rapidly decreasing reliability. Stoto's (1983) study on historical projections of populations and actual growth paths of these populations, found that the high and low variants of these projections, in general, seem to resemble a standard deviation confidence interval. Forecast errors are age specific; relatively large forecast errors have been found in the 0-4 year age groups and for persons 75 years and over, particularly in the Netherlands (Groenewold and Navaneetham 1998). Keilman (1998) has investigated whether population forecasts for some regions of the world have been more accurate than for others, and whether the accuracy of the UN forecasts has improved over time. He examined the accuracy of the UN forecasts of the age structure and crude birth and death rates in seven major regions of the world: Africa, Asia, Europe, the former Soviet Union, Latin America, Northern America and Oceania. For a few large countries in these regions, such as India and China within Asia and the United States of America within Northern America, he found that population change in some regions is more difficult to forecast than in other regions, and that the accuracy has indeed improved over time, in part because data quality has improved. In other words, the accuracy of the projection depends on the length of the projection horizon. He expressed his concern with regard to our lack of knowledge about the accuracy of the UN population forecasts for Third World countries.

The above studies no doubt provide important findings to evaluate the accuracy of forecasts. Among others the most important findings are the relationships between accuracy and the projection horizon, heterogeneity in age-specific accuracy, and type of errors especially due to the base-year population. These findings are based on several studies conducted on developed countries. However, knowledge about developing countries' data is almost absent in literature. Heterogeneity in the effects of these components on population projections is very important for six Southeast Asian countries: Indonesia, Malaysia, Singapore, Philippines, Thailand, and Vietnam. For example, migration is very important for Singapore, while fertility is important for Vietnam after the war. In addition to the demographic components, the current age structure also affects the accuracy of the population projections. Therefore, a full-length study is needed to draw general conclusions.

The present study attempts to explore the accuracy of the UN forecasts made for six Southeast Asian countries: Indonesia, Malaysia, Singapore, Philippines, Thailand, and Vietnam. The UN forecasts made between 1951 and 2000 are evaluated in this paper. The research questions set for the study are:

a) How accurate were the UN projections for 1980 and 2000?

b) Does accuracy differ much among the countries?

c) Do the UN forecasts improve over time?

It is anticipated that the outcome of the queries will enhance our knowledge about the accuracy of the UN forecasts and the data as a whole. Accuracy is very important for a country's policy implications.

We turn our attention now to the data and methodology of this study. Following this, we describe the research findings and draw some conclusions. All of the tables and figures used in the following sections can be found at the end of this paper.

Methodology

The data used for this study come from various UN publications (see Table 1; UN 1958, 1966, 1980, 1985, 1994, 1999). To evaluate the accuracy of the UN projections, we compare the total population of each country called "projected" with that of independent estimates by the UN called "observed." For example, if we want to consider the 1950 projection for 1980, then this population is called projected; on the other hand, the most recent mid-year estimate or medium variant for 1980 is considered as observed. The selection of the appropriate measure of the accuracy of a forecast is still a subject of philosophical issue and according to Ahlburg and Lutz (1998), much rethinking is needed in the choice of measures of accuracy in population forecasts. To summarize the results of the comparisons for each country and over time, most of the measures presented in the text are relative error or percentage error (PE), where PE is defined as

$$PE = \left(\frac{\text{projected} - \text{observed}}{\text{observed}} \right) \times 100$$

Thus, if PE = 0, it indicates “no error”; in other words, the projection was perfect. A positive value of PE indicates that the projection was high, “an overestimation”; a negative value of PE indicates that the projection was low, “an underestimation.” A large magnitude of the error within a certain direction also reflects too high or too low. In this study, we also use other measures, for example, “actual difference” which is the deviation or magnitude between projected and observed population sizes. By ignoring the direction of the “actual difference” we can compare errors in absolute terms, called “absolute errors” (see Tables 2 to 7). The mean absolute percentage errors (MAPE) are used to make a comparison between the errors at the aggregate levels for our six selected countries. In addition, this study also uses a technique that allows us to decompose total errors according to the base-year population error and the change (or unknown) error. All of the above indices have been used in this paper to measure errors in forecasts.

Analyses of Errors in the UN Projections

Let us briefly discuss the errors made by the UN in their 1950 projections of the population in 1980 for our six selected countries. This study does not investigate such errors in detail because of the long projection time horizon; we focus mainly on a shorter projection period. The longer period is considered here basically to test the pattern of changes over time. Therefore, to check the accuracy for a short time, we consider the 1975 and the 1980 projections. The analysis of errors has been carried out separately for both projections for the population in 2000. The age distribution in the population projections of our six selected countries has been evaluated using the most recent mid-year estimate. The study only concentrates on the age distribution of the total population; it does not perform analyses for sex distribution. The data are presented in Table 1. In addition to total population, the study considers three important cohorts: the younger, aged 0-4 years; the middle, aged 35-39 years; and the older, aged 70 years and over. Tables 2 to 13 and Figures 1 to 17 contain all the results of the study.

It has been found that heterogeneity exists in errors for total population size as well as for cohorts of the population in different countries. By looking at the direction of the values, we can interpret the underestimation or overestimation. For example, as can be seen in Table 2, the younger cohort of Singapore was overestimated by 187 percent, whereas the population of Vietnam was underestimated by 37 percent. A similar pattern with much improved accuracy is observed for the older cohort of Singapore (9 percent); on the other hand, the size is completely reversed for the middle cohort. The MAPE for the total population of our six selected countries is about 14 percent. It is the highest (46 percent) for the younger cohort followed by the older cohort (14 percent); the smallest error is found in the middle cohort. A similar pattern is observed for other assumptions: rapid fertility decline, mortality decline, and conservative decline. When comparing the MAPE of the four scenarios presented in Tables 2 to 5, we see that the mortality decline assumption generally provides less error (is more accurate) for the total as well as for each cohort. It can, therefore, be concluded that these mortality assumptions will improve the forecasts. This may be explained by the fact that mortality trends are easy to predict for the six selected countries, compared to fertility and migration, which depend on so many factors at different levels. On the other hand, conservative decline provides the highest error and indicates that a conservative assumption does not help much to improve the accuracy of the population distribution. The variability in population errors is due to errors in fertility, mortality and migration, which in turn depend on many factors of our daily life. These errors will be decomposed and discussed later in this section.

As expected, the medium variants of all projections for the year 2000 are very close no matter whether these projections were prepared in 1975 or in the mid-1980s. For instance, Tables 6 and 7 show the extremely wide range of the “variant” or “scenario” in some of the projections. In general for our six selected countries, projections appear to track close to the actual data. As expected, the magnitudes of MAPE for the cohort aged 35-39 years were found to be the smallest (12 percent). The MAPE calculated for the cohort aged 0-4 years are larger (23 percent) than that of the cohort aged 70 years and above (18 percent). This may be due to stability in mortality at the middle ages. The errors are increased over the projection horizon. For example, considering the younger cohort, the MAPE is about 23 percent in the 1975 projection, while it is 20 percent in the 1980 projection. The MAPE suggests that the projections are fairly accurate for the middle cohort. A similar pattern is observed for the total population. Therefore, one important finding is that the MAPE consistently reduces over time. This statement confirms the earlier studies conducted by Keilman (1998).

In the 1975 projection, the total population in 2000 was forecasted fairly accurately for Vietnam and Indonesia as indicated by absolute percentage errors of 4.3 and 0.6, respectively. Interestingly, five years later, all absolute percentage errors show a declining pattern apart from Singapore and Vietnam. This may be due in part to wrong assumptions made for those countries. There is variability in error for each cohort, but it is hard to draw conclusions for the six selected countries separately. The results suggest that age distributions in all population projections are markedly varied over time.

There has always been a question about the selection of the base-year population, which certainly has a direct effect on the magnitude of errors for this type of comparison over various points in time. There are two types of selection errors: one that can be adjusted by inspection from time to time, and an inherent error that is associated with many unknown factors. The total errors incurred in the UN projections can be broken down into two parts: the jump-off or base-year error, and the change error (or unknown error). The base-year error is due to a selection bias regarding the assumptions for projecting the population or for selecting the initial population. This may be caused by the poor quality of data or by the lack of data. The change error is largely due to the methodological issues adopted and to unknown factors. In this paper, both errors are elaborately discussed in order to evaluate the deep-rooted inherent phenomenon. This study considered the 1950 projection to evaluate the accuracy in population forecasting. It has, however, ignored details of analysis simply due to time constraints. This study considers the 1975 and 1980 projections to evaluate the errors made in forecasting the population for 2000. For comparison purposes, the UN’s 1998 estimates were used.[1]

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[1] At the time of this writing, the most recent estimates were found in UN (1999).

Population projections are normally based on the assumptions of indicators such as crude birth rates, crude death rates, total fertility rates (TFR), infant mortality rates and life expectancy. The scenarios of the past assumptions made for our six selected countries are shown in Table 8. They test the forecast errors for two periods: 1975-1980 and 1995-2000. It should be noted that the infant mortality index was not used in the 1975 projection. Therefore, the only comparison of error is made between the 1980 projection and the 1998 estimate (UN 1999). Table 8 helps us to make a general conclusion about the past assumptions for each of the two periods. A declining trend is assumed to follow over time for crude birth rate, crude death rate and TFR, with an increasing trend in life expectancy.

While comparing the projections of 1975 and 1980 with the 1998 estimates (UN 1999), an interesting finding occurred when decomposing the total errors. For example, when considering the 1975 projection, the total error in TFR for Indonesia is about 0.8, of which 0.45 is due to base error and 0.35 due to change error. This separation into base and change errors can be carried out for each country. The mean absolute errors for the total, base and change errors were calculated in order to draw a conclusion about the pattern. Looking at the TFR assumption, it can be seen from Table 9 that the total error is reduced by almost half. It is interesting to see that the base-year error has declined more than half, and the change error has shifted very little. Now we will examine all other assumptions and try to figure out whether the total and other components of error follow any particular pattern.

Examining the crude birth rate presented in Table 10, it is observed that the total error shifted from 4.40 in the 1975 projection to 3.2 in the 1985 projection. On the other hand, the base-year error declined from 4.10 to 1.58. Unfortunately, no declining pattern was observed for the change error. Table 11 shows the errors made due to the crude death rate which indicates that the mean absolute errors have a declining pattern. It is not possible to compare the infant mortality rate since it was absent in 1975. Finally, the life expectancy assumption reveals that mean absolute errors are decreasing for total and base errors, but are increasing for change errors. The analysis helps us to conclude that the errors due to assumptions are decreasing over time, particularly the base-year errors, partly due to improvements in the quality of the data in recent years. The other type of change error does not follow the declining scenario for all assumptions. However, a closer look shows that all types of errors are generally decreasing over time. It should be noted that much is unknown about the causes of the change error in population forecasts; without reducing such errors, it is difficult to forecast accurately.

Conclusions

This paper examines the accuracy of the past UN forecasts for six Southeast Asian countries: Indonesia, Malaysia, Singapore, Philippines, Thailand, and Vietnam. This study considers some past UN projections for 1950, 1975 and 1980, and explores the errors made in those projections for forecasting the population of 1980 and 2000. It appears that there is a certain degree of error encountered in the past UN forecasts. It has also been found that the forecast error decreases as the projection horizon decreases, and that the magnitude of error is bigger in the future. The finding is consistent with that of

Keilman (1998). This is attributable to the improvement in the accuracy of the base-year population.

There has been considerable heterogeneity in the accuracy of projections between the countries with respect to the size of the population and its age structure. It has been found that large variability exits in younger and older cohorts, which indicates more uncertainty for the younger and the older cohorts. There may be a number of reasons behind such errors. One can easily argue about the wrong assumptions made in those forecasts; such unrealistic assumptions are largely responsible for these kinds of error. Therefore, an analysis of errors in assumptions has been carried out in order to explain the types of variability or heterogeneity in errors. Although the magnitude of error is not tested statistically in the present study, it would be worth conducting such studies in the future. The trends in assumptions are dependent upon the demographic, socioeconomic, cultural and political situations of the country. Thus, the forecaster takes into account the historical error for any forecasting purposes. The assumptions about mortality, fertility, migration and life expectancy may be hard to guess. Although there is a clear improvement in accuracy over time, the change errors do not clearly follow a declining scenario. The change error is likely to be associated with many factors of uncertainty and therefore, further study is needed to explore the important factors in order to improve our knowledge. Most recently, research has begun to improve the predicting power of forecasting by gathering information from expert opinion (see, for example, Lutz and Scherbov 1997; Lutz et al. 2000). This scientific step certainly helps the forecaster to improve his accuracy. It is a completely new area and is worth serious research.

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Table 1. Analysis of the United Nations' population forecasts for six Southeast Asian countries.

Population	Reference	Source	Remarks
Base year 1950	UN (1958)	Report III: The population of South-East Asia (Including Ceylon and China: Taiwan) 1950-1980.	Total population and five-year age groups for the year 1980.
Base year 1960	UN (1966)	World Population Prospects as Assessed in 1963.	Population estimates, 1920-1960, and projections up to 1980, for countries in each region.
Base year 1975	UN (1980)	Selected Demographic Indicators by Country, 1950-2000: Demographic Estimates and Projections as Assessed in 1978.	Total population and five-year age groups for the year 2000.
Base year 1980	UN (1985)	World Population Prospects: Estimates and Projections as Assessed in 1982.	Total population and five-year age groups for the year 2000.
Observed 1980	UN (1994)	The Sex and Age Distribution of the World Populations: The 1994 Revisions.	Total population and five-year age groups for the year 1980. Testing accuracy in 1950 projection for population of 1980.
Observed 2000	UN (1999)	World Population Prospects: The 1998 Revision, Vol. II: Sex and Age.	Total population and five-year age groups for the year 2000. Testing accuracy in 1975 and 1980 projections for population of 2000.

Table 2. Actual and percentage errors in the 1950 projection assumed to follow a moderate fertility decline.

Country	Forecasted in 1950 for 1980	Observed in 1980	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	17934	22374	-4440	-19.8
Malaysia	2300	1868	432	23.1
Philippines	7960	7528	432	5.7
Singapore	556	194	362	186.6
Thailand	6086	6344	-258	-4.1
Vietnam	5312	8394	-3082	-36.7
		Mean absolute percentage error = 46.00		
Middle cohort: aged 35-39 years				
Indonesia	7176	8215	-1039	-12.6
Malaysia	613	700	-87	-12.4
Philippines	2441	2358	83	3.5
Singapore	119	136	-17	-12.5
Thailand	2060	2364	-304	-12.9
Vietnam	2692	2108	584	27.7
		Mean absolute percentage error = 13.60		
Older cohort: aged 70 years and above				
Indonesia	2882	2738	144	5.3
Malaysia	307	304	3	1.0
Philippines	736	741	-5	-0.7
Singapore	71	65	6	9.2
Thailand	642	967	-325	-33.6
Vietnam	1051	1574	-523	-33.2
		Mean absolute percentage error = 13.83		
Total population				
Indonesia	130970	150958	-19988	-13.2
Malaysia	13078	13763	-685	-5.0
Philippines	47559	48317	-748	-1.5
Singapore	3074	2415	659	27.3
Thailand	39089	46718	-7629	-16.3
Vietnam	42293	53711	-11418	-21.3
		Mean absolute percentage error = 14.10		

Table 3. Actual and percentage errors in the 1950 projection assumed to follow a rapid fertility decline.

Country	Forecasted in 1950 for 1980	Observed in 1980	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	14130	22374	-8244	-36.8
Malaysia	1813	1868	-55	-2.9
Philippines	6271	7528	-1257	-16.7
Singapore	438	194	244	125.8
Thailand	4795	6344	-1549	-24.4
Vietnam	4185	8394	-4209	-50.1
		Mean absolute percentage error = 42.78		
Middle cohort: aged 35-39 years				
Indonesia	7176	8215	-1039	-12.6
Malaysia	613	700	-87	-12.4
Philippines	2441	2358	83	3.5
Singapore	119	136	-17	-12.5
Thailand	2060	2364	-304	-12.9
Vietnam	2692	2108	584	27.7
		Mean absolute percentage error = 13.60		
Older cohort: aged 70 years and above				
Indonesia	2882	2738	144	5.3
Malaysia	307	304	3	1.0
Philippines	736	741	-5	-0.7
Singapore	71	65	6	9.2
Thailand	642	967	-325	-33.6
Vietnam	1051	1574	-523	-33.2
		Mean absolute percentage error = 13.83		
Total population				
Indonesia	123422	150958	-27536	-18.2
Malaysia	12148	13763	-1615	-11.7
Philippines	44298	48317	-4019	-8.3
Singapore	2853	2415	438	18.1
Thailand	36561	46718	-10157	-21.7
Vietnam	39960	53711	-13751	-25.6
		Mean absolute percentage error = 17.27		

Table 4. Actual and percentage errors in the 1950 projection assumed to follow a low mortality decline.

Country	Forecasted in 1950 for 1980	Observed in 1980	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	26497	22374	4123	18.4
Malaysia	2888	1868	1020	54.6
Philippines	11175	7528	3647	48.4
Singapore	-	194	-	-
Thailand	8769	6344	2425	38.2
Vietnam	7431	8394	-963	-11.5
		Mean absolute percentage error = 34.22		
Middle cohort: aged 35-39 years				
Indonesia	7751	8215	-464	-5.6
Malaysia	622	700	-78	-11.1
Philippines	2587	2358	229	9.7
Singapore	-	136	-	-
Thailand	2207	2364	-157	-6.6
Vietnam	2838	2108	730	34.6
		Mean absolute percentage error = 13.52		
Older cohort: aged 70 years and above				
Indonesia	3832	2738	1094	40.0
Malaysia	322	304	18	5.9
Philippines	903	741	162	21.9
Singapore	-	65	-	-
Thailand	843	967	-124	-12.8
Vietnam	1286	1574	-288	-18.3
		Mean absolute percentage error = 19.78		
Total population				
Indonesia	159728	150958	8770	5.8
Malaysia	14428	13763	665	4.8
Philippines	57032	48317	8715	18.0
Singapore	-	2415	-	-
Thailand	47523	46718	805	1.7
Vietnam	49131	53711	-4580	-8.5
		Mean absolute percentage error = 7.76		

Table 5. Actual and percentage errors in the 1950 projection assumed to follow a conservative decline.

Country	Forecasted in 1950 for 1980	Observed in 1980	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	21738	22374	-636	-2.8
Malaysia	2787	1868	919	49.2
Philippines	9649	7528	2121	28.2
Singapore	674	194	480	247.4
Thailand	7377	6344	1033	16.3
Vietnam	6439	8394	-1955	-23.3
		Mean absolute percentage error = 61.20		
Middle cohort: aged 35-39 years				
Indonesia	7176	8215	-1039	-12.6
Malaysia	613	700	-87	-12.4
Philippines	2441	2358	83	3.5
Singapore	119	136	-17	-12.5
Thailand	2060	2364	-304	-12.9
Vietnam	2692	2108	584	27.7
		Mean absolute percentage error =13.60		
Older cohort: aged 70 years and above				
Indonesia	2882	2738	144	5.3
Malaysia	307	304	3	1.0
Philippines	736	741	-5	-0.7
Singapore	71	65	6	9.2
Thailand	642	967	-325	-33.6
Vietnam	1051	1574	-523	-33.2
		Mean absolute percentage error = 13.83		
Total population				
Indonesia	138518	150958	-12440	-8.2
Malaysia	14008	13763	245	1.8
Philippines	50840	48317	2523	5.2
Singapore	3295	2415	880	36.4
Thailand	41617	46718	-5101	-10.9
Vietnam	44626	53711	-9085	-16.9
		Mean absolute percentage error = 13.23		

Table 6. Actual and percentage errors in the 1975 projection assumed to follow the medium variant.

Country	Forecasted in 1975 for 2000	Observed in 2000	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	23437	21972	1465	6.7
Malaysia	1972	2608	-636	-24.4
Philippines	9990	9878	112	1.1
Singapore	220	257	-37	-14.4
Thailand	8393	4833	3560	73.7
Vietnam	9851	8207	1644	20.0
		Mean absolute percentage error = 23.38		
Middle cohort: aged 35-39 years				
Indonesia	15955	14681	1274	8.7
Malaysia	1310	1556	-246	-15.8
Philippines	5216	4733	483	10.2
Singapore	273	360	-87	-24.2
Thailand	5012	4972	40	0.8
Vietnam	4894	5707	-813	-14.2
		Mean absolute percentage error = 12.32		
Older cohort: aged 70 years and above				
Indonesia	4923	5835	-912	-15.6
Malaysia	488	549	-61	-11.1
Philippines	1646	1606	40	2.5
Singapore	136	163	-27	-16.6
Thailand	1321	2204	-883	-40.1
Vietnam	1975	2587	-612	-23.7
		Mean absolute percentage error = 18.26		
Total population				
Indonesia	221187	212107	9080	4.3
Malaysia	20165	22244	-2079	-9.3
Philippines	83930	75967	7963	10.5
Singapore	3095	3567	-472	-13.2
Thailand	76039	61399	14640	23.8
Vietnam	79355	79832	-477	-0.6
		Mean absolute percentage error = 10.28		

Table 7. Actual and percentage errors in the 1980 projection assumed to follow the medium variant.

Country	Forecasted in 1980 for 2000	Observed in 2000	Actual error	Percentage error
Younger cohort: aged 0-4 years				
Indonesia	20361	21972	-1611	-7.3
Malaysia	2016	2608	-592	-22.7
Philippines	8157	9878	-1721	-17.4
Singapore	194	257	-63	-24.5
Thailand	6834	4833	2001	41.4
Vietnam	8827	8207	620	7.6
		Mean absolute percentage error = 20.15		
Middle cohort: aged 35-39 years				
Indonesia	14339	14681	-342	-2.3
Malaysia	1598	1556	42	2.7
Philippines	5290	4733	557	11.8
Singapore	284	360	-76	-21.1
Thailand	5060	4972	88	1.8
Vietnam	5119	5707	-588	-10.3
		Mean absolute percentage error = 8.33		
Older cohort: aged 70 years and above				
Indonesia	5162	5835	-673	-11.5
Malaysia	561	549	12	2.2
Philippines	1750	1606	144	9.0
Singapore	125	163	-38	-23.3
Thailand	1715	2204	-489	-22.2
Vietnam	2162	2587	-425	-16.4
		Mean absolute percentage error = 14.10		
Total population				
Indonesia	204486	212107	-7621	-3.6
Malaysia	20615	22244	-1629	-7.3
Philippines	74810	74967	-1157	-1.5
Singapore	2976	3567	-591	-16.6
Thailand	66115	61399	4716	7.7
Vietnam	78129	79832	-1703	-2.1
		Mean absolute percentage error = 6.46		

Table 8. Assumptions in various past projections for six Southeast Asian countries in 1975, 1980, and 1998, for the periods 1975-1980 and 1995-2000.

Country	Crude birth rate			Crude death rate			Total fertility rate			Infant mortality rate			Life expectancy		
	1975	1980	1998	1975	1980	1998	1975	1980	1998	1975	1980	1998	1975	1980	1998
							Period 1975-1980								
Indonesia	39.3	36.4	35.4	14.4	15.1	15.1	5.13	4.81	4.68	-	99	105	50.7	50.0	52.8
Malaysia	30.8	35.6	30.4	6.9	8.6	7.2	4.26	5.03	4.16	-	33	34	65.3	61.7	65.3
Philippines	40.3	33.9	35.9	8.8	7.7	9.0	5.83	4.62	4.96	-	59	62	61.2	62.5	59.9
Singapore	23.4	17.2	17.2	5.6	5.1	5.1	2.47	1.84	1.87	-	13	13	69.7	70.8	70.8
Thailand	38.7	31.4	31.6	9.0	8.4	8.3	5.53	4.27	4.25	-	59	56	60.7	61.2	61.2
Vietnam	40.9	39.4	38.3	17.3	12.3	11.4	5.84	5.48	5.59	-	106	82	48.1	55.8	55.8
							Period 1995-2000								
Indonesia	26.9	22.4	22.7	6.8	9.7	7.5	3.38	2.46	2.58	-	57	48	60.9	59.7	65.1
Malaysia	23.2	20.9	25.0	5.5	5.4	4.8	2.70	2.46	3.18	-	20	11	69.5	70.7	72.0
Philippines	28.6	23.5	28.6	5.3	5.2	5.8	3.75	2.87	3.62	-	28	35	68.9	70.1	68.3
Singapore	16.0	13.4	14.8	5.3	6.0	4.9	2.10	1.74	1.68	-	9	5	73.1	74.4	77.1
Thailand	26.7	22.5	16.7	5.4	6.8	6.7	3.28	2.51	1.74	-	28	29	68.7	66.8	68.8
Vietnam	31.6	24.9	22.4	10.0	7.8	6.8	4.39	2.87	2.60	-	58	38	59.6	64.8	67.4

Table 9. Total fertility rate.

	1975 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	5.13	3.38	1.75	4.68	2.58	2.1	0.8	0.45	0.35
Malaysia	4.26	2.7	1.56	4.16	3.18	0.98	-0.48	0.1	-0.58
Philippines	5.83	3.75	2.08	4.96	3.62	1.34	0.13	0.87	-0.74
Singapore	2.47	2.1	0.37	1.87	1.68	0.19	0.42	0.6	-0.18
Thailand	5.53	3.28	2.25	4.25	1.74	2.51	1.54	1.28	0.26
Vietnam	5.84	4.39	1.45	5.59	2.6	2.99	1.79	0.25	1.54
						Mean absolute error:	**0.860**	**0.592**	**0.608**

	1980 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	4.81	2.46	2.35	4.68	2.58	2.1	-0.12	0.13	-0.25
Malaysia	5.03	2.46	2.57	4.16	3.18	0.98	-0.72	0.87	-1.59
Philippines	4.62	2.87	1.75	4.96	3.62	1.34	-0.75	-0.34	-0.41
Singapore	1.84	1.74	0.1	1.87	1.68	0.19	0.06	-0.03	0.09
Thailand	4.27	2.51	1.76	4.25	1.74	2.51	0.77	0.02	0.75
Vietnam	5.48	2.87	2.61	5.59	2.6	2.99	0.27	-0.11	0.38
						Mean absolute error:	**0.448**	**0.250**	**0.578**

Table 10. Crude birth rate.

	1975 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	39.3	26.9	12.4	35.4	22.7	12.7	4.2	3.9	0.3
Malaysia	30.8	23.2	7.6	30.4	25	5.4	-1.8	0.4	-2.2
Philippines	40.3	28.6	11.7	35.9	28.6	7.3	0	4.4	-4.4
Singapore	23.4	16	7.4	17.2	14.8	2.4	1.2	6.2	-5
Thailand	38.7	26.7	12	31.6	16.7	14.9	10	7.1	2.9
Vietnam	40.9	31.6	9.3	38.3	22.4	15.9	9.2	2.6	6.6
						Mean absolute error:	**4.400**	**4.100**	**3.567**

	1980 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	36.4	22.4	14	35.4	22.7	12.7	-0.3	1	-1.3
Malaysia	35.6	20.9	14.7	30.4	25	5.4	-4.1	5.2	-9.3
Philippines	33.9	23.5	10.4	35.9	28.6	7.3	-5.1	-2	-3.1
Singapore	17.2	13.4	3.8	17.2	14.8	2.4	-1.4	0	-1.4
Thailand	31.4	22.5	8.9	31.6	16.7	14.9	5.8	-0.2	6
Vietnam	39.4	24.9	14.5	38.3	22.4	15.9	2.5	1.1	1.4
						Mean absolute error:	**3.200**	**1.583**	**3.750**

Table 11. Crude death rate.

	1975 projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	14.4	6.8	7.6	15.1	7.5	7.6	-0.7	-0.7	0
Malaysia	6.9	5.5	1.4	7.2	4.8	2.4	0.7	-0.3	1
Philippines	8.8	5.3	3.5	9	5.8	3.2	-0.5	-0.2	-0.3
Singapore	5.6	5.3	0.3	5.1	4.9	0.2	0.4	0.5	-0.1
Thailand	9	5.4	3.6	8.3	6.7	1.6	-1.3	0.7	-2
Vietnam	17.3	10	7.3	11.4	6.8	4.6	3.2	5.9	-2.7
						Mean absolute error:	**1.133**	**1.383**	**1.017**

	1980 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	15.1	9.7	5.4	15.1	7.5	7.6	2.2	0	2.2
Malaysia	8.6	5.4	3.2	7.2	4.8	2.4	0.6	1.4	-0.8
Philippines	7.7	5.2	2.5	9	5.8	3.2	-0.6	-1.3	0.7
Singapore	5.1	6	-0.9	5.1	4.9	0.2	1.1	0	1.1
Thailand	8.4	6.8	1.6	8.3	6.7	1.6	0.1	0.1	0
Vietnam	12.3	7.8	4.5	11.4	6.8	4.6	1	0.9	0.1
						Mean absolute error:	**0.933**	**0.617**	**0.817**

Table 12. Infant mortality rate.

	1980 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	99	57	42	105	48	57	9	-6	15
Malaysia	33	20	13	34	11	23	9	-1	10
Philippines	59	28	31	62	35	27	-7	-3	-4
Singapore	13	9	4	13	5	8	4	0	4
Thailand	59	28	31	56	29	27	-1	3	-4
Vietnam	106	58	48	82	38	44	20	24	-4
						Mean absolute error:	**8.333**	**6.167**	**6.833**

Table 13. Life expectancy (both sexes).

	1975 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	50.7	60.9	-10.2	52.8	65.1	-12.3	-4.2	-2.1	-2.1
Malaysia	65.3	69.5	-4.2	65.3	72	-6.7	-2.5	0	-2.5
Philippines	61.2	68.9	-7.7	59.9	68.3	-8.4	0.6	1.3	-0.7
Singapore	69.7	73.1	-3.4	70.8	77.1	-6.3	-4	-1.1	-2.9
Thailand	60.7	68.7	-8	61.2	68.8	-7.6	-0.1	-0.5	0.4
Vietnam	48.1	59.6	-11.5	55.8	67.4	-11.6	-7.8	-7.7	-0.1
						Mean absolute error:	**3.200**	**2.117**	**1.450**

	1980 Projection			1998 Estimate (UN 1999)					
Country	1975-1980	1995-2000	Projected decline	1975-1980	1995-2000	Estimated decline	Total error	Base error	Change error
Indonesia	50	59.7	-9.7	52.8	65.1	-12.3	-5.4	-2.8	-2.6
Malaysia	61.7	70.7	-9	65.3	72	-6.7	-1.3	-3.6	2.3
Philippines	62.5	70.1	-7.6	59.9	68.3	-8.4	1.8	2.6	-0.8
Singapore	70.8	74.4	-3.6	70.8	77.1	-6.3	-2.7	0	-2.7
Thailand	61.2	66.8	-5.6	61.2	68.8	-7.6	-2	0	-2
Vietnam	55.8	64.8	-9	55.8	67.4	-11.6	-2.6	0	-2.6
						Mean absolute error:	**2.633**	**1.500**	**2.167**

Figure 1: Percentage errors in projected age structures, 1950 projections, Indonesia.

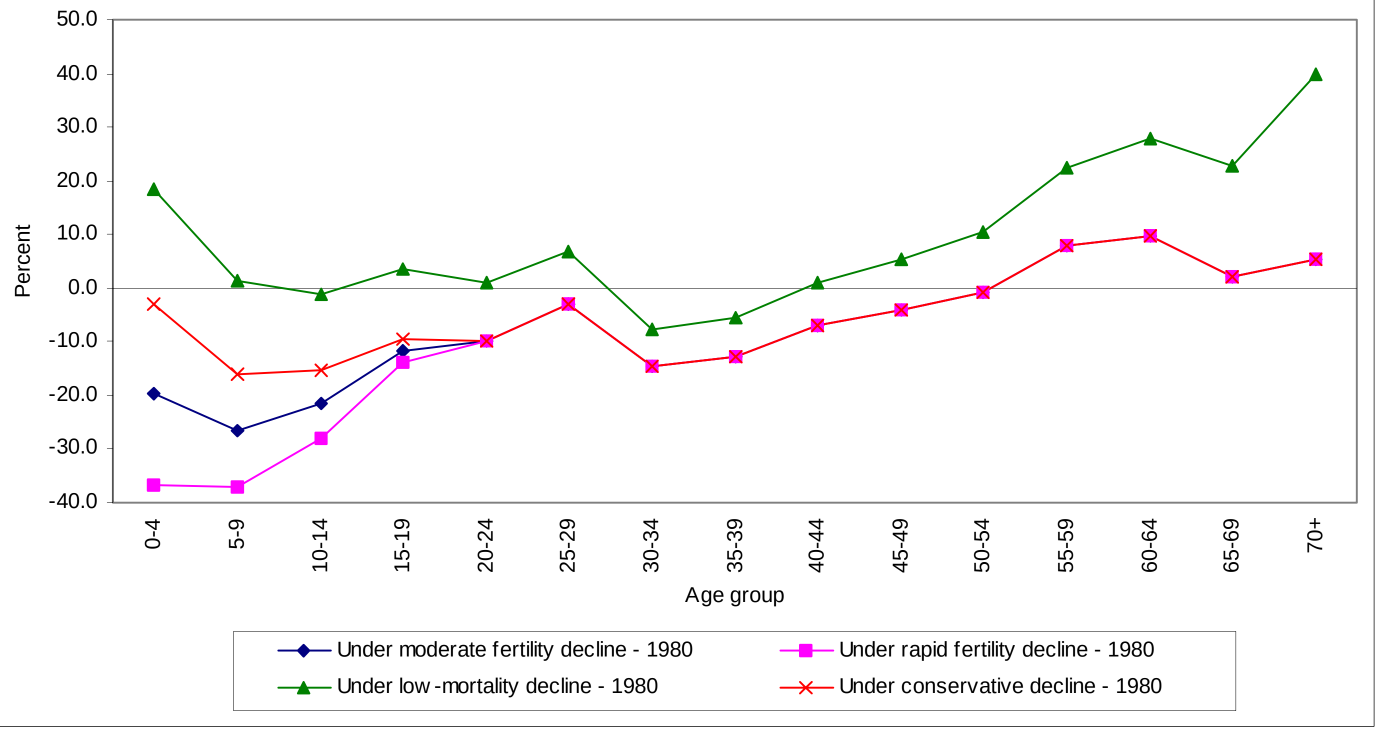


Figure 2: Percentage errors in projected age structures, 1950 projections, Malaysia.

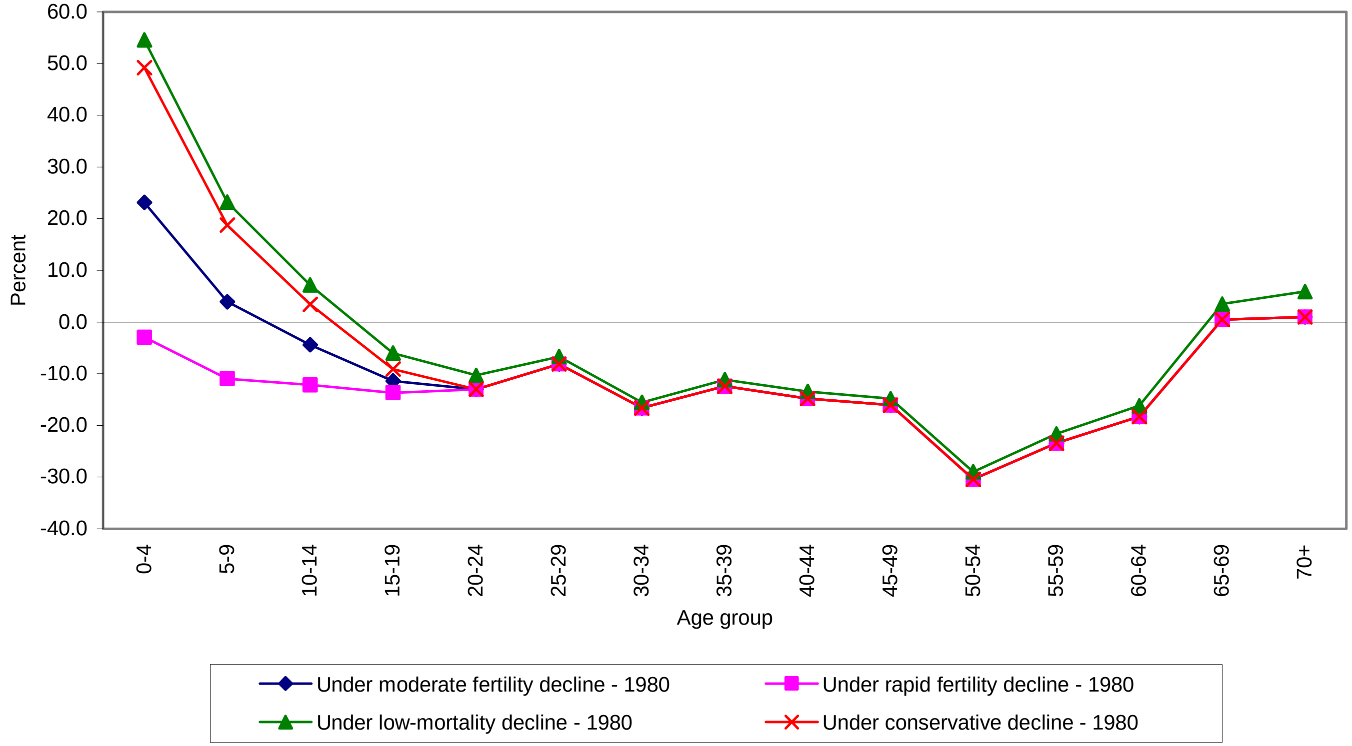
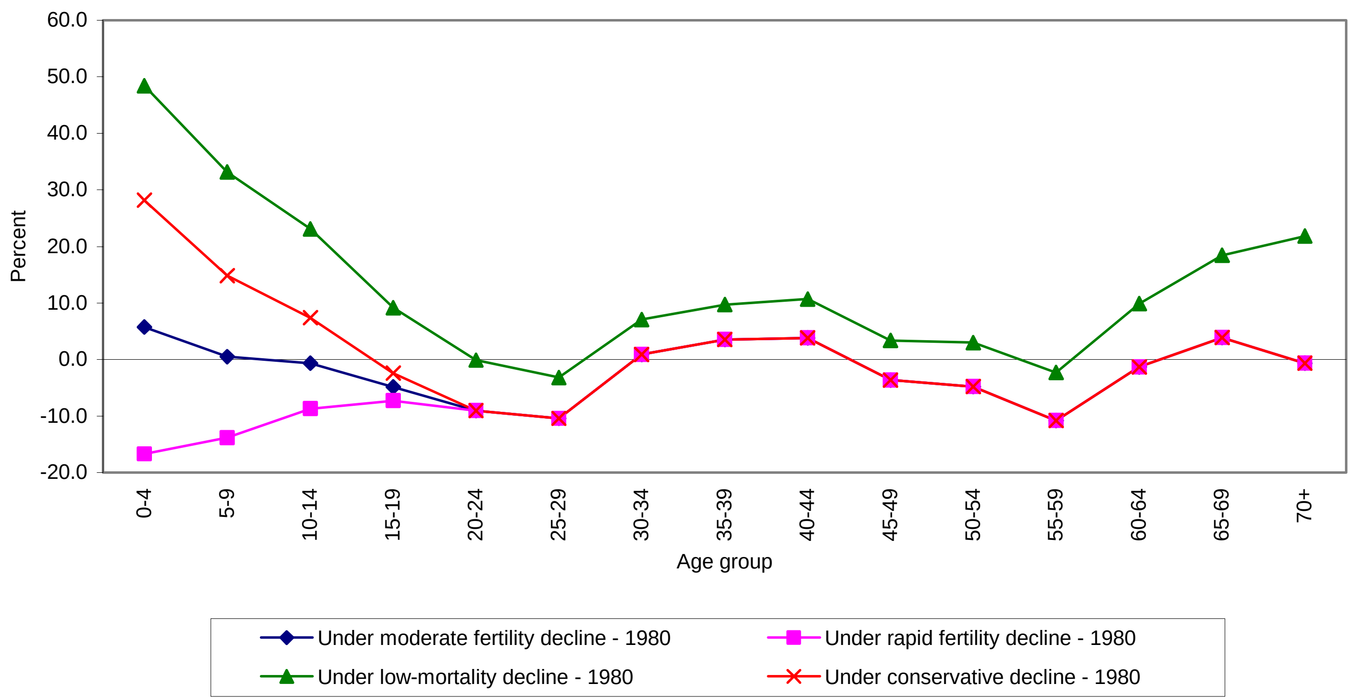


Figure 3: Percentage errors in projected age structures, 1950 projections, Philippines.



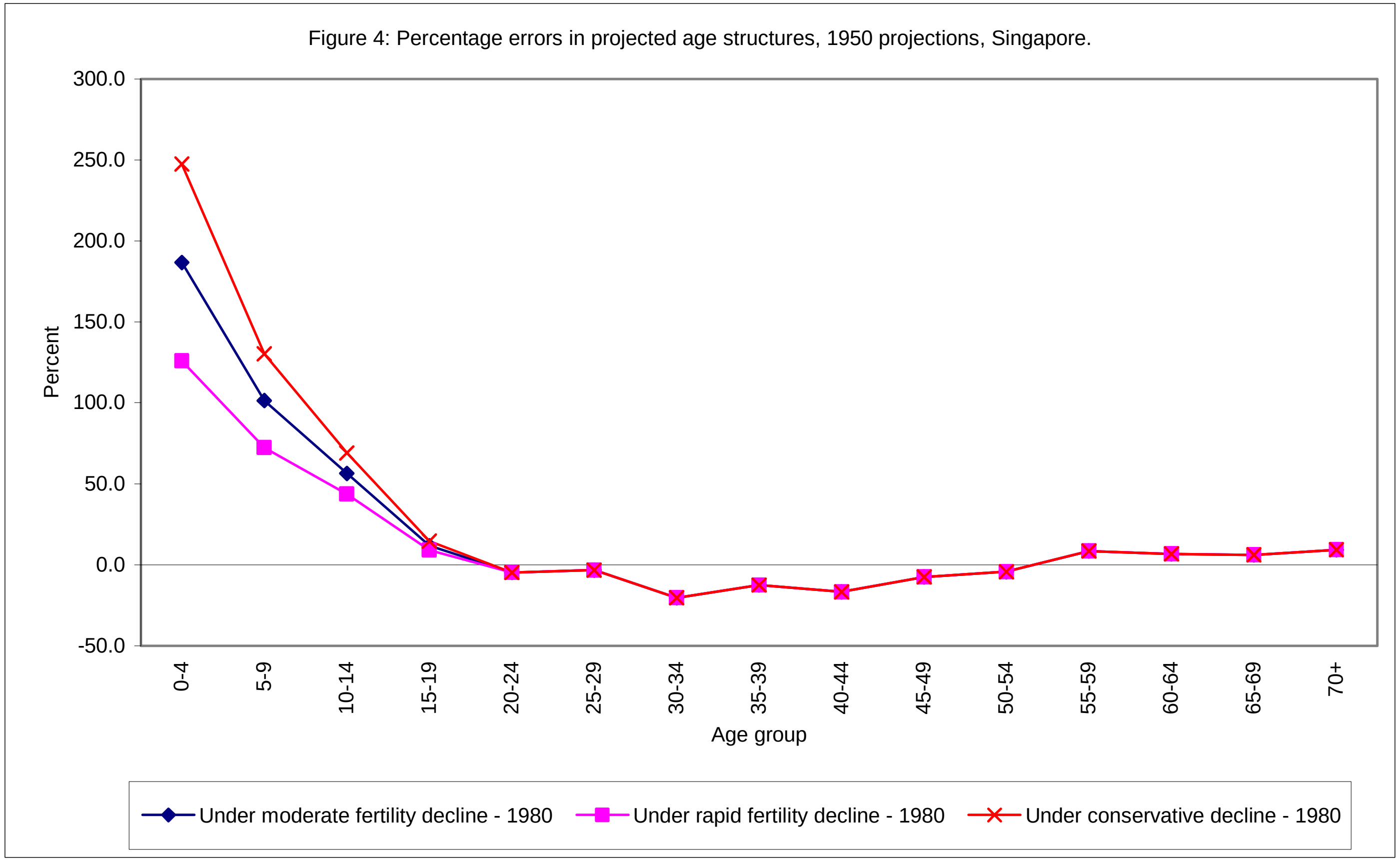


Figure 4: Percentage errors in projected age structures, 1950 projections, Singapore.
300.0
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
Percent
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Under moderate fertility decline - 1980
Under rapid fertility decline - 1980
Under conservative decline - 1980

Figure 5: Percentage errors in projected age structures, 1950 projections, Thailand.

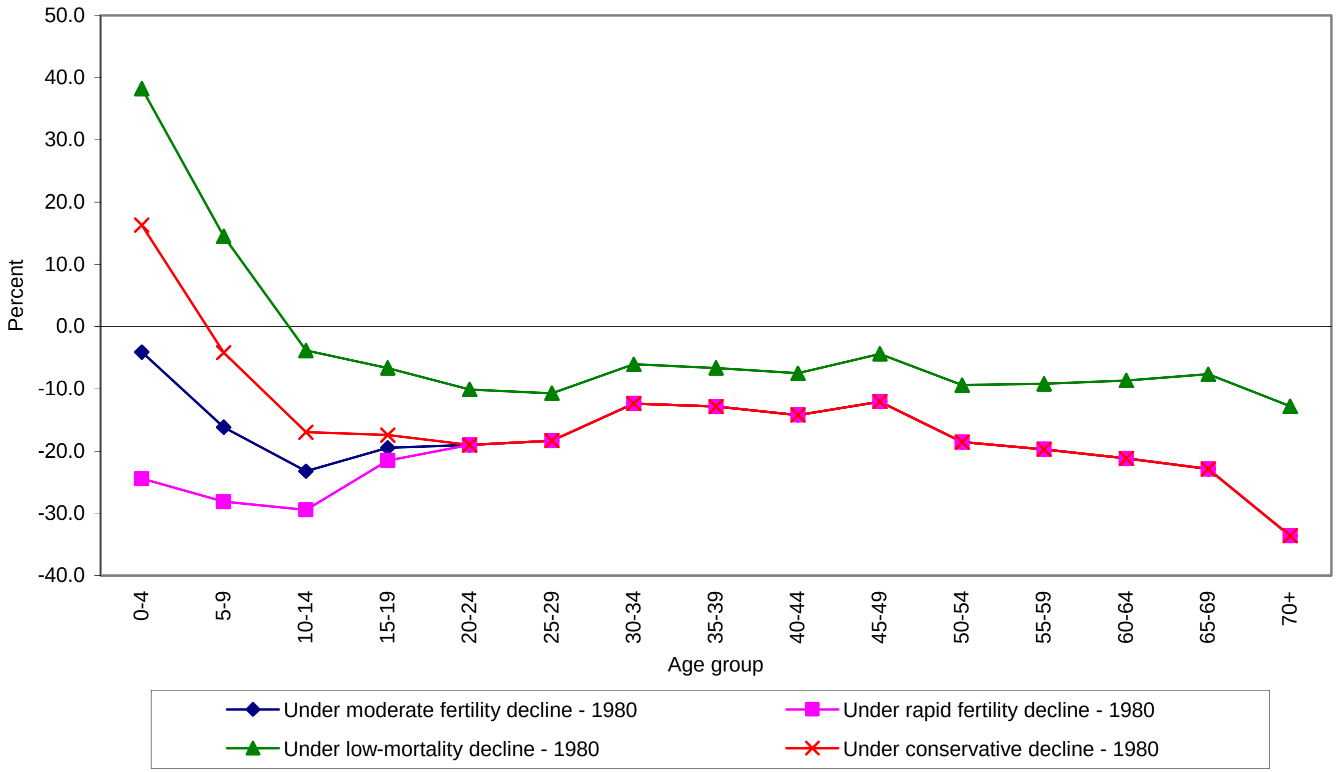


Figure 6: Percentage errors in projected age structures, 1950 projections, Vietnam.

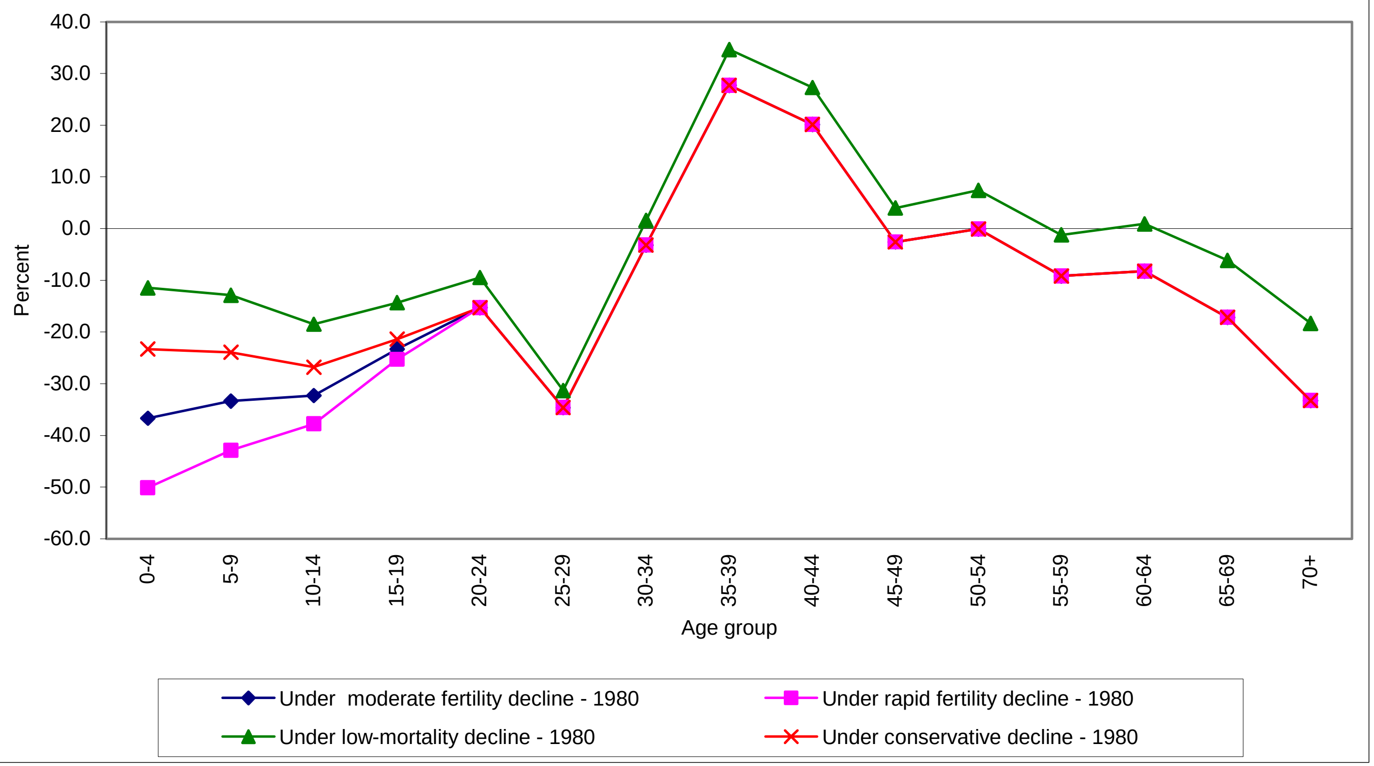


Figure 7: Percentage errors made in 1950 population projections for six Asian countries.

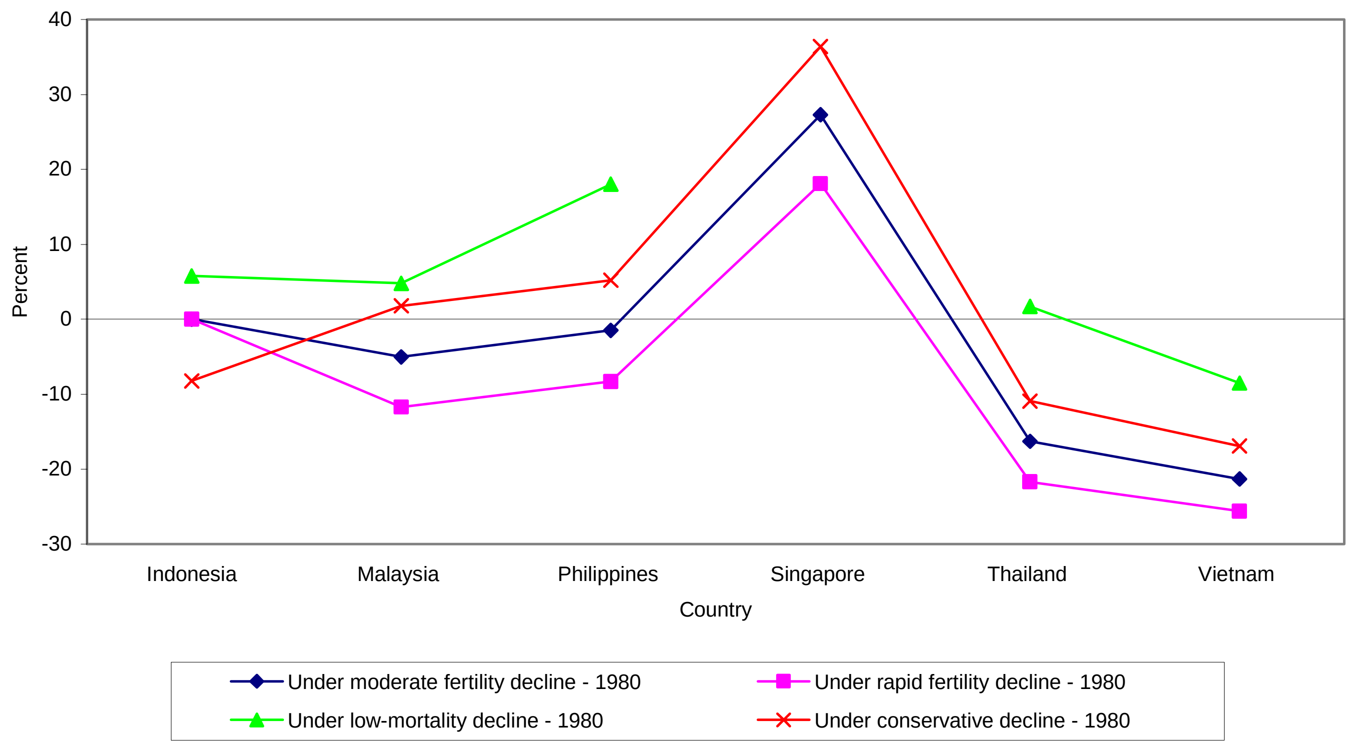
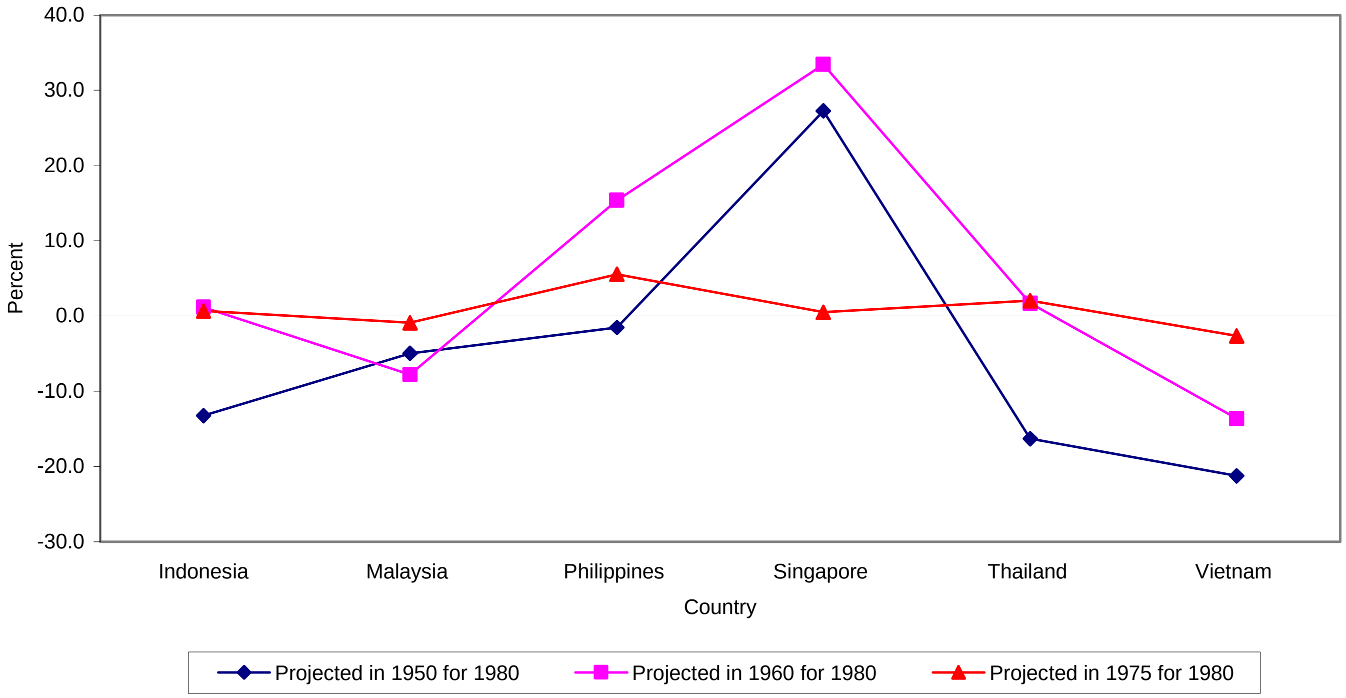


Figure 8: Percentage errors made in the past 1950, 1960 and 1975 projections for six Asian countries.



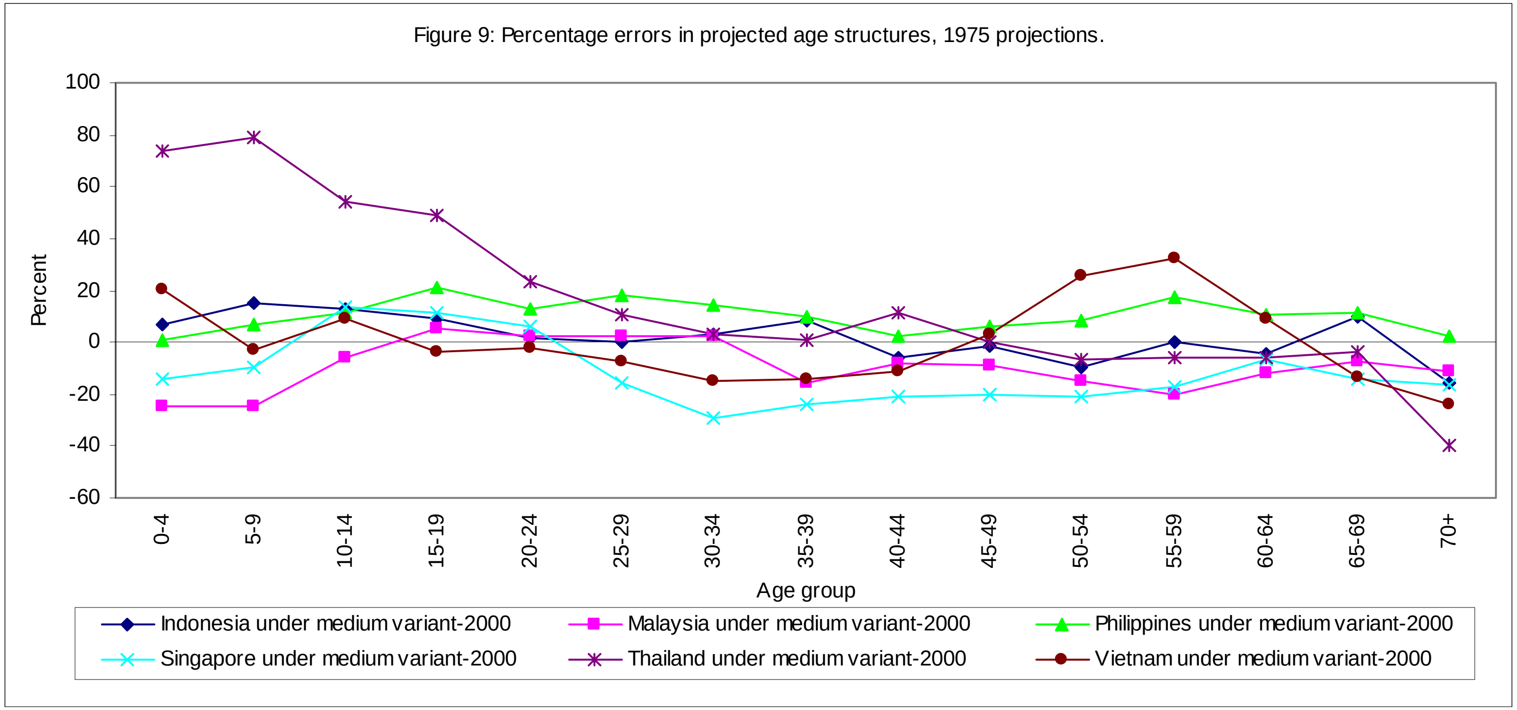


Figure 9: Percentage errors in projected age structures, 1975 projections.
Percent
100
80
60
40
20
0
-20
-40
-60
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Indonesia under medium variant-2000
Malaysia under medium variant-2000
Philippines under medium variant-2000
Singapore under medium variant-2000
Thailand under medium variant-2000
Vietnam under medium variant-2000

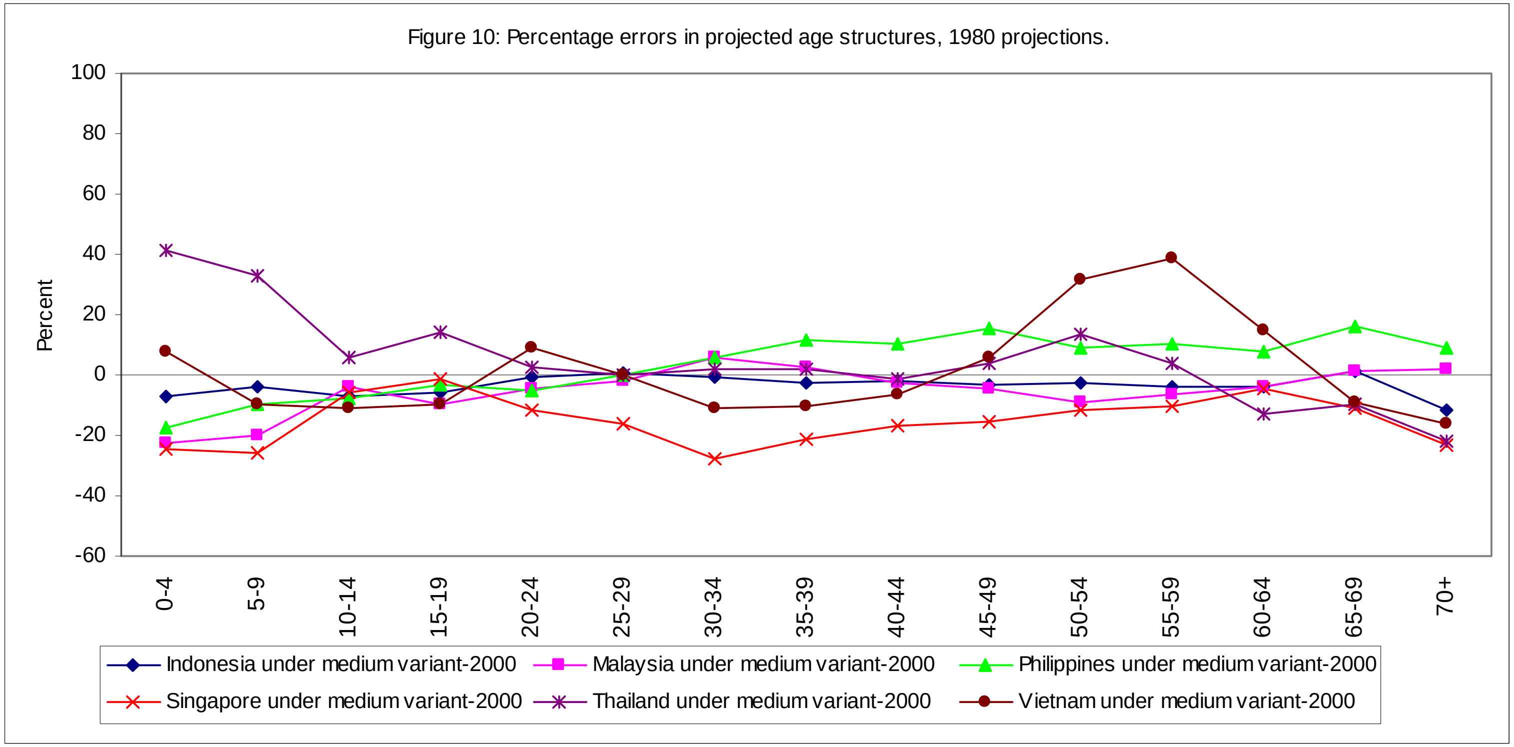


Figure 10: Percentage errors in projected age structures, 1980 projections.
Percent
100
80
60
40
20
0
-20
-40
-60
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Indonesia under medium variant-2000
Malaysia under medium variant-2000
Philippines under medium variant-2000
Singapore under medium variant-2000
Thailand under medium variant-2000
Vietnam under medium variant-2000

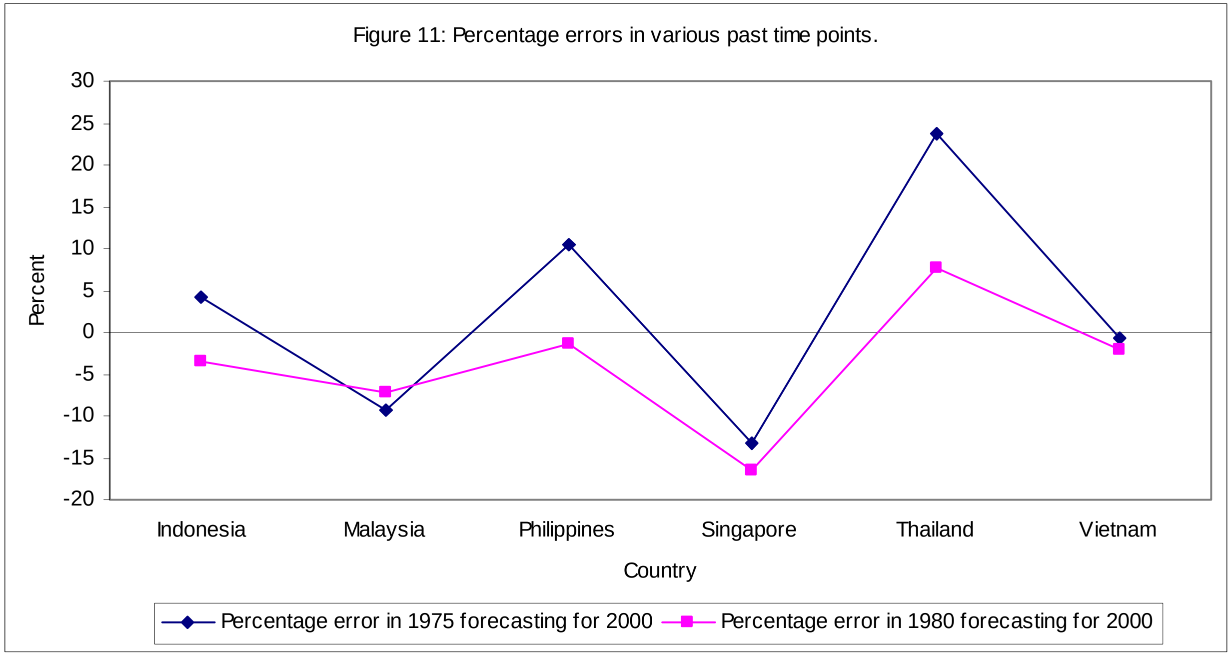


Figure 11: Percentage errors in various past time points.
30
25
20
15
10
5
0
-5
-10
-15
-20
Percent
Indonesia
Malaysia
Philippines
Singapore
Thailand
Vietnam
Country
Percentage error in 1975 forecasting for 2000
Percentage error in 1980 forecasting for 2000

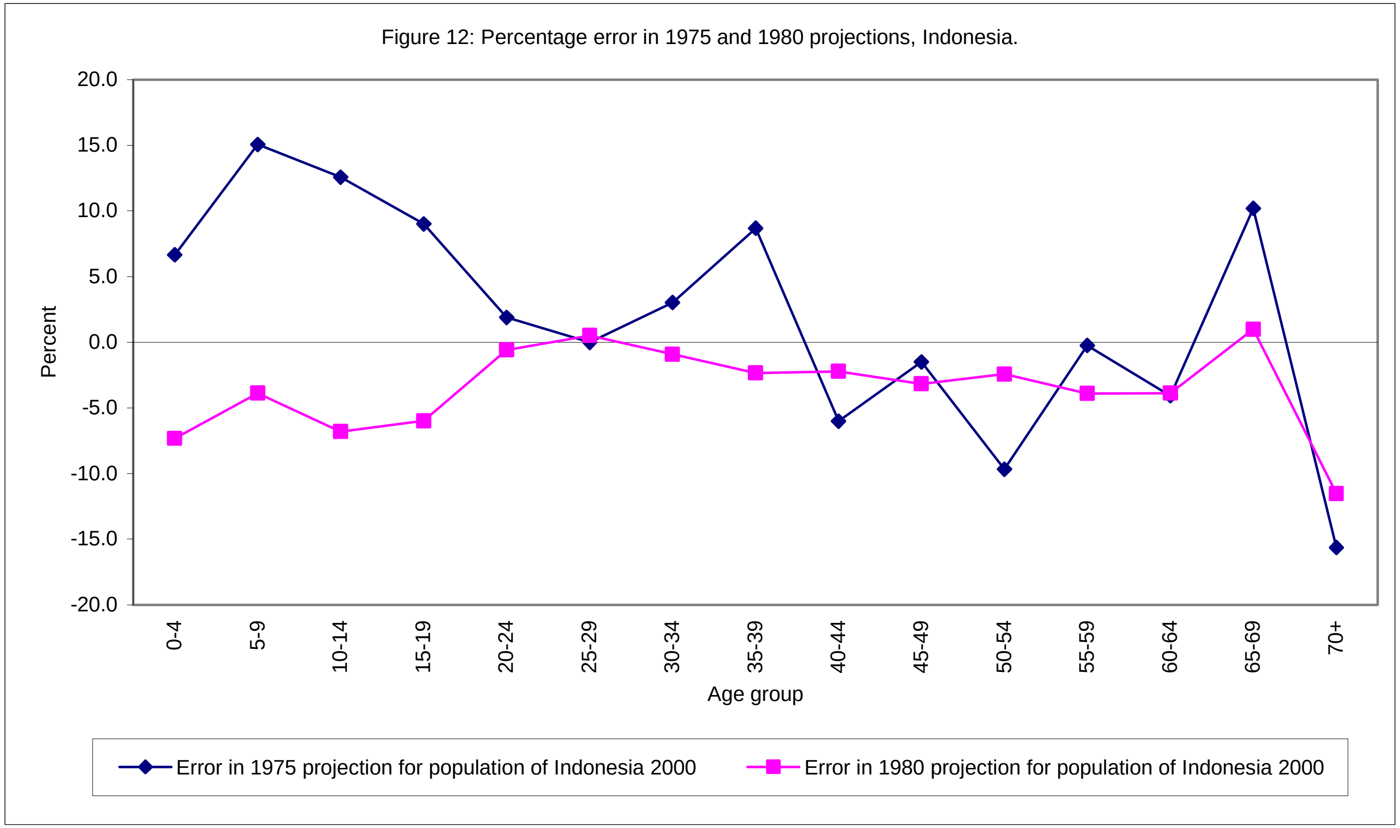


Figure 12: Percentage error in 1975 and 1980 projections, Indonesia.
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
Percent
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Error in 1975 projection for population of Indonesia 2000
Error in 1980 projection for population of Indonesia 2000

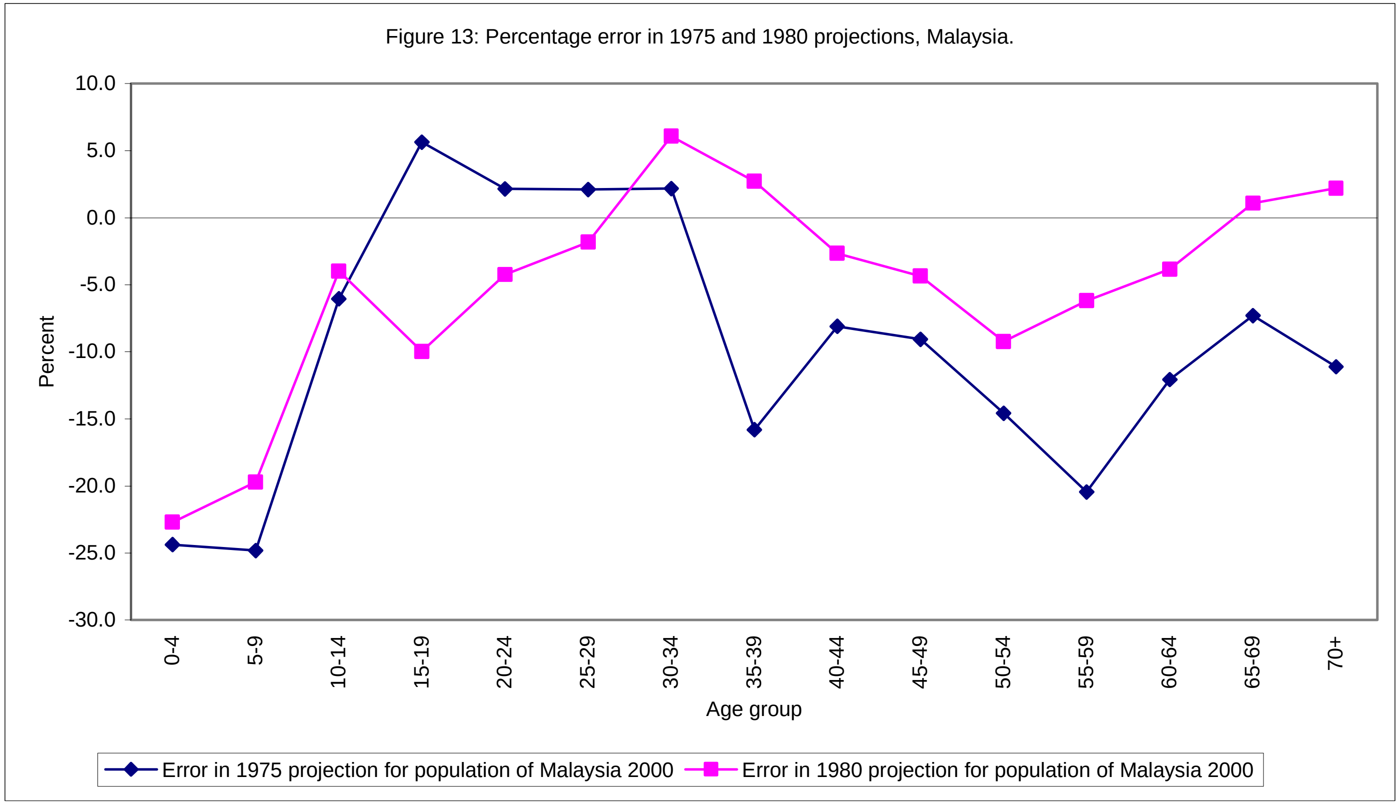
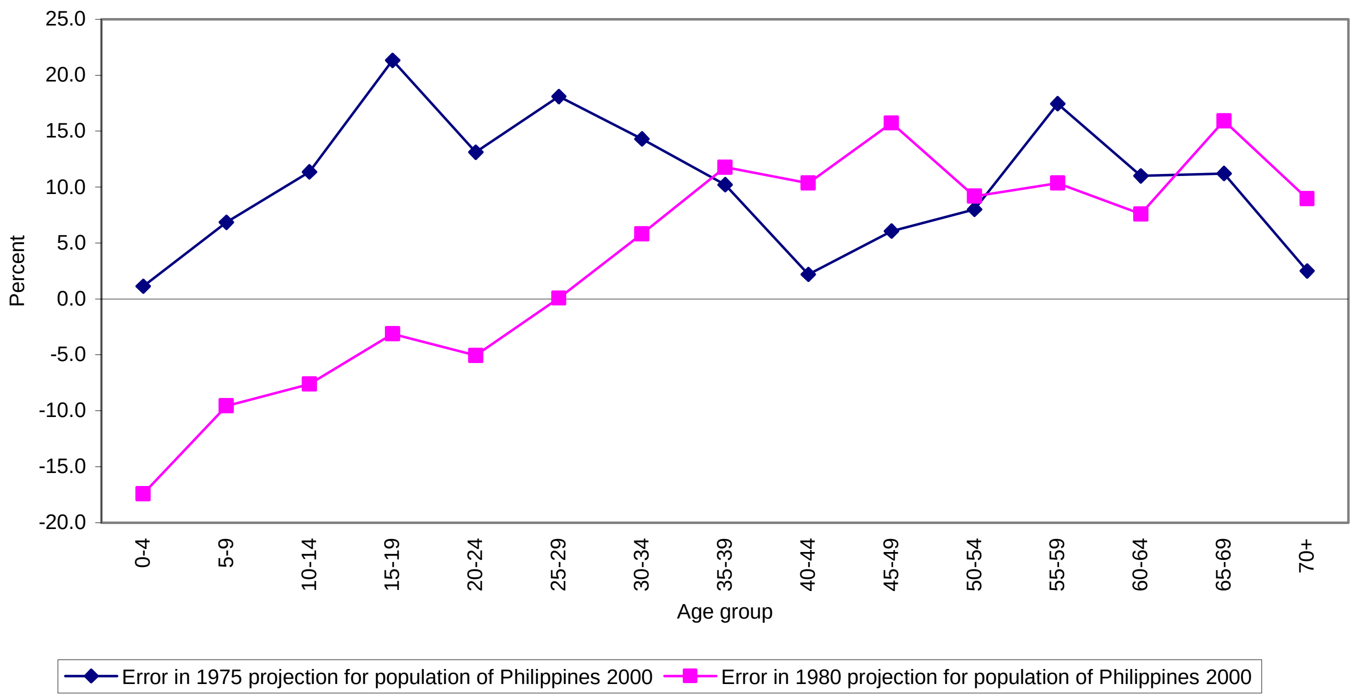


Figure 13: Percentage error in 1975 and 1980 projections, Malaysia.
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
Percent
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Error in 1975 projection for population of Malaysia 2000
Error in 1980 projection for population of Malaysia 2000

Figure 14: Percentage error in 1975 and 1980 projections, Philippines.



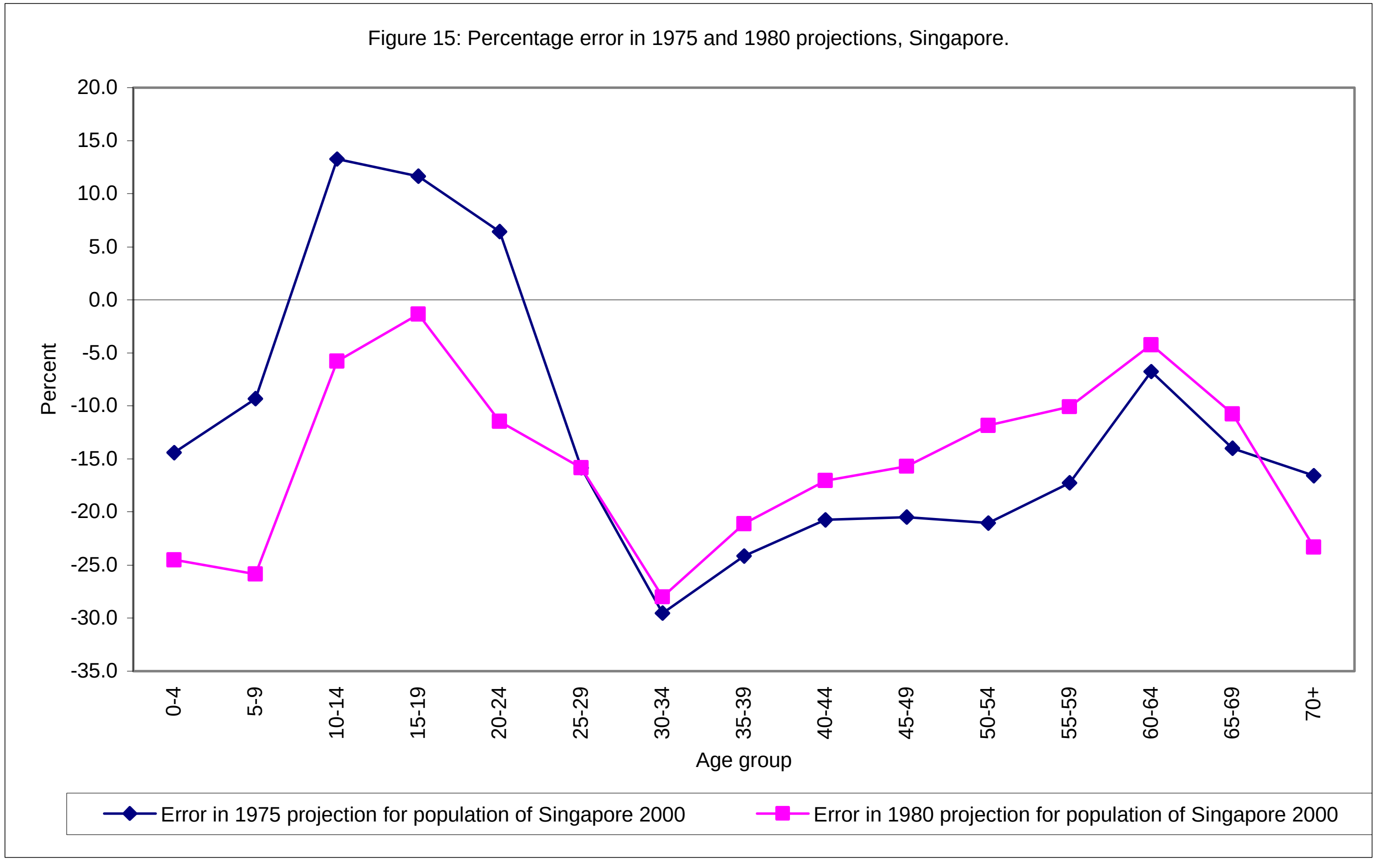


Figure 15: Percentage error in 1975 and 1980 projections, Singapore.
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
Percent
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Error in 1975 projection for population of Singapore 2000
Error in 1980 projection for population of Singapore 2000

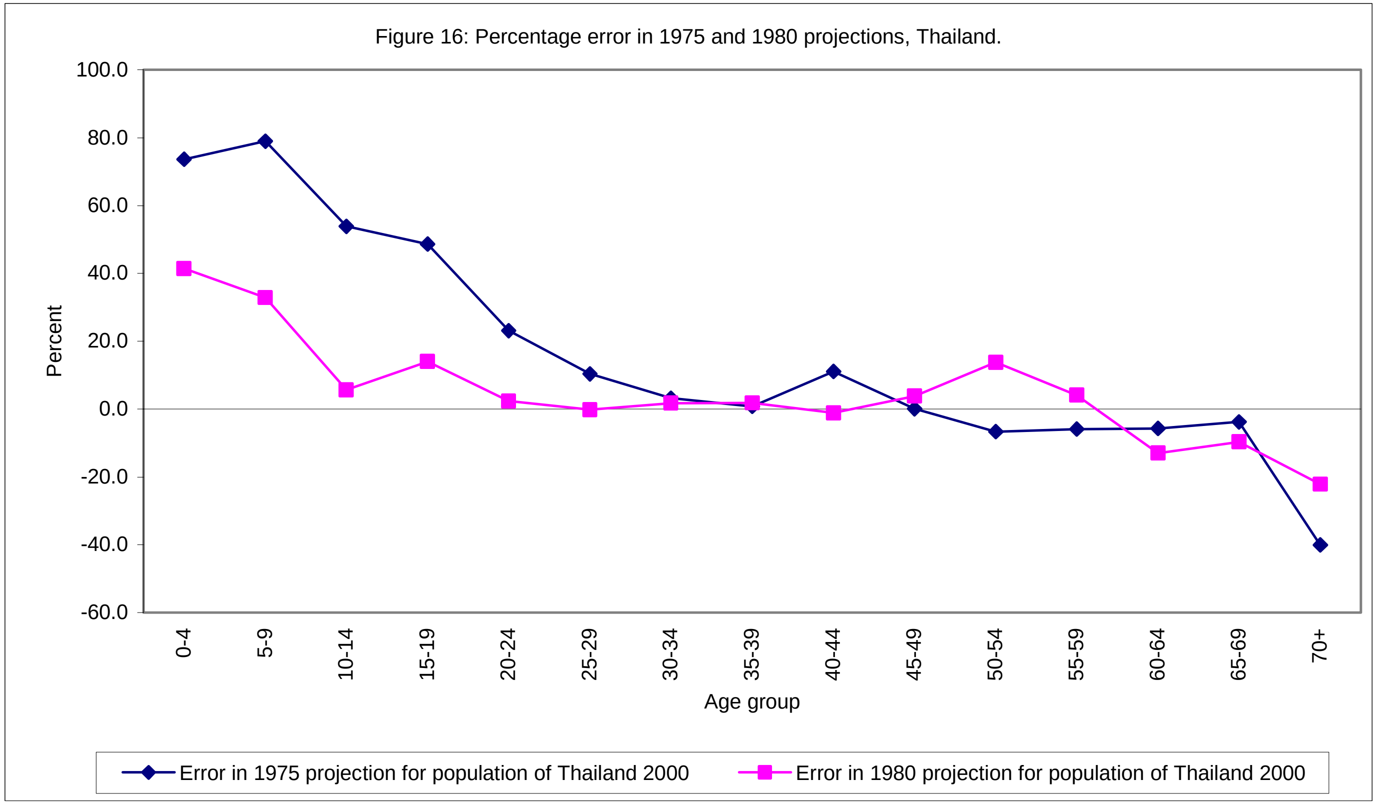


Figure 16: Percentage error in 1975 and 1980 projections, Thailand.
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
Percent
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Error in 1975 projection for population of Thailand 2000
Error in 1980 projection for population of Thailand 2000

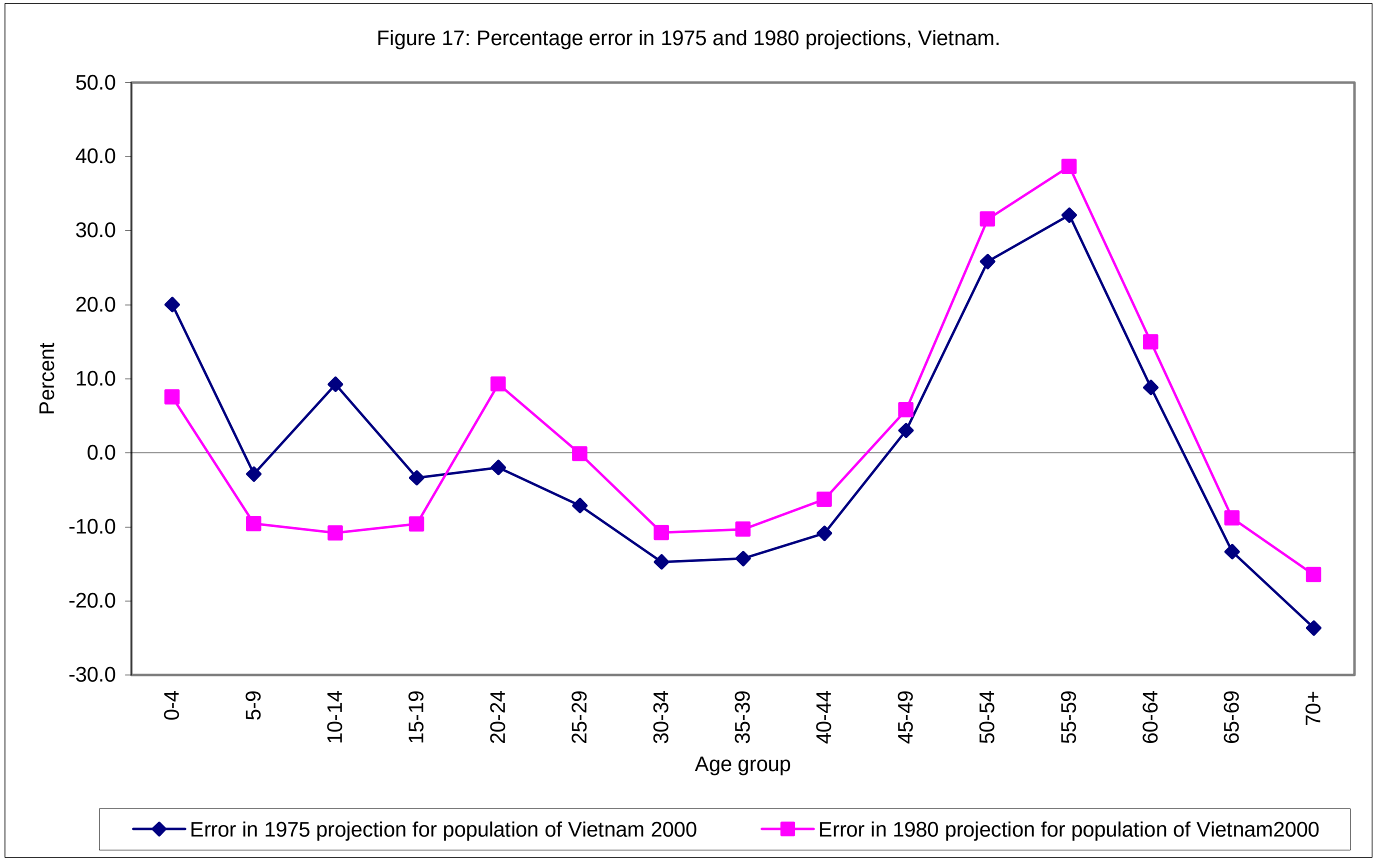


Figure 17: Percentage error in 1975 and 1980 projections, Vietnam.
Percent
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70+
Age group
Error in 1975 projection for population of Vietnam 2000
Error in 1980 projection for population of Vietnam2000