Data Appendix

A New Dataset on Infant Mortality Rates, 1816-2002

By M. Rodwan Abouharb & Anessa L. Kimball

Introduction

Infant mortality rates are of interest to a wide variety of researchers. They are of interest to demographers that wish to understand the basic population characteristics of a country (Eberstein, 1989; Pampel Jr. & Pillai, 1986). These researchers often connect infant mortality rates (IMRs) to the fertility rate or use it in the development of estimations concerning life expectancy (Adlakha, 1972; Palloni & Rafalimanana, 1999; Przeworski, et al., 2000). Researchers concerned with political and economic development across nations have also examined the infant mortality rate as it relates to government expenditures on health and education (Flegg, 1982; Gallagher, 1989; Przeworski, et al., 2000; Wimberley, 1990) and socio-economic status (Gortmaker & Wise, 1997; London & Williams, 1988; Rodwin & Neuberg, 2005; Waldmann, 1992; Wennemo, 1993; Wigle, 1995)[1]. There is a research program in comparative politics that examines the connection between regime characteristics and infant mortality rates (Bueno de Mesquita, et al., 2003; Zweifel & Navia, 2000).

This Appendix reviews some of the literature where infant mortality rates are a dependent variable. This review is broken into two sections 1) the relationship between infant mortality and domestic factors such as the role and type of government as well as wealth and inequality and 2) the relationship between infant mortality and international factors such as the environment & international financial institutions. Next we discuss the temporal domain of existing analyses using infant mortality rate data. We then examine some of the data quality issues associated with using infant mortality rates, which include the ability of government to

[1]There are also several single area studies within the US (Stockwell, et al. (1995) (metropolitan Ohio 1989-91); Willie (1959) (Syracuse, New York 1950-56).

register infant deaths and the practice of infanticide. Finally, we provide information comparing our IMR data to recently published research by Urdal (2005).

Infant Mortality as a Dependent Variable

Domestic Factors & Infant Mortality

The Role & Type of Government

Some work has examined the role government has played in reducing levels of infant mortality (e.g. Adhikari & Maskay, 2004; Carpenter, 1995). This has included research examining Central America and Caribbean governmental efforts in reducing infant mortality. The poor outcomes of such efforts have been ascribed to political rather than economic factors (Hojman, 1996). Others have focused on the limits in trying to reduce levels of infant mortality of already efficient health care systems (Nakamura, et al., 1991). Indeed, other research has found that access to basic infrastructure services plays an important role in reducing the infant mortality rate aside from traditional variables such as income and education (Fay, et al., 2005). Finally, there is research which has indicated that autocratic regimes are likely to have higher infant mortality rates than their democratic counterparts (Przeworski, et al., 2000; Zweifel & Navia, 2000). Meanwhile, Bueno de Mesquita, et al., (2003) provide evidence that infant mortality rates are negatively related to the size of the minimum winning coalition: the smallest number of individuals whose approval is required for a leader to retain political power. These results are consistent with their claim that as the size of the minimum winning coalition increases governments need to improve the welfare of larger numbers of their citizens to retain office.

Wealth & Inequality

Other research has examined the impacts of wealth on infant mortality. Some work has noted differing infant mortality rates by levels of income (Rodwin & Neuberg, 2005; Wigle, 1995), fluctuations in income (Sultan, 1995) and income inequality (Waldmann, 1992; Wennemo, 1993) within both advanced industrialized and less developed countries (Rodwin & Neuberg, 2005; Sultan, 1995; Wennemo, 1993; Wigle, 1995). Citizens in lower income brackets, even in advanced industrialized democracies, have higher levels of infant mortality, while fluctuations in income and uneven distributions of income have been associated with a higher infant mortality rate (Sultan, 1995; Waldmann, 1992; Wennemo, 1993).

There is evidence from five Eastern European states that when countries are at war and internal displacement reaches high levels, the infant mortality rate is likely to increase (Ibrahim, et al., 2003). The infant mortality rate has also been explored as it relates to social inequalities in the provision of healthcare between rural and urban areas in China (Zhang & Kanbor, 2005). Other research has explored the relationship between socio-economic and demographic factors and the infant mortality rate in Zambia (Madise, et al., 2003). Moreover, within the Mexican context the exact location of birth has also been linked to an increased risk of infant mortality and its decade long economic decline over the period 1986-96 significantly increased infant mortality rates throughout the country (Frank & Finch, 2004). Others have explored the relationship between economic decline and infant mortality in Brazil (Costa, et al., 2003). Finally, some have tested theories of women's status in society showing an inverse relationship between women's status and infant mortality rates (Boehmer & Williamson, 1996). Research has also been undertaken which assesses the impact of international factors on infant mortality rates.

International Factors & Infant Mortality

The Environment & International Financial Institutions

Some have examined the impact of international factors such as changes in the environment and international financial institutions on infant mortality rates. Environmental factors, such as air pollution have been examined. The results indicated that a one-unit decrease in the particulates found in the air would lead to a .35% decline in the rate of infant mortality (Chay & Greenstone, 2003). Others have examined the impact of international financial institutions using infant mortality rates as a measure of the standard of living. The results provide evidence that consequences of World Bank structural adjustment agreements worsen rates of infant mortality in loan recipient countries (Kawani, 1995).

The Temporal Domain of Existing Data

The temporal domain of existing research involving infant mortality ranges from cross-sectional research conducted on the 1960s, 1970s, 1990s, (Adlakha, 1972; Boehmer & Williamson, 1996; Flegg, 1982; Hertze, et al., 1994; Hojman, 1996; Leppert, 1993; London & Williams, 1988; Waldmann, 1992; Wigle, 1995), to work covering the periods 1950-75 (Pampel & Pillai, 1986), 1968-88 (Vallin, 1992; Wimberly, 1990 [between 1967-80]), the 1980s-90s (Carpenter, 1995) and longer periods of the 1940s-80s (Nakamura, et al., 1991; Roserobixby, 1991), 1920-90 (Palloni & Rafalimanana, 1999), 1966-90 (Kawani, 1995), 1950 or 1960 to 1990 or 1999 (Bueno de Mesquita, et al., 2003; Przeworski, et al., 1999; Zweifel & Navia, 2000) and 1954-91 (Sultan, 1995) and from 1800 to 1990 (for Basque Spain) (Sanchez, et al., 2002).

The geographic coverage of previous work has also ranged from single country studies of both developing and advanced industrialized nations (Carpenter, 1995; Leppert, 1993; Nakamura, et al., 1991; Roserobixby, 1991; Sultan, 1995; Wigle, 1995) to regional comparative studies of twenty two central American and Caribbean countries (Hojman, 1996; Palloni & Rafalimanana, 1990; Pampel & Pillai, 1986), to larger cross-national studies ranging from 42-96 developing countries (Boehmer & Williamson, 1996; Flegg, 1982; Kawani, 1995; London & Williams, 1988; Vallin, 1992; Waldmann, 1992; Wimberley, 1990). Finally, some scholars have attempted to cover the possible universe of countries for time periods generally after 1950 (Bueno de Mesquita, et al., 2003; Przeworski, et al., 1999; Zweifel & Navia, 2000).

Thus, our data collection effort is the largest both geographically and temporally relative to existing research. Moreover, since our emphasis is on annual values our data contains much more variation than data relying solely on UN data efforts. Where the quality of demographic data is questionable anytime the source indicated uncertainty with respect to the data reported we also coded this in our dataset by inputting a (.1) after the source number reference. When unable to find any other annual sources of information we utilized the UN five-year reported averages as a final resort. Those averages are only used for the post-1950 time period and there is no country whose data are only from the UN sources. Approximately 750 or (7%) of our datapoints come from this source. It should be noted that the individual UN Demographic Yearbooks actually report annual level data, the five-year averages are the data that the UN provides electronically. Thus, any sources that are the UN Demographic Yearbook are annual level data for various years as reported to the UN.

Data Quality Issues

Registration of Infant Deaths

Registration of infant deaths in many developing countries is often not systematic generating questions about the quality of the data[2]. Many countries both developing and developed have had, at times, limited registration capabilities, meaning that not all infant deaths were recorded. In some cases the limited information has meant that demographers do not have infant mortality estimates for certain period of time. For example Lee et and co-authors confine their examination of mortality in late imperial China to the period 1700-1840 citing a decline in the quality of the data after 1840 for their reluctance to examine infant mortality rates in the latter part of the 19th century (Lee et al., 1994; Lee & Feng, 1999; 2001). China according to the Correlates of War project joins the international system in 1860 and thus enters into our data-set in that year. Like Lee, et al., (1994) we also do not, as yet, have estimates for infant mortality in late imperial China, because of the unavailability of reliable data for this period. Rates of registration are often difficult to assess, even in developed countries (Chase, 1969).

[2] We thank one of the reviewers for their insights on this issue.

Others have re-examined historical infant mortality rates in a variety of countries, for example, the old Soviet Union (Velkoff & Miller, 1995), the United States (1940-70), India between 1971-90 (Bhat, 2002), and the Tokugawa period (1603-1868) in Japan (e.g. Caldwell & Caldwell, 2005; Janetta & Preston, 1991). Velkoff & Miller (1995) discuss how the Soviet Union used a narrower definition of infant mortality than that used by the World Health Organization lowering the infant mortality rate. They also assess arguments that the continued rise of the infant mortality rate was due to more complete registration. They find that while registration improved the improved coverage was for deaths after one year of age (Velkoff & Miller, 1995: 256). Shin (1975) indicates that while there is no direct information about the extent of under-registration in the United States; in 1940 registration of Black infant deaths was at 81.3 percent. White registration was 94 percent. The threshold for incomplete registration by U.S. standards was recording less than 90 percent of all deaths. In Japan the village and temple registration system omitted between 80-90 percent of infant mortality during the Tokugawa period (Janetta & Preston, 1991).

Recent research has provided possible ways to more accurately estimate infant mortality rates in countries with incomplete registration systems (Morris, et al., 2003; Salomon & Murray 2001). Differences across states regarding reporting systems could lead one to consider these data as more similar to compositional data than normal aggregate data (Aitchison, 1986; Katz & King, 1999; Salomon & Murray, 2001). This concern is relevant to the heterogeneity across states in terms of registration and reporting systems particularly in the 19th century. This is an important criticism and one that we cannot address fully here. We strongly recommend reviewing Aitchison (1986) and King and Katz (1999) for a more thorough review of how one might analyze these data.

In basic terms, following the lead of Salomon and Murray (2001), we might believe that there are J different registration systems that affect IMR, we create a vector registration system fractions $P_i = (P_{i1},\ldots, P_{ij})$ for each observation i that contains information about that individual registration system. Then, a (J-1) vector, (Y_i), is calculated using the log ratios of each registration system fraction relative to the fraction for system J.

$$Y_{ij} = \ln\left(\frac{P_{ij}}{P_{iJ}}\right) \quad (1)$$

Y_i is then assumed to be multivariate normal and each log ratio is assumed to be a linear function of the explanatory variables used in the model. Registration issues are one source of concern that may affect the quality of data reported, infanticide is another.

Infanticide

The issue of infanticide also generates some concerns about data quality. Infanticide has been most common in Asia, particularly India, Japan and China (Caldwell & Caldwell, 2005). To be sure, it is difficult to have precise estimates about the levels of infanticide because even when not proscribed these actions have often had “an element of secrecy…and the subsequent fate of the newborn were enveloped in the privacy and even seclusion of women” (Caldwell & Caldwell, 2005: 208). India enters our data-set in 1947 and infanticide remains a problem the post-independence period. Demographic research in regions of India has found infanticide to be practiced in Bihar (Sudha & Irudaya Rajan, 1999: 594-596) and rural Tamil Nadu have seen a high rate of female infanticide, with 18 percent and 1 percent of female and male babies being killed (Chunkath, 1997: 25). Concluding their survey on Indian infanticide Caldwell and Caldwell (2005: 212) that the “total demographic impact is probably small and much less than the loss of females due to comparative neglect.” Infanticide in Japan appears most prevalent between 1726-1852 where the population hardly grew in comparison with significant earlier and later growth (Caldwell & Caldwell, 2005: 212).

Japan enters our data-set in 1860, thus many of the trends found during the Tokugawa period of 1603-1868 do not affect most of years for which we have data. The worst cases of infanticide were practiced during crises of the earlier Tokugawa period such as the Temmei famine of the 1780s (Hanley & Yamamura, 1977). Nevertheless, Tokugawan society is one described by “some infanticide” with some emphasis on females (Caldwell & Caldwell, 2005: 213). Indeed, Saito (2000) comes to a similar conclusion discussing the continuing low fertility rate in 1913, which suggests that earlier infanticide had been less important than previously thought (in Caldwell & Caldwell, 2005: 213).

Infanticide has also been an issue in China. Most cases of infanticide were in pre-modern China. Gauging accurate figures for the level of infanticide is also difficult but there is agreement that it took place (e.g. Fei, 1946; Lee & Wang, 1999). In general, infant mortality rates were not recorded (Lavely & Wong, 1998: 723). The Household and Population Registers of the Eight Banner Han Chinese Army, which were used to register the population of northeast China, used every three years, omitted infants (Lee & Campbell, 1997: 16-17). China enters our data-set in 1860, with the first data point in 1929. We have continual infant mortality data from 1944. The issue of infanticide lessens in importance once the Communists take power, with the numbers of “excess female deaths (probably infanticide) declined precipitously in the Communist period” (Coale & Banister, 1994: 459). Estimates of the levels of excess female deaths were made and ranged from 15 percent in 1936, to four percent in 1950, reaching seven percent in 1954, two percent over the period 1960-72 and five percent in 1984 (Coale & Banister, 1994: 459).

Finally, there is some work which questions the link between economic well being and infant mortality. Research on demographic change in eighteenth and nineteenth century Germany indicated that one of the key factors affecting the infant mortality rate was the breast feeding choices made in these villages (Knodel, 1988). Likewise, others have discussed the sensitivity of the Human Development Index (Crafts, 2002). To be sure we would agree that the connection between well being and infant mortality may be limited but we would argue that the actions of government are an important factor in this process, to which these works pay little attention.

Comparing our IMR data to data used by Urdal (2005)

Focusing on recent research findings by Urdal (2005), we re-analyze his data using our measure of infant mortality. Before discussing the findings there are several important differences to note. First, Urdal's time domain is from 1950 until 2000—thus re-analyzing Urdal's models does not allow us to fully utilize the temporal span of our data (from 1816-2002) which is one of the substantial benefits of our dataset. Second, and also related to the span of Urdal's data relative to ours, Urdal's list of countries that comprise his dataset is substantially different from ours since we rely on the Correlates of War list of Independent States we have a substantially smaller number of datapoints than Urdal (7,341 versus Urdal's 8,797). The Correlates of War list is based upon the concept of sovereign states. In comparison, Urdal includes observations for sub-national territories such as Puerto Rico, Solomon Islands, Netherlands Antilles, Gaza, New Caledonia, Guam and others, which are not independent states but comprise a variety of legal entities that range from protectorates to UN-governed areas, to autonomous countries within sovereign states. For example, the Netherlands Antilles is described as an autonomous country within the Kingdom of the Netherlands (CIA Factbook 2006). To what extent this particular example and the others that differ our data-set from Urdal's truly represent the choices of sovereign entities with respect to their domestic populations is unclear. Given our focus concerning the political choices governments make with respect to their citizens these cases do not necessarily fulfill that criteria Additionally, Urdal includes more than 1,100 data observations for many states before they were internationally recognized as independent states according to the Correlates of War Project (e.g. Guinea-Bissau, Sierra Leone, Uganda, Kenya, Tanzania, Angola, Namibia, Swaziland, United Arab Emirates, Turkmenistan, Tajikistan, Kazakhstan, Papua New Guinea, Fiji etc.) For example, he includes data for the Bahamas from

1950 until 1972 resulting in an additional 23 observations since the Bahamas are not formally recognized as a state until 1973. Likewise, he includes data for Namibia from 1950 until 1989 increasing his number of observations by 39 since Namibia does not gain formal independence until 1990. We have provided a list of the countries and years where Urdal includes data observations for states that are not formally recognized, which can be found at the end of this appendix. Third, Urdal uses infant mortality rate data provided by the UN, however these data are only reported in five-year averages. Thus, Urdal's IMR data is a constant for every five years in his dataset, while, in contrast, our data varies annually. The result is that Urdal's data has a smaller range (2 - 264) than ours (2.3 – 304) but a higher mean value (80 vs. 67) and standard deviation (59 vs 52). Thus, there are a number of systematic ways in which Urdal is inflating his number of observations. Despite these substantial differences the two infant mortality rates are correlated at .9157 and there is a large amount of consistency between the datasets. See below:

	Country	# Obs.	Mean	S.D.	Range
Urdal	USA	51	16.7	7.6	7 - 28
Ours	USA	51	20.9	10.1	7 - 36
Urdal	UK	51	15.7	7.3	7 - 29
Ours	UK	51	17	8.1	5.5 - 35

Overall, the data are clearly similar to one another but there are important geographic and temporal differences between the datasets that deserve discussion before the results from models estimated can be compared. Nonetheless, re-estimating Model 1 from Urdal (2005: 428) further supports our claims of consistency as the coefficient on his IMR measure is .00646 while using our measure of IMR the coefficient in the same model is .00675 both are significant. For model 2 the relevant coefficients are Urdal's = .0055 and our = .006. These suggest that the more fine-tuned data has a stronger magnitude in the same models.

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Country Name	COW country code	Additional Years in Urdal's data	# of Observations	Year of Independence (COW)
Bahamas	31	1950-72	23	1973
Jamaica	51	1950-57	8	1962
Trinidad & Tobago	52	1950-57	8	1962
Barbados	53	1950-57; 1963-65	11	1966
Dominica	54	1957; 1963-69; 1973-78	13	1978
Grenada	55	1957; 1963-70;	9	1974
St. Lucia	56	1957; 1963; 1965-70; 1976; 1978	10	1979
St. Vincent & Grenadines	57	1957; 1963-73; 1977; 1978	14	1979
Antigua & Barbuda	58	1957; 1963-65; 1980	5	1981
St. Kitts-Nevis	60	1957; 1963-72; 1982	13	1983
Belize	80	1950-80	31	1981
Guyana	110	1950-65	16	1966
Surinam	115	1950-74	25	1975
Monaco	221	1950-53; 1959-61; 1963; 1965-70	14	1993
Liechtenstein	223	1950-66; 1968-73	23	1990
Andorra	232	1950-54; 1989-92	9	1993
German Federal Republic	260	1950-54	5	1955
German Democratic Republic	265	1950-53	4	1954
Austria	305	1950-54	5	1955
San Marino	331	1950; 1951; 1960-73;	16	1992
Malta	338	1950-63	14	1964
Cyprus	352	1950-59	10	1960
Cape Verde	402	1950-74	25	1975
Sao Tome - Principe	403	1955-58; 1961-72; 1974	17	1975
Guinea-Bissau	404	1950-73	24	1974
Equatorial Guinea	411	1950-67	18	1968
Gambia	420	1950-64	15	1965
Burkina Faso	439	1959	1	1960
Sierra Leone	451	1950-60	11	1961

Country Name	COW country code	Additional Years in Urdal's data	# of Observations	Year of Independence (COW)
Togo	461	1950-59	10	1960
Cameroun	471	1950-59	10	1960
Nigeria	475	1950-59	10	1960
Zaire	490	1950-59	10	1960
Uganda	500	1950-61	12	1962
Kenya	501	1950-62	13	1963
Tanzania	510	1950-60	11	1961
Zanzibar	511	1950-62	13	1963
Djibouti	522	1950-76	27	1977
Eritrea	531	1950-92	3	1993
Angola	540	1950-74	25	1975
Mozambique	541	1950-74	25	1975
Zambia	551	1950-53	4	1964
Zimbabwe	552	1950-53; 1964	5	1965
Malawi	553	1950-53	4	1964
Namibia	565	1950-89	39	1990
Lesotho	570	1950-65	16	1966
Botswana	571	1950-65	16	1966
Swaziland	572	1950-63	14	1964
Malagasy Republic	580	1950-59	10	1960
Comoros	581	1950-74	25	1975
Mauritius	590	1950-67	18	1968
Seychelles	591	1950-73	24	1976
Morocco	600	1950-55	6	1956
Algeria	615	1950-61	12	1962
Tunisia	616	1950-55	6	1956
Libya	620	1950	1	1951
Sudan	625	1950-55	6	1956
Yemen People's Republic	680	1950-66	17	1967
Kuwait	690	1950-60	11	1961
Bahrain	692	1950-70	21	1971

Country Name	COW country code	Additional Years in Urdal's data	# of Observations	Year of Independence (COW)
Qatar	694	1950-70	21	1971
UAE	696	1950-70	21	1971
Oman	698	1950-70	21	1971
Japan	740	1950; 1951	2	1952
Bhutan	760	1950-70	21	1971
Maldive Islands	781	1950-64	15	1965
Cambodia	811	1950-52	3	1953
Laos	812	1950-52	3	1953
Dem. Rep. Of Vietnam	816	1950-53	4	1954
Malaysia	820	1950-56	7	1957
Singapore	830	1950-64	15	1965
Brunei	835	1950-83	35	1984
Papua New Guinea	910	1950-74	25	1975
Vanuatu	935	1950-80	31	1981
Solomon Islands	940	1950-77	29	1978
Fiji	950	1950-69	20	1970
Fed. States of Micronesia	987	1982; 1985; 1987; 1990	4	1991
Western Samoa	990	1950-75	26	1976
		Total Additional Observations	1124	