Assessing the impact of the stopping rule on sex ratio of last births in Viet Nam

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Abstract

Despite a wide range of studies on determinants increasing the sex ratio in Asian countries, little attention has been given to the role of the stopping rule in human fertility - the decision of couples to cease child bearing when they obtain a son.

This paper explores the hypothesis that the stopping rule has an impact on the sex ratio of last births (SRLB). We quantify this impact and estimate the SRLB, using the ratio of parity stop ratios (PSR) at the male vs. the female last births at parity *i*: $\frac{PSR_m^i}{PSR_f^i}$. The method is then employed to measure the impact of the stopping rule on the SRLB in Viet Nam, using the data from the Population Change Survey 2006.

The net impact of the stopping rule increases the SRLB of Viet Nam to 127 for the period 1970-2006. However, when other influences are taken into account, the SRLB reaches to 132.5. The analysis suggests that the ratio $\frac{PSR_m^i}{PSR_f^i}$ is a potential measurement of son preference in Viet Nam. The

stopping rule has the potential to accentuate the trend to one son families in Vietnamese society when combined with sex selection and the fertility below the replacement rate of 2.1.

1. Background

1.1 Terminology and increased sex ratios in Asia

Scholars have begun to study the long-term implications of demographic changes at the global level, based on current patterns of increased sex ratio in the most populous countries in Asia (Boer and Hudson 2004). There are four measures of sex ratios (SR) for a population, namely SR at conception, SR at birth (SRB), SR of children (aged 1-15 years) and SR of adults (above 15 years).

The SR at conception is influenced by a wide range of biological factors, from the pH chemical balance of the female genital tract and the gonadotropin hormone level at conception (James 1996; James 2004a) to parental and maternal age and coital rates the in earlier stage of menstrual cycle (James 2003, 2004b; McMahan 1951; Polasek et al. 2005), races (James 1987a, 1987b) and seasons of the child's and mother's birth (Joffe et al. 2007; Nonaka et al. 1999). In-vitro fertilisation techniques are also reported effects on SR at conception (Beernink, Dmowski and Ericsson 1993; Reubinoff and Schenker 1996; Tarin et al. 1995). However, there is no evidence showing that these influences have impact on increasing SRB at the population level.

The SRB is commonly measured as the number of boys being born per one hundred girls. A normal SRB is defined as 105 boys per 100 girls (Hardy 2002:Chap. 14 p288). A wider range of 103-107 is also conventionally accepted as normal. The increase of the SRB is defined as "significant" if its estimate exceeds the upper normal limit of 107. The SRB is determined by the survival of fetuses during pregnancy and therefore, largely influenced by the socio-economic and political determinants (Chahnazarian, 1988). The SRB are often estimated by parity (or birth order) i.e. first or last births.

The SR of an adult population is an outcome of the combination of SRB and age and sex specific mortality and in and out flux migration of that population. The increased SR of the adult population has been observed in some countries in Southern and Eastern Asia, while normal in South-eastern and Western. Previous studies estimated a shortage of women in marriageable age in India (Arnold, Kishor and Roy 2002; Jha et al. 2006) and China (Mosher 2006; Yi et al. 1993). China estimated a short fall of 23.8 million females aged 0-24 by 2004 (Xin 2006). Similarly, India estimated missing 36 million women and girls by 2001 (Sen 2003). The high SRB of South Korea in the previous decades has been recently reported stabilising (Chung and Gupta 2007).

Three factors have been identified as underlying causes of the increased SRB in Asia: (i) modern sex selection including determination of the fetal sex via ultrasound and abortion of female fetuses (sex selective abortion) (Arnold et al. 2002; Belanger 2002a; Mason and Bennett 1977); (ii) under reporting of female births in population data (Lai 2005); and (iii) excess female mortality in early childhood, particularly female neonatal death (Kana Fuse and Crenshaw 2006; Wu, Viisainen and Hemminki 2006). However, the impact of the stopping rule on the sex ratio is still poorly understood and omitted in the recent discussions.

1.2 Stopping rule in human fertility decision

The concept of the stopping rule was first discussed in probability and statistics theory, notably in the optimal stopping theorem (Shirjaev 1978) and more recently in decision making theory, in which the rule is characterized as a mechanism for deciding whether to continue or stop a process on the basis of the present position and past events (Sirjaev 2008). The main expression of the stopping rule in human fertility is that couples would decide to have no more additional children following the achievement of a desired number and sex composition of their children.

The stopping rule is an indication of son preference. Son preference has been identified as an important factor influencing fertility decision making (Widmer, McClelland and Nickerson 1981). Son preference is strong in some parts of Asia and particularly large in countries in the South, Southeast and Central Asia (Filmer, Friedman and Schady 2008). In these societies, one would expect a majority of women continue their child bearing in order to obtain a son and would cease the childbearing when a son is obtained (Wen 1993). This strategy has also been adopted by Vietnamese women (Belanger 2006).

To illustrate the increase in the chance to obtain a son by progressing to the next parity, we assume that if a woman has a child at parity i then the probability of having a boy is p and a girl is $1–p$. In a normal situation, where the SR is 105, the probability of having a boy, p is equal to 0.512 and the probability of having a girl, $1-p$ = 0.488. The probability of having all girl(s) at the parity i is roughly equal to $(1-p)^{i.}$ If the woman decides to have an additional child, she progresses to parity $i+1$, then the probability of having all girls at parity $i+1$ now is equivalent to $(1-p)^{i+1}$. In this case, the probability of having all girls has declined. In contrast, the probability of having a boy has increased by progressing to the parity *i+1*. As a result of this process, the stopping rule has a potential effect on increase of the SRLB.

The first attempt to quantify the magnitude of son preference of couples was made by Comb and colleagues (1975) using longitudinal population data of Taiwan in 1970s and an ordinal scale to measure and their willingness to have additional child in order to achieve their expected number of son. Another attempt to measure the effect of sex preference on formulating family size was made by Mc Clelland (1979). Clark (2000) explored the impact of the stopping rule on sex composition of children and revealed that the stopping rule declines the proportion of son in the families as the family size increases.

1.3 The recently increased SRB in Viet Nam

The public concern about a possibility of increasing SRB in Viet Nam was first raised when the data of the *Census 1999* was published. The data showed that the SRB estimate for 1999 was slightly high, 107.7 based on 5% sample, but normal at 105.2 based on the complete data (GSO 1999). However, an analysis of the hospital data indicated that the SRB of Hanoi, the capital city of Viet Nam was higher than the expected value, particularly among the women in higher socioeconomic status (Belanger et al. 2003). The SRB of 2006 was reported at 110 (95% CI 107-113) (GSO 2007). The increased SRB of Viet Nam has been recently confirmed (GSO 2008; Guilmoto, Xuyen and Toan 2009).

Previous studies showed that son preference is an important factor influencing fertility decisions of Vietnamese people (Belanger 2006; Haughton and Haughton 1995). A study on the expectation of Vietnamese people on the sex composition of their children indicated that the proportion of women wished for a son was higher than those wished for a daughter, 30% compared to 23%, respectively (GSO 2002). The country's fertility has remarkably declined over the last decade and reached the replacement level of 2.1 in 2005 and remained below this level in the following years (GSO 2007, 2008). An analysis of socio-political and heath practices in Viet Nam argued that the recent reinforcement of the one-to-two child family policy, son preference, open access to ultrasound to determine the fetal sex and legal abortion are important factors increasing the SRB in Viet Nam (Pham et al. 2008a).

There were several data sources available for gender analysis in Viet Nam such as the Demographic and Health Survey in 2002, the annual Population Change Surveys (PCS) in 2006 and 2007, the Birth records in 2007 of the Health Information System, the Birth registrations in 2008 of the Vital Registration System. The data quality of those data sources for analysis of SRB trend has been discussed elsewhere (Pham, Hill and Adair 2009). According to this assessment, the PCS in 2006 is the first population survey including comprehensive information allowing in-depth analysis of SRB. We therefore selected this data to examine the operation of the stopping rule.

We examine son preference and its influence on fertility behaviour: the stopping rule and its specific demographic outcome on the SRLB. The term 'last birth' means the final birth, which is determined once a woman has ceased reproduction. The main research question is how to quantify the impact of the stopping rule on the SRLB. To address this question, we propose a method using the ratio between the parity stop ratio (PSR) at the male vs. the female last births at parity *i* $\frac{PSR_m^i}{PSR_f^i}$. Then we use the method to quantify the impact of the stopping rule on the SRLB in Viet Nam. In the following section, we present the method.

2. Method to quantity the impact of the stopping rule on the SRLB

The method consists of three steps: (1) defining the *Parity Stop Ratio* (PSR) at the male and female last births; (2) calculating the ratio $\frac{PSR_m^i}{PSR_f^i}$; (3) estimating the SRLB using the default value of SRB of 105 and the actual value of SRB.

2.1 Defining parity stop ratio (PSR)

PSR is defined as the percentage proportion of women with a given number of children, who cease their child bearing at particular parity, among the number of women who give births at that parity. PSR is calculated by dividing the numbers of women who stop their child bearing at parity *i* for the total number of women giving birth at parity *i.*

$$\text{PSR} = \frac{\text{Number of women stopping child bearing at parity } i}{\text{Number of women giving births at parity } i} \times 100$$

This definition is complementary to the existing demographic concept of *Parity Progression Ratio* (PPR), which refers to the proportion of women, with a given number of children progress to the next birth parity among the total number of women giving birth at that parity (Preston 2002). (Because the total values between PPR and PSR is of one at parity *i*, another way to calculate PSR is of *PSR= 1 – PPS)*.

We denoted PSR_f^i as the proportion of women stop having child at female births and PSR_m^i as the proportion of women stop having child at male births. If the sex of the child was not a factor entering the decision to stop having children, the values of these proportions should be the same for both male and female births at all parities. In contrast, if the sex of the child is a factor influencing the fertility decision of couples, one can see the difference between the two proportions.

2.2 Calculating the ratio $\frac{PSR_m^i}{PSR_f^i}$

As we hypothesised that in a context of son preference, the proportion of women stopping having children after male births is higher than that of women stopping having children after female births. It means the PSR of male last births is greater than that of the female last births at parity *i*. The difference between the PSR at male vs. female last births has increased the SRLB. In other words, the value of the ratio $\frac{PSR_m^i}{PSR_f^i}$ would be greater than 1 for the last births at parity *i*. The ratio $\frac{PSR_m^i}{PSR_f^i}$ therefore, demonstrates the impact of the stopping rule on the SRLB. The value of this ratio reflects the extent of son preference of a population. A high SRLB (stop having child at male births) or a low sex ratio of non-last births (continue child bearing at female births) by contrast therefore is an indication of the operation of the stopping rule.

To measure the net impact of the stopping rule on the SRLB, we assume that the SRLB of parity *i* of the population is the product of two components: the SRB (of all births) and the ratio $\frac{PSR_m^i}{PSR_f^i}$. With that assumption, we decompose the SRLB of parity *i* into two components: the SRB of parity *i* and the ratio $\frac{PSR_m^i}{PSR_f^i}$ at parity *i.* While the first component reflects the biological influences and sex selection practices on the SRB, the second component demonstrates the net impact of the stopping rule itself on the SRLB at parity *i*.

2.3 Estimating the SRLB

In an assumed situation, where the influence of biological factors (parental and maternal age) and socio-economic political determinants (sex selective abortion) are not in place, the value of the SRB should be 105. In this situation, any increase of the SRLB should be attributed purely to the affect of the stopping rule. The SRLB of parity *i* under the impact of the stopping rule should be at

$\frac{PSR_m^i}{PSR_f^i} \times 105$. This calculation therefore, provides an estimation of the SRLB of parity *i* under the net impacts of the stopping rule.

However, in the actual situation, the SRLB of parity *i* is also affected by other influences such as biological, socio-economic determinants and fertility behaviour. The actual SRLB of parity *i* is therefore a product between the ratio $\frac{PSR_m^i}{PSR_f^i}$ and the actual SRB of parity *i*: $\frac{PSR_m^i}{PSR_f^i} \times SRB$. This calculation straightforward provides estimation of actual SRLB of parity *i* under all possible influences. These SRLB estimates using the method should be identical to the values of SRLB calculated directly from a dataset.

3. Quantify the impact of the stopping rule on the SRLB in Viet Nam

In this section, we use the proposed method to quantify the impact of the stopping rule on the SRLB in Viet Nam. The material used for this exercise is the data from the PCS 2006. By doing so, we aim at achieving two targets: (i) to test the hypothesis in an actual situation i.e. Viet Nam, where son preference is strong and (ii) to document the situation of SRLB in Viet Nam.

The PSC 2006 was conducted by the General Statistics Office to provide key socio-economic and development data for the Vietnamese Government for social and development planning. It employed a stratified random sampling method, based of the sampling frame work of the *Census 1999* to collect general demographic data from 461,475 women in reproductive age, 15-49. Details of the survey design, sampling framework and weighting procedures have been discussed elsewhere (Pham et al. 2008c).

We use STATA version SE for analyses. The results are presented in weighted data using sample weights. The 95% confidence interval was also calculated for each SR estimate, using Taylor's linearization method to validate the reliability of the estimation. An increased SR estimate is considered as 'significant' if the 95% CI of the estimate is above the normal range of 103-107.

To quantify the impact of the stopping rule on the SRLB in Viet Nam, we conducted the analysis in four steps. Firstly, we calculated the total births and the total births disaggregated by the sex of the children, then the actual SRB of all births by parity. The results are shown in column 1, 2, 3 and 4 of Table 1. Secondly, we calculated the total last births and the total last births disaggregated by the sex of the children, then the SRLB by parity, from 1 to 5. The results are shown in column 5, 6, 7 and 8 of Table 1. Thirdly, we calculated the PSR for male last births, female last births and all births by parity. The results are shown in column 9, 10 and 11 of Table 1. Finally, we calculated the ratio $\frac{PSR_m^i}{PSR_f^i}$ to quantify the impact of the stopping rule on the SRLB by parity. Then we estimated the SRLB using the assumed normal SRB of 105 and the actual SRB, which has been calculated directly from the data in the first step. The results are shown in column 12, 13, 14 of Table 1. These analyses were conducted by parity, from 1 to 5.

To demonstrate the distinguished SRBL under the net impact of the stopping rule and the SRLB under all possible influences, we constructed Figure 1. Finally, we calculated the SRLB by year of birth to assess the impact of the stopping rule on the time trend of SRLB over the period 1970-2006. The results are shown in Figure 2.

We used the information on maternal age, year of birth and sex of child of 296,845 *most recent births* born over the period 1970-2006 and total children ever born by the survey time and the sex of all siblings. The last births were identified from *most recent births* by selecting women aged 40 or above by 2006. With this selection condition, the selected *most recent births* are more likely the last births because most of women are supposed to have stopped child bearing after the age of 40. The family sizes were also identified as the total children ever born at the last birth.

4 Results

4.1 Estimating the SRLB in Viet Nam using the method

Table 1 shows the metric of estimation of SRLB in Viet Nam for the whole period 1970-2006. The data showed that the actual SRB was slightly high, 109.5 for all parity for the whole period 1970-2006 (column 4). The SRB for the parity 1 was 112.8, considerably higher than those at higher parities. The SRLB was very high across all parities, and at 132.4 on average (column 8). Similar to the higher SRB observed at parity 1, the SRLB for the parity 1, 138.4 was also likely higher than those of other parities. About a half of women aged 15-49 (49.3%) ceased their child bearing at parity 3. Compared the PSR of male last births (column 9) to female last births (column 10), the data show that the former were consistently higher than the latter across all parities. For example, 54.3% of women stopped having child at third male birth compared to 43.9% of women did so at third female birth. These observations confirm the operation of the stopping rule in the fertility decision of Vietnamese.

The ratio $\frac{PSR_m^i}{PSR_f^i}$ was consistently above the value of 1 across all parities, at 1.21 on average (column 12). The lowest value was of 1.1 at parity 5 and the highest value of 1.27 was at parity 2. The data show that the PSR of the male last births were significantly higher than that of the female ones, above 10%. For instance, the ratio was of 1.23 at parity 1. That means that the stopping rule has increased the SRLB of parity 1 by 23.0%. Similarly, we can see that the stopping rule has increased the SRLB by 27%, 24%, 17% and 10% at parity 2, 3, 4 and 5, respectively and 21% for all parities.

Assuming a normal SRB at 105 as the situation where modern sex selection methods were not available, the SRLB was estimated very high, 128.6 at parity 1, 133.4 at parity 2, 129.8 at parity 3, 122.7 at parity 4, and 115.4 at parity 5 and 127.0 for all parities (column 13). However, when we used the actual values of SRB, which have been calculated directly from the PCS 2006 data (column 4), the actual SRLB were estimated even higher: 138.7 for parity 1, 138.7 for parity 2, 131.4 for parity 3, 125.4 for parity 4, and 117.7 for parity 5 and 132.5 for all parities (column 14). It is noted that the values of SRLB as shown in column 8 and column 14 should be identical. The slightly differences in these values between the two approaches are due to rounding errors.

Figure 1 shows the actual SRB (column 4), the SRLB estimate based on the normal SRB of 105 (column 13) and the SRLB estimate based on the actual SRB (column 14) by parity and for all parities. The Figure shows that the actual SRLB was consistently higher than the SRLB estimated in the condition without sex selection. For instance of all parities, the former was 132.5 compared to 127 for the latter.

Figure 2 shows the SRLB by year of birth over the period 1970-2006. The data showed that the trend of declining SRLB, from the level of 200 in 1970 to the level of 120 in the year 2001, then the ratio increased and reached the level of 130 in 2005. The SRLB estimates varied widely in the period 1970-1985 and in 2006 with wide ranges of 95% CIs due to small cohorts of last births recorded in these periods.

4. Discussion

Using the method, we have been able to quantify the net impacts of the stopping rule on the SRLB in Viet Nam over the period 1970-2006 by measuring the ratio $\frac{PSR_m^i}{PSR_f^i}$. The results show that the values of this ratio were above 1 across all parities, suggesting the common of the stopping rule in the fertility decision of Vietnamese. However, the ratio has decreased by parity, from 1.27 at parity 2, to 1.24 at parity 3, 1.17 at parity 4, and 1.1 at parity 5. This observation suggests that the weight of the stopping rule is larger at lower parity than higher parity. That means the operation of the stopping rule is stronger in the families with fewer children than in those with more children. As a result, smaller size families are more likely to have sons at their last births than the larger ones.

The previous studies on sex selection showed that SRB increased by birth parity (Biggar et al. 1999; Green 2000), but the SRB in the absence of sex selection was negatively associated with parental and maternal ages (Chahnazarian 1988) (higher age parents are more likely to produce female children). Our analysis shows that the SRB decreases by parity (see column 4). This pattern is also observed in the SRLB (see column 14). These observations suggest that our data are more likely affected by the parental and maternal age rather than biased with sex selective abortion. The SRLB declined by parity faster than the SRB because the impacts of parental and maternal factors are greater on the last births than on the previous births. The difference between the SRLB and the SRB is larger at lower parity i.e. 138.7 vs. 112.8 at parity 1, respectively, but smaller at higher parity i.e. 117.7 vs. 107 at parity 5. This is because the last births comprise the majority of births at higher parities compared to the minority at lower parities.

In the absence of the sex selective abortion, the value of SRB should be around 105. The SRLB for parity *i* therefore, should be a product of the ratio $\frac{PSR_m^i}{PSR_f^i}$ and 105. The stopping rule has increased the SRLB of all parities by 20%, to the level of 127. The weight of the stopping rule appears greatest at parity 2 when it increases the SRLB by 27%, to above the level of 130.

Although the SRLB can be calculated directly from the PCS 2006 data (as shown in column 8) and our proposed method has an advantage in quantifying the net impact of the stopping rule as demonstrated in the value of the ratio $\frac{PSR_m^i}{PSR_f^i}$. Thus, the method has decomposed the increased SRLB into two components: the increased SRLB under the impact of the stopping rule (column 13) and the increased SRLB under possible influences (column 14). Comparing the values of the SRLB in the column 8 to which in column 14, we see that these values should be identical. The slightly differences (less than 0.5%) between the two approaches are not significant. These variations are mostly due to the weighting and/or rounding processes. This comparison has verified the proposed method as it provides the same results to the direct calculation using the PCS 2006 data. Figure 1 shows the SRLB estimates under separate influences.

The above findings also suggest that while the stopping rule is a large contributor, it is not the only factor increasing the SRLB in Viet Nam in the period 1970-2006. Indeed, the stopping rule alone can lead the SRLB to increase to the level of 127, and when combined with other influences they increased the SRLB to the level of 132. These estimates are comparable to the results of the previous studies on SRB in Asia i.e. 120 in China (Poston et al. 1997) and 133.4 in Korea (Park 1983).

The time trend of the SRLB shows two different trends in the period 1970-2006 (see Figure 2). While the SRLB remained very high, it decreased from the level of 140 to the level of 125 over the period 1986-2001, approximately one point per year on average. With an assumption that sex selective abortion were not in Viet Nam in the 1980s and 1990s, the increased SRLB observed in these decades are mostly influenced by the stopping rule. The decline in SRLB therefore suggests a decline in son preference over this period.

However, another trend of increasing SRLB is observed in the period 2001-2005. This suggests that while the impact of the stopping rule probably continues to decline and the influence of biological factors remains unchanged, the influences of socio-economic and political determinants have increased to a significant level that reverses the trend of declining SRLB since 2001. Given the growing evidence of the sex selection practices (Pham, Hall and Hill 2008b) and the reinforcement of one-to-two child family recently in Viet Nam (Pham et al. 2008a), we argue that the increased SRLB observed in the period 2001-2005 is highly attributable to the spread of sex selection in the population.

If we assume that the SRLB of Viet Nam is an outcome of the combination between the stopping rule in the period 1970-2006 and the sex selective abortion in the period 2001-2006, we can decompose the contributions of the stopping rule and the sex selective abortion to the overall increased SRLB. The impact of the stopping rule, as demonstrated by the value of the ratio $\frac{PSR_m^i}{PSR_f^i}$, accounts for an increase of 21% of the SRLB, from the normal level of 105 to the high level of 127 while the sex selective abortion accounts for an increase by 5% of the SRLB, from 127 to 132.5 ((132.5-127)/105*100=5%). In other words, the SRLB of Viet Nam for the whole period 1970-2006 can be decomposed as a product of 105*1.21*1.05. In which, sex selective abortion has increased the SRB from the normal level of 105 to above the level of 110 (105*1.05=110.2). This value is close to the published estimates at 110 for 2006 (GSO 2007; Pham et al. 2008c). The stopping rule has increased the SRLB from the level of 110 to above the level of 130 (110*1.21=133).

Recently published work suggests that the SRB might be a heritable trait, passed on via the male line (Gellatly 2009). The impact of this factor is limited to the individual, and cannot contribute significantly to the change of the SRLB at the population level. The decision of stop having children after male births is always made after the child has been born. The stopping rule mechanism therefore, has no affect on the SR at conception or the SRB. It only biases the sex composition of the last births towards more males than females at a particular parity. While son preference is the engine of the stopping rule, it is hard to quantify the extent of son preference statistically at the national level. The proposed method has helped to quantify it by measuring the SRLB.

The stopping rule can act on family size in two different ways. In the past, when sex selection methods were unavailable, it contributed to expanding family size. The consistently increased SRLB across all parities in the 1980s and 1990s in Viet Nam, when the modern sex selection methods were supposed not in practices are important evidence of the operation of the stopping rule. An implication of this mechanism is that girls tend to grow up in significantly larger size families than boys do (Filmer et al. 2008). Compared to SRLB reported in a study in Korea in mid 1970s i.e. 114.4 for one child families, 133.4 for two child families, 145.5 for three child families, 130.0 for four child families, 121.6 for five child families (Park 1983), our estimations for Viet Nam have provided comparative estimates.

However, the greatest concern is the synergistic effects between the stopping rule and sex selection practices at first birth, which will accelerate the trend to one son families in Vietnamese society. A previous study suggests that the stopping rule can be used to predict sex selection when fertility declines (Widmer et al. 1981). The fertility of Viet Nam has declined from 3.8 in 1989 to the replacement level of 2.1 in 2005 and remained below that level in the following years (GSO 1989, 2007, 2008). As the fertility approaching replacement level, there has been a growing proportion of women stopping having children after their male first births. Indeed, our analysis shows that the proportion of women with only one child has increased from 7.4% in 1986 to 10.8% in 2005. The high SRLB observed at parity 1, 138.7 among women aged >=40 for the period 1970-2006 strongly suggests the operation of the stopping rule at the male first births. This decision, on the other hand is probably a contributor to further declined fertility in Viet Nam.

The impact of the stopping rule is even further reinforced by political factors such as the one child policy of China, which allows a second child if the first one is a girl. As a result of such policy, there were more than 1.1 million excess male births in 2005 alone (Zhu, Lu and Hesketh 2009). As the proportion of one son families increases in the population, it will have a potential to contribute to the imbalance in the SR of the adult population in the long term. Our prediction supports the conventional theory that the declining birth rate will increase the disparity of SRB, and refutes suggestions that the lower birth rate would result in a decline in the SRB in the context of son preference (Yoon 2006).

5. Conclusion

High SRLB is an import measure of son preference of a population. The proposed method based on the parity stop ratios at the male last births vs. female last births has allowed us to quantify the impact of the stopping rule on the increase of SRLB. The method has distinguished between the impacts of the stopping rule and the other influences of socio-economic determinant i.e. sex selective abortion. The method has been validated in the context of Viet Nam and can be replicable in similar settings.

Using the method, the net impact of the stopping rule has been quantified as a contributor to the increase of SRLB by 1.21 times, to the levels of 127.0 for all parties over the period 1970-2006. When combined with other influences, the SRLB has increased to above the level of 130. The operation of the stopping rule is an important mechanism in the fertility decision-making of the Vietnamese. Through the lens of SRLB, we have provided the evidence of decreased son preference over the period 1986-2001, but increased sex selection over the period 2001-2005. As the fertility declines below the replacement level and the modern sex selection methods are more accessible, the operation of the stopping rule has the potential to accelerate the trend of increasing one son families in Vietnamese society in coming years.

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List of Tables and Figures

Table 1 Quantify the impact of the stopping rule on sex ratios of last births by parity, Viet Nam, 1970-2006 (weighted data)

Birth Parity	SRB of parity *i*				SRLB of parity *i*				PSR at parity i (%)			Estimation of SRLB		
	male births	female births	Total births	Actual SRB	male births	female births	total	Actual SRLB	PSR_m^i	PSR_f^i	total	$\frac{PSR_m^i}{PSR_f^i}$	SRLB*	SRLB**
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]
			[1]+[2]	[1]/[2]*100			[5]+[6]	[5]/[6*100	[5]/[1]*100	[6]/[2]*100	[7]/[3]*100	[9]/[10]	105*[12]	[4]*[12]
1	2,857,343	2,534,089	5,393,017	112.8	308,010	222,623	530,633	138.4	10.8	8.8	9.8	1.23	128.6	138.7
2	2,535,761	2,322,588	4,862,324	109.2	1,073,036	773,489	1,848,914	138.7	42.3	33.3	38.0	1.27	133.4	138.7
3	1,547,228	1,459,004	3,013,333	106.0	839,373	640,560	1,485,621	131.0	54.3	43.9	49.3	1.24	129.8	131.4
4	786,350	733,836	1,527,553	107.2	479,627	383,127	869,050	125.2	61.0	52.2	56.9	1.17	122.7	125.4
5	338,155	316,100	658,571	107.0	203,291	173,037	379,499	117.5	60.1	54.7	57.6	1.10	115.4	117.7
Total	**8,064,837**	**7,365,617**	**15,454,798**	**109.5**	**2,903,337**	**2,192,836**	**5,113,717**	**132.4**	**36.0**	**29.8**	**33.1**	**1.21**	**127.0**	**132.5**

*Estimation of SRLB using the assumed normal SRB at 105

**Estimation of SRLB using the assumed actual SRB of all births

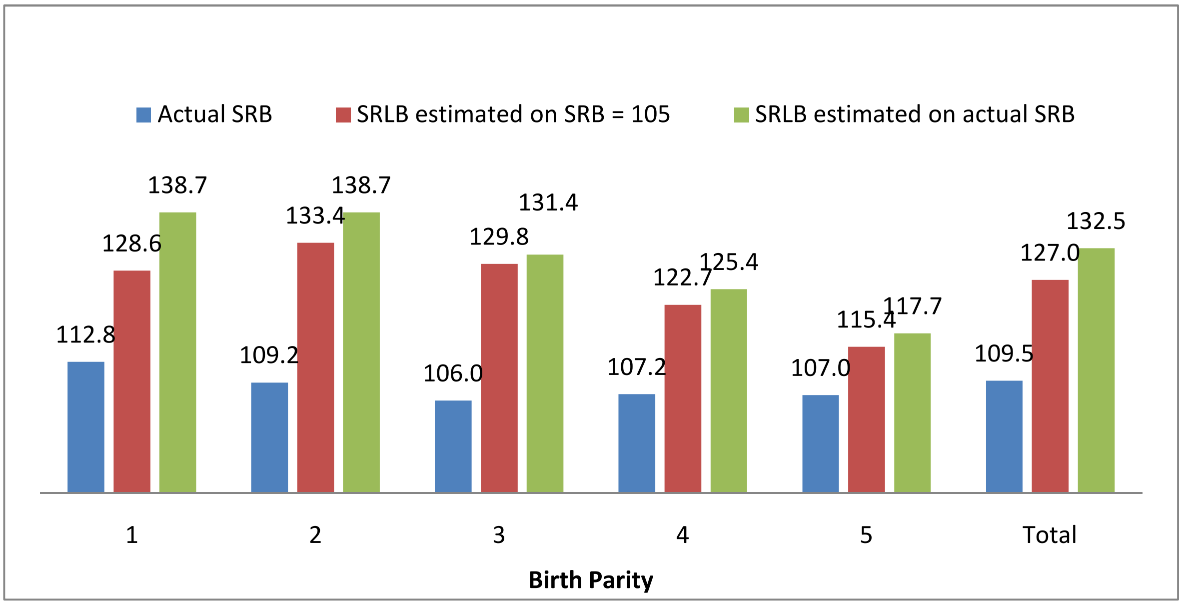

Figure 1 SRB and SRLB under the net impact of the stopping rule and under the impacts of all influences by parity, Viet Nam, 1970-2006

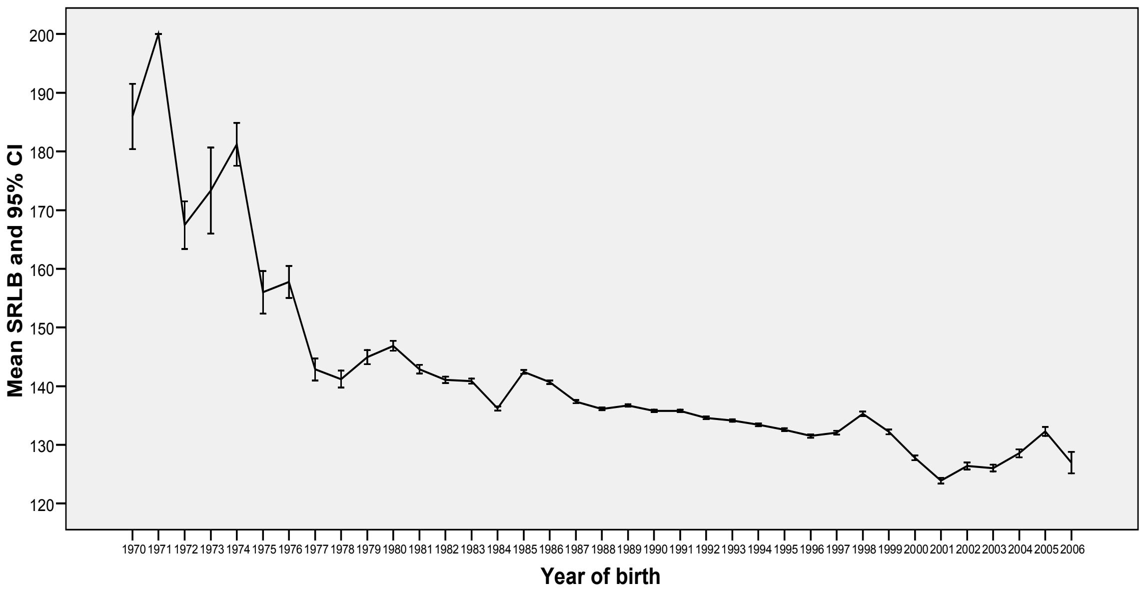

Figure 2 Mean sex ratio of last births and 95% CI by year of birth, Viet Nam, 1970-2006 (weight data)