CONSULTING ASSISTANCE ON ECONOMIC REFORM II

DISCUSSION PAPERS

The objectives of the Consulting Assistance on Economic Reform (CAER II) project are to contribute to broad-based and sustainable economic growth and to improve the policy reform content of USAID assistance activities that aim to strengthen markets in recipient countries. Services are provided by the Harvard Institute for International Development (HIID) and its subcontractors. It is funded by the U.S. Agency for International Development, Bureau for Global Programs, Field Support and Research, Center for Economic Growth and Agricultural Development, Office of Emerging Markets through Contracts PCE-C-00-95-00015-00 and PCE-Q-00-95-00016-00.

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CAER II Discussion Paper No. 32
October 1998

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May 1998

Helpful comments were received from participants at a workshop held at the Harvard Institute for International Development on January 16-18, 1998, on "The Mortality Crisis in Post-Soviet Societies." The conference was sponsored by the Office of Emerging Markets, Economic Growth Center, Bureau for Global Programs, Field Support and Research, United States Agency for International Development under the Consulting Assistance on Economic Reform (CAER) II Project, contract PCE-0405-C-00-5015-00. The views and interpretations in this paper are those of the authors and should not be attributed to USAID. The authors are also grateful for comments received from participants at the BU/Harvard /MIT Health Economics Seminar, and a videoconference seminar with Tsukuba University. Finally, the authors wish to thank Neil Bennett, Eric Bettinger, Elizabeth Brainerd, David Canning, John Gallup, Sherry Glied, Sergei Ivanov, Ajay Mahal, Andrew Warner, and Eric Weinstein for valuable discussions, Erin Kleindorfer for excellent research assistance, and Alison Howe and Charles Mann for their encouragement and support of this work.

Macroeconomic Consequences of the Russian Mortality Crisis

Abstract

This paper examines macroeconomic consequences of the Russian mortality crisis. Life expectancy in Russia decreased from 70 to 65 years during the first half of the 1990s, which we estimate accounts for approximately 1.6 million excess deaths during 1990-95. Coupled with its disproportionate impact on working age males, the large number of excess deaths suggests the crisis may have had a significant negative impact on the level and growth of Russia's per capita income. We estimate the economic cost of the crisis using two alternative approaches. First, we estimate the capitalized value of the income forgone due to the crisis, which represents between 1.8 and 2.7 percent of Russia's 1990 GDP. There are, however, both theoretical and empirical problems with this approach to estimating the cost of the crisis. Second, we estimate the parameters of a macroeconomic growth model and use it to calculate the effect of the crisis on Russia's rate of economic growth. Our calculations suggest that the net effect of the fall in life expectancy, the decline in the rate of total population growth, and the even larger decline in the rate of growth of the working age population have been to lower the annual rate of growth of income per capita in Russia by roughly one-third of one percentage point. Given that Russia's per capita income fell at an average annual rate of nine percent during 1990-95, we conclude that the mortality crisis – which has unquestionably been catastrophic in human terms – has been at most a small contributor to Russia's poor macroeconomic performance. The paper also discusses the effects of the crisis on other macroeconomic variables such as income inequality and the fiscal balance of the pension system. The paper concludes with a discussion of possible new approaches to modeling the two-way linkages between health status and economic growth.

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Macroeconomic Consequences of the Russian Mortality Crisis

Introduction

Recent estimates indicate that between 1990 and 1995, some 1.3 to 3.1 million Russians died prematurely. These excess deaths represented 11 to 26 percent of total deaths during this six-year period. Corresponding to these excess deaths the life expectancy of Russians declined precipitously from 70 to 65 years.[1]

While the term 'cold war' sought to analogize the economic and strategic contest between East and West to armed conflict, the demography of the Russian mortality crisis of 1990 to 1995 bears an uncomfortable similarity to true military casualties. Not only does the level of excess mortality appear to be unprecedented in a modern industrial country free of war and repression, but the dead and suffering are disproportionately male, with the largest relative increases in age-specific death rates concentrated among those of working age.

The Russian mortality crisis is, by any standards, a human tragedy, and for those immediately affected it is surely a financial one as well. However, whether a sharp increase in mortality has crisis-like implications for a macroeconomy is less clear. On the one hand, the direct medical costs imposed by declining health status are likely to be large, as is the income forgone by those who fall ill or die. This pattern suggests that a mortality crisis might indeed have a large economic impact. On the other hand, the evidence on the macroeconomic effects of other mortality crises, such as epidemics of AIDS, influenza, and the plague, is mixed. In a series of related papers, Cuddington (1993), Cuddington and Hancock (1994), and Kambou, Devarajan, and Over (1992) conclude, on the basis of alternative simulation analyses, that the AIDS epidemic has had, and will continue to have, a negative impact on income per capita in sub-Saharan Africa. By contrast, Bloom and Mahal (1997a), analyzing data on actual economic growth for 51 countries worldwide from 1980 to 1992, find no evidence that the epidemic slowed the growth rate of per-capita gross domestic product (GDP).

Similar controversy exists about the economic impact of the plague, which killed nearly one-fourth of the population of Western Europe during 1348-1351. Hirshleifer (1987) argues that the excess mortality caused by the epidemic reduced the supply of labor, thereby leading to a short-term increase in wages, and attributes the economic stagnation of the decades that followed the Black Death primarily to recurring epidemics of bubonic and pneumonic plague. However, Bloom and Mahal (1997a) find no evidence that real wages departed from their long-term trend during this period. While dramatic increases in mortality are always disruptive to economic systems, they may also have counterbalancing effects, such as increasing the capital and land to labor ratios in excess labor economies. In general the overall effect of mortality shocks on an economy depends on various factors, such as the structure of the economy, the structure of the labor market, and the number of excess deaths and their distribution across age and skill groups.

Economic performance is one lens through which to view the severity of Russia's mortality crisis. Translating the magnitude of the crisis from human to monetary terms may well improve its chances of gaining attention from economic policymakers. In addition, estimates of the economic impacts of the crisis are crucial ingredients in economic evaluations of policies and programs aimed at mitigating the crisis. For these reasons, and also to shed light on the broader issue of the connection between health and economic growth, the central objective of this paper is to assess selected macroeconomic implications of Russia's recent mortality crisis.

There are three main reasons that the Russian mortality crisis might be expected to have a large macroeconomic effect. The primary reason, of course, is the large number of excess deaths. Second, the disproportionate impact of the crisis on the working age population raises the possibility of increased costs based on the level of forgone income associated with the crisis. Third, the effect of the mortality crisis on the labor force is further magnified because of its disproportionate occurrence among men. While Soviet ideology may have held a gender-blind workforce as a stated ideal, in Russia, as elsewhere, prime-age males still account for a disproportionate portion of labor inputs, and even more so since the economic reforms of 1992.[2]

In addition to forgone output, there are direct costs associated with Russia's mortality crisis. For example, the increased morbidity that undoubtedly accompanies the rising mortality diverts scarce resources toward medical care and away from other uses. While incremental medical care expenditures associated with the excess morbidity might represent a significant cost of the crisis, an accurate evaluation of this cost is complicated by two factors. First, an appropriate evaluation requires comparing the medical care costs to the costs of the medical services that those individuals affected by the crisis would otherwise have consumed over their lifetimes. Second, an important factor contributing to the crisis may have been falling public expenditures on health care following the collapse of the former Soviet Union. This decline must also be accounted for in an evaluation of the direct costs of the crisis.

Central to any economic assessment of the crisis are estimates of both the size and the structure of the demographic shock. We begin, therefore, by reporting excess mortality calculations during the crisis period using a methodology that differs somewhat from approaches found elsewhere in the literature. Notwithstanding these methodological differences, our calculations also show that the number of excess deaths is large, and that they are disproportionately selective of working age men. We then evaluate the economic impact of Russia's mortality crisis using health economists' standard cost of illness method. Given its ubiquity in the health economics literature, it seems natural to apply this method to evaluate the impact of the crisis. Our calculations show that the capitalized value of forgone income associated with cumulative excess mortality during the six-year crisis represents only about 3 percent of Russia's GDP in 1990. This number is a lower bound on the actual value of forgone incomes, as it does not incorporate the costs of the morbidity associated with the crisis. As this lower bound is relatively small, it provides inconclusive evidence of the economic magnitude of the crisis. Moreover, the estimate should be interpreted with caution due to conceptual weaknesses with this method as well as problems of missing and imperfect data. Several of these deficiencies are noted below in the interest of clarifying the nature of the COI method and the interpretation of COI estimates.

We then apply an alternative method to evaluate the effects of the crisis on economic growth. Recently estimated empirical growth models suggest a strong influence of a population's age structure and its general health status on economic growth. We extend these models conceptually and empirically to account for heterogeneity in the labor force. As no Russian data are available on many of the factors believed to affect economic growth, we appeal to evidence derived from other countries. We apply the parameter estimates from these cross-country empirical regressions to the Russian demographic data that are available in order to calculate the impact of reduced life expectancy and slower growth of the working age population on future economic growth. Once again, the estimate of the economic impact of the crisis is small relative to recent changes in Russia's income per capita.

The paper concludes with a discussion of other practical and theoretical implications of these results and suggestions for further work. As the excess mortality is likely to have implications for the distribution of economic well-being in Russia and for the fiscal performance of Russia's pension system, we explore the direction and magnitude of such effects. We also discuss possible ways in which to model the linkages between health status and economic growth. While both country time series and country cross-sectional data have established that health status tends to increase with income per capita, economists have only recently begun to explore the impact of improved health status on subsequent economic growth. We argue that in the case of developing countries the interplay of these two effects can lead to a virtuous cycle with respect to both health and economic growth. However, a negative income shock, such as that which Russia's transition to a market economy seems to have caused, may have triggered a downward growth-health spiral.

Demographic Structure of the Crisis

In this section we discuss the demographic characteristics of the crisis. We calculate excess deaths associated with the crisis by comparing actual deaths that occurred between 1990 and 1995 to estimates of the deaths that would have occurred in the absence of the crisis.[3] We estimate this counterfactual number of deaths using two different assumptions. Under the first assumption, we assume that age-specific death rates would have remained the same as in 1989. We apply these death rates to the population in each five-year age group for every year from 1990 to 1995. Under the second assumption we posit that age-specific death rates from 1989 on follow the time trend in the death rate in each five-year age group from 1959 to 1985.[4] The trends are estimated through regression analysis of the death rate data for 36 age-group/gender combinations. Once again, the estimated death rates for each year from 1990 to 1995 are applied to the population in each age group for that year to give the counterfactual number of deaths for each year.[5] Excess deaths are calculated as the number of reported deaths minus the number of estimated deaths in every age group, under each assumption.

Table 1 reports our results for the calculation of excess deaths under the second assumption, that is, that death rates in the absence of the crisis would follow a trend extrapolated from age-specific death rates between 1959 and 1985. The total number of excess deaths under this calculation is 1.57 million, while under the alternative assumption of constant 1989 death rates the estimated number of excess deaths is 1.68 million. By comparison, Bennett, Bloom, and Ivanov (1998), using a technique whereby they extrapolate a trend in life expectancy and apply it to a model age distribution of Russian death rates, find that excess deaths amounted to 1.36 million to 1.57 million. The close consistency of the estimates of excess mortality derived through these alternative methods contributes to our overall confidence in the estimates presented herein.[6]

The scale of Russia's mortality crisis suggests that it may have a significant impact on Russia's economy. Table 1 highlights two other demographic characteristics of the excess deaths that could exacerbate these effects. First, almost two-thirds of the excess mortality is male. The Russian labor force participation rate for men is 71.2 percent, significantly higher than the female labor force participation rate of 56.1 percent. Male wages are also higher than female wages: the ratio of average female wages to average male wages is 68 percent.[7] These facts indicate that men contribute disproportionately to GDP per capita, and suggest that the gender differential in excess mortality could magnify the economic impact of the crisis.

Second, the table highlights the impact of the crisis on the working age population. Seventy percent of the excess mortality between 1990 and 1995 was accounted for by individuals in the age range 20 to 65, almost twice the share of deaths that they accounted for in 1989. High mortality among those of working age has a negative effect on economic growth, as a relative reduction in the number of workers increases a country's dependency ratio, potentially reducing its per capita income and consumption. Indeed, Bloom and Williamson (1998) show that while growth in the population below age 15 has a negative impact on economic growth, and growth in the population above age 65 is neutral in its effect, growth in the working age population has a significant positive effect on economic growth. As Table 1 shows, the Russian mortality crisis had almost no effect on the growth rate of young dependents. By contrast, it was associated with a significant fall in the growth rate of older dependents, although Bloom and Williamson's (1998) results suggest that this shift would have had little effect on economic growth rates. The growth rate of Russia's working age population, however, is estimated to be 60 percent less than what it would have been in the absence of the crisis, which can be expected to have a negative effect on economic growth.

Cost of Illness

In this section we evaluate the costs of the mortality crisis in Russia using the human capital method of estimating the cost of illness (COI).[8] Developed in the early 1960s, this approach is a standard technique used by health economists to evaluate the cost to society of a particular illness. It attempts to account for both the direct and indirect costs associated with an illness. The direct costs include personal medical care costs such as expenditures on diagnosis, treatment, and care and non-personal medical care costs such as government expenditures on education and basic research. The indirect costs include an estimate of the value of the productivity forgone because of the morbidity and mortality associated with the illness and some measure of pain and suffering.

Forgone income associated with the mortality crisis is the capitalized value of future lifetime earnings that ill and prematurely deceased people would have received. We calculate a lower bound estimate of these forgone incomes by taking the discounted wage loss for a representative death in each age and gender group based on the pre-crisis probabilities of survival, labor force participation rates, and wage levels. We then multiply these estimates by the number of excess deaths in each age and gender group, and sum them up across groups.

The literature contains much discussion on the appropriate discount rate to be used to capitalize forgone incomes. Rather than positing a single best rate, it appears preferable to explore two alternative scenarios that allow us to examine the sensitivity of the COI estimates to the assumed discount rate. We therefore perform separate calculations with 4 percent and 10 percent rates of discount. Based on these calculations, the capitalized value of forgone incomes associated with excess mortality in Russia between 1990 and 1995 is Rub. 17.6 billion at a 4 percent discount rate, and Rub. 11.5 billion at a 10 percent discount rate (in 1990 rubles).[9] Table 2 expresses these numbers as a percentage of Russia's 1990 GDP and 1995 GDP.[10]

At first glance, 1.8 percent to 4.7 percent of GDP may appear substantial. However, the ratio of lost income to GDP is a comparison of stock and flow measures, which is difficult to assess, and perhaps even somewhat misleading. Indeed, this problem of defining an appropriate yardstick for gauging the magnitude of the COI estimates is even more complicated when the COI estimate itself is taken as the sum of a stock and a flow variable, that is, lost income and medical care costs. Moreover, these numbers should be viewed with caution, as there are substantial problems with the data used for the calculations, and also, more fundamentally, with the theoretical underpinnings of the COI method. These issues are explored below in the context of the Russian mortality crisis.

Data Issues

The data available for estimating the costs of the mortality crisis have a number of limitations. For example, the above calculations are based on average reported wages for each age group, which may misrepresent actual earnings insofar as a significant percentage of Russia's labor force works in the informal sector, or labor income is under-reported for tax purposes. In addition, a high productivity loss undoubtedly arises from morbidity. Data on workdays lost to illness would be necessary to calculate this cost, but are unfortunately unavailable.

The COI method also requires the incorporation of other costs, such as the medical costs, both private and non-private, associated with the crisis. Some observers have placed part of the blame for the crisis on the collapse of the medical system caused by harsh cutbacks in public spending. Estimates indicate that public expenditure on health in Russia fell by more than 50 percent between 1989 and 1994.[11] However, evidence suggests that private expenditures on health rose sharply during this period.[12] To arrive at the true medical costs of the crisis, it would be necessary to evaluate how much total expenditures changed (either increased or decreased). The net increase in medical expenditure must then be compared to the medical costs that would have been incurred by the prematurely dead over the rest of their lifetimes in the absence of the crisis. As might be expected, few of these data are available, making such a calculation infeasible.

Another omitted factor is the presumably large implicit cost of pain and suffering among those who died prematurely and their families and friends. One might attempt to estimate this cost using economic damage calculations accepted in tort cases. However, in the case of Russia, such data are, once again, unavailable.

Theoretical Issues

There are also various theoretical problems associated with the COI method. First, the calculations often do not take into account the value of leisure or other activities that are not directly priced by the market.[13] Second, wages may be a poor measure of marginal product in the presence of labor market distortions, such as those arising from discrimination or the presence of labor unions.[14] Third, the method fails to account for the structure of the labor market. More specifically, the COI calculation attempts to evaluate the capitalized value of lost wages associated with an inward shift of the labor supply curve (see Figure 1). This would be the difference in the wage bill associated with the old equilibrium E_0, and the new equilibrium E_1. However, by assuming that there is no increase in wages, the new equilibrium is assumed to be E_2. The COI method therefore calculates the area AE_0E_2C instead of the area AE_0E_1B. The only case in which these areas are equal is when labor demand is perfectly elastic, which runs counter to most theory and evidence in labor economics. In general, the lost income calculation may overstate or understate the value of lost output, depending on the elasticities of labor supply and demand.[15]

More common is the case of perfectly elastic labor supply, a situation not unlikely in the presence of high unemployment rates. In this extreme case, the reduced labor has no effect whatsoever on output, because unemployed or underemployed individuals come forth to fill the vacant jobs left by those who died prematurely. There is, moreover, a literature that discusses the increased mortality associated with unemployment.[16] Cornia (1996) shows a correlation between mortality rates and unemployment in post-transition Eastern European and former Soviet countries, including Russia. This would suggest non-randomness in Russian excess mortality. If the crisis disproportionately affects the unemployed, the impact on the wage bill is likely to be much smaller.

Finally, the application of the COI method requires the use of current wages and labor force participation rates to evaluate the capitalized value of future earnings. The transition period is clearly one of tremendous economic upheaval, with comparatively high unemployment and downward pressure on wages. Thus, these labor market data are unlikely to capture the conditions that these prematurely deceased workers would have faced in the years to come.

Economic Growth Calculation

Given the difficulties involved in estimating the cost of the Russian mortality crisis using the human capital method, we explore an alternative approach to this problem. In particular, we use a standard neoclassical growth model to estimate the impact of the demographic shock on the rate of economic growth. As the absence of appropriate data do not permit estimation of the parameters of a Russia-specific growth model, we use instead the estimates from a cross-sectional analysis of 78 other countries to evaluate the average contribution of changing life expectancy and age structures to economic growth. We use the resulting estimates to evaluate the impact of Russia's mortality crisis on economic growth.

This approach avoids the major theoretical problems associated with the COI method. It also takes natural account of two of the three major aspects of Russia's mortality crisis: the size of the crisis, and its impact on the composition of Russia's population. It does not, however, incorporate the differential gender impact of the crisis. Although it is in principle possible to use this approach to account for gender differentials in the mortality crisis, the high correlation between growth rates of male and female populations rules this out in practice.

The empirical growth model we use is based on the standard Ramsey growth model, which assumes a Cobb-Douglas production function with constant returns to scale and diminishing marginal returns to each input. The savings rate is determined by consumers who maximize utility over an infinite horizon subject to a budget constraint. The estimation equation derived from this model is similar to that used elsewhere in the empirical literature on economic growth.[17] Following the Asian Development Bank (1997), we assume that the steady state growth rate is determined by the following variables: schooling, natural resource abundance, government savings, trade policy, quality of institutions, and geography. Recognizing the importance of a population's health status for its productivity and for incentives to invest in human capital, the regression specifications also include life expectancy.

The Ramsey model assumes, however, that the population of the economy consists entirely of workers. Bloom and Williamson (1998) highlight the importance of the non-working segment of the population, which has a direct influence on income per capita, the usual dependent variable in a model of economic growth. As the incidence of the Russian mortality crisis falls disproportionately on the working age population, the change in the dependency ratio caused by the crisis could have a significant effect on the rate of economic growth. We therefore adopt the Bloom and Williamson modification of the standard model to incorporate the growth rate of both the economically active population and the total population. However, we also allow for possible differences in the contribution of different age groups (that is, those aged 15-44 and 45-60) to economic growth. This may be important in the Russian context, as the estimated age patterns of premature mortality show that the crisis affects different age groups within the working ages differently. The derivation of this model is described in the appendix.

Table 3 reports ordinary least squares estimates of the empirical growth model. The premature mortality in Russia affects four of the variables assumed to affect economic growth in this empirical exercise: life expectancy, population growth, and growth in the two components of the working age population. The fall in life expectancy lowers the steady state level of income per capita, and therefore reduces current growth. Changes in the growth rate of the population and the growth rate of the working age population affect income growth rates through their impacts on the dependency ratio, and possibly directly as well, for example, through their effect on the capital-to-labor ratio or on incentives to adopt new technologies. As previously mentioned, we estimate the effect of the growth of the population aged 15-45 separately from the growth of the population aged 45-60. We use the coefficients of these four variables to estimate the overall effect of changes in life expectancy, population growth, and growth of the working age population on the Russian economy.[18] The results are shown in table 4.

The results in table 4 may be interpreted as follows. Assume two countries, A and B, that are identical in terms of all the determinants of economic growth noted earlier except for initial life expectancy, the growth rate of the total population, and the growth rate of the economically active population (disaggregated). Assume further that country A exhibits Russia's pre-crisis demographic characteristics, while country B exhibits Russia's post-crisis demographic characteristics. Based on the regression estimates, country A's income per capita could be expected to grow, on average, 0.31 percent faster per year than country B. This differential may also be interpreted as an estimate of the impact of the mortality crisis on Russia's economic growth. As Russia's average annual growth rate of GDP per capita was minus 9 percent during 1990-95, the Russian mortality crisis does not seem to be a significant contributor to Russia's dramatic macroeconomic downturn.

Discussion

The COI and the economic growth analyses reported here endeavor to explore the macroeconomic dimensions of the Russian mortality crisis in terms of forgone income and economic growth. There are however, two other potential economy-wide effects of the crisis that deserve mention: income inequality and the fiscal health of the pension system. Since the transition to a market economy began in Russia in the early 1990s, wage inequality has nearly doubled,[19] and from 1991 to 1996 the Gini coefficient rose from 0.260 to 0.375.[20] Shkolnikov (1997a) finds some evidence that the less educated are bearing a disproportionate share of the burden of excess mortality. As less educated members of society generally earn lower wages, the crisis may have contributed to increased income inequality. However, individual- and family-level data for several years bracketing the crisis are necessary to estimate the magnitude of this contribution. Nevertheless, to the extent that the excess deaths are disproportionately concentrated among less educated and low-income individuals, the forgone income estimates reported earlier will tend to overestimate the true amount of lost income.

With respect to the Russian pension system, the mortality crisis may actually convey a perverse benefit. Russia's pension system is currently structured as an unfunded, pay-as you-go system, for which current workers are taxed to pay for social security for present retirees. A high elderly dependency ratio places a high tax burden on workers, thereby reducing consumption and savings and creating distortions within the labor market.[21] The elderly dependency ratio in Russia in 1995 was 0.352. While this ratio is expected to improve modestly over the next few years, it is predicted to rise rapidly after 2005. A long-term demographic implication of the crisis is a decline in the relative number of elderly dependents. Middle scenario demographic projections reported by Ivanov (forthcoming) suggest that the elderly dependency ratio would have been 0.546 in 2025 in the absence of the crisis. Taking into account the effects of the crisis, the ratio will instead be 0.499. If Russia continues with its current pension system, the reduced tax burden on workers may have beneficial effects on Russia's economic growth rate. However, the impact of the crisis on elderly dependency ratios will not be significant until after the year 2010.[22]

Modeling the Impact of the Russian Mortality Crisis

It is well known that improvements in per capita incomes have the effect of improving standards of health in a country.[23] As health functions as a normal consumption good, it is natural that increases in income lead to greater expenditures on health care. The high correlation of income and health status throughout the world is consistent with this view.

A literature on the reverse relationship - namely, the effects of health status on economic growth - is now also emerging.[24] Improvements in health are assumed to improve the productivity of workers and to reduce morbidity-related absenteeism. Improvements in life expectancy also increase the returns to investment in human capital, and will therefore increase the incentives to invest in education.[25] This literature therefore focuses on health as an investment good. The results in table 3 provide empirical support for the hypothesis that improvements in health are an important contributor to economic growth, as the coefficients on life expectancy in this growth equation are large, positive, and significant. The strong empirical evidence from the analyses of the one-way relationships between health and growth suggest the need for modeling the reciprocal relationship between these factors.

The standard neoclassical approach to modeling the interaction between health and growth (for instance Barro and Barro 1996; Meltzer 1995) treats growth as a factor of production, much like physical capital, in a standard Cobb-Douglas constant returns to scale model. However, the dual nature of health as both a consumption good and an investment good suggests that health may, in reality, function quite differently than capital in the growth process.

Perhaps the simplest indication that health inputs have a non-standard relationship to output is that they display traits that, when modeled in the absence of other factors, indicate increasing returns to scale. One instance of this phenomenon is already well known. In the theory of nutrition-based efficiency wages, the production function for a subsistence worker is posited to be an increasing function of health, with increasing and then decreasing returns to nutrition. Other evidence suggests that increasing returns to health might be possible at higher levels of the health/wage spectrum as well. For example, it is well known that a country's early investments in health care tend to go towards improving infant and child health. It is generally only later that further resources are allocated more toward adult health, which will have a direct effect on labor force productivity.

If there are, in fact, increasing returns to health in a nation's production function, the interaction between health and growth will provide the opportunity for endogenous growth, where improvements in either one will bring about improvements in the other, resulting in a spiral of improving growth and health. In this situation, however, a negative shock such as the Russian mortality crisis has the potential to push health below a critical point into a vicious cycle, where declining health leads to a decline in output, which further contributes to declining health.[26] This "poverty trap" scenario is plausible if the decline in health status affects the productive capacity of the workforce enough to depress output. The economy thereby gets trapped in a low output–low health equilibrium. This is borne out to some extent by the Russian example, where a decline in income was followed by a decline in health, which the foregoing calculations suggest may have had a further negative (albeit modest) effect on income and economic growth rates.

Note, however, that richer frameworks, which include the interactions between health and physical capital, might generate a different set of implications. In non-market economies, such as Russia under the Soviet system or Cuba today, investments in physical or human capital (namely, health and education) are determined by a centralized planning board that is often unresponsive to the relative rates of return to these investments. If such countries "over-invest" in health, the marginal returns to these investments may be significantly lower than to investments in physical capital. Such an economy, when opened to market forces, can expect to see a shift from health capital toward physical capital. Viewed from such a perspective, the Russian mortality crisis can, in fact, be seen as a natural outcome of the shift to a market economy, with an "efficient" allocation of resources. This may explain the decline in health expenditure from 6 percent of GDP in the late 1960s and early 1970s to under 3 percent in 1992.[27] Anecdotal evidence also points to the direct conversion of health capital to physical capital. For example, Field (1995) points out that the response time of the Russian emergency medical service, once well known for its efficiency, deteriorated from minutes to several hours, because many ambulances now double as taxi-cabs.

In evaluating whether the shift of resources within Russia's economy is a natural adjustment to a market system or a dangerous regression into a downward spiral of declining health and growth, it is useful to compare Russia's life expectancy with that of other countries. Figure 2 plots the relationship between real GDP per capita and life expectancy for 88 countries as of 1993. The figure indicates that Russia's life expectancy falls noticeably below the level expected for a country with its level of GDP per capita.

In sum, it is clear that there is wide scope for further conceptual and empirical work on the relationship between health and economic growth. Such work will perhaps shed some light on Russia's mortality crisis and also further our understanding of a fundamental issue in social and economic development.[28]

APPENDIX

The standard cross country growth regression (for example, see Barro and Lee 1994 or Mankiw, Romer, and Weil 1992) is based on a Ramsey growth model that assumes a constant returns to scale Cobb-Douglas production function:

$$Y = AK^{a} L^{1-a}$$

The empirical model assumes that the growth rate of income per worker for each country is proportional to the ratio of the log of income per worker in the steady state to the log of income per worker in the initial period:

$$d\log(\frac{Y}{L}) = b[\log(\frac{Y}{L})_{SteadyState} - \log(\frac{Y}{L})_{Initial}]$$

This standard approach assumes that every member of the population is a worker, and does not incorporate the effects of changes in the age structure of a population. In order to incorporate these effects, Asian Development Bank (1997) and Bloom and Williamson (1998) convert the dependent variable in the growth equation above into output per person, Y/N, instead of output per worker, using the following adjustment:

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{N} = y\frac{L}{N}$$

which implies:

$$\frac{d}{dt}\tilde{y} = \dot{y} + \dot{L} - \dot{N}$$

or:

$$g_y = g_y + g_{workers} - g_{population}$$

where g represents the growth rate.

We make a further adjustment in this paper. As 65 percent of the excess deaths among the working ages occurred among people between the ages of 45 and 60, we adjust the growth model to allow for a differential effect of labor growth in each of these categories. We do so by expressing the standard Cobb-Douglas production function in terms of effective labor L_e as follows:

$$Y = AK^a L_e^{1-a}$$

$$L_e = L_y^{g_y} L_o^{g_o}$$

where L_y represents younger workers and L_o represents older workers. We estimate two specifications of this growth model. The first specification constrains the coefficients on L_y and L_o to sum to unity. Imposing this constraint forces the model to exhibit a natural homogeneity, that is, doubling the number of young and older workers leads to a doubling of the number of effective workers. The second specification does not impose this constraint. As the variable representing initial income is now income per unit of effective labor, L_e, its value varies depending on the value of L_e, which is itself dependent on γ_y and γ_o. We use an iterative estimation procedure to account for this non-linearity in the regression model.

This procedure for estimating the contribution to economic growth of components of the labor force differentiated by age can be extended to account for other sources of labor force heterogeneity as well, such as gender, schooling, race, and marital status.

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Figure 1. The Effect of a Shift in the Supply Curve of Labor.

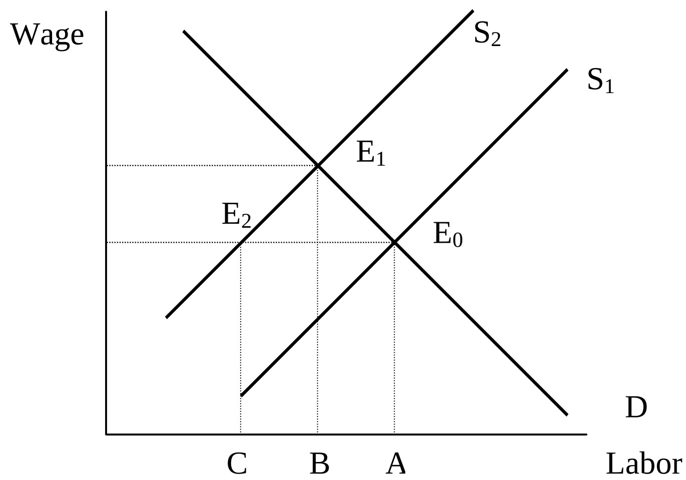

Figure 2. Life Expectancy and GDP Per Capita, Selected Countries. 1993.

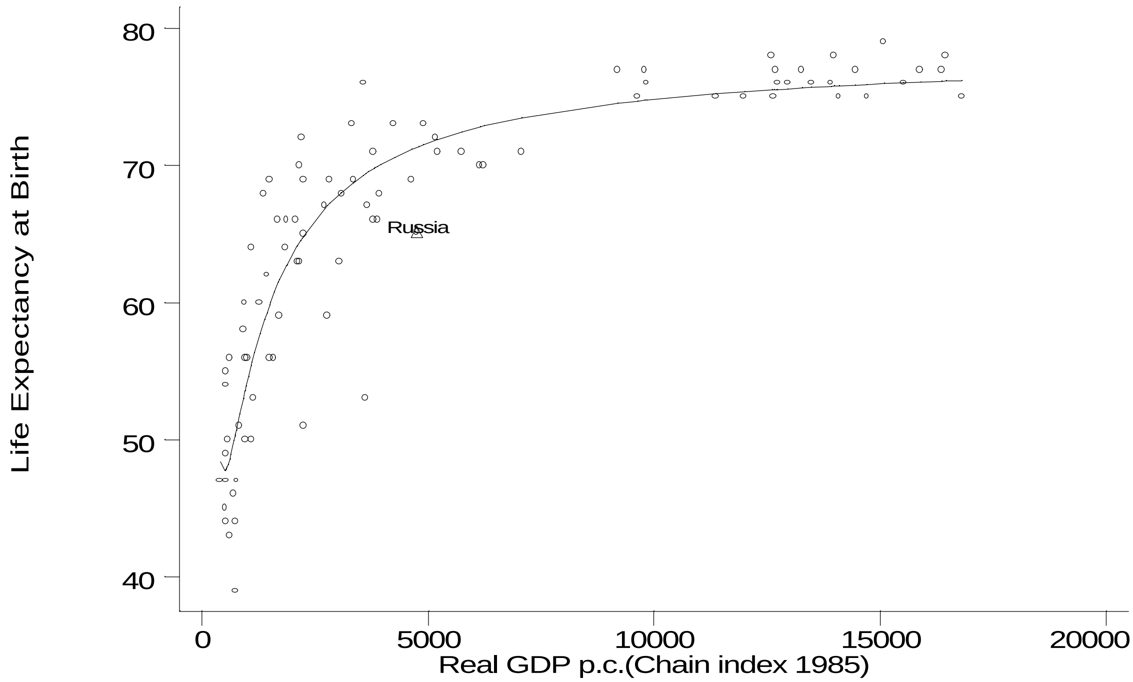

Table 1. Excess Mortality and its Impact on Population Growth Rates in Russia 1990-1995

	Population Growth Rates (in percent)		*Excess Mortality (in thousands)*
	Actual	***Without Crisis***	
Total	0.08	0.25	1,568.5
Working Age	0.11	0.29	895.2
Below 20	-0.81	-0.80	29.1
60+	1.58	2.01	644.3
Male Total	0.15	0.39	999.6
Working Age	0.13	0.42	691.3
Below 20	-0.80	-0.79	17.6
60+	2.97	3.54	290.7
Female Total	0.01	0.13	568.9
Working Age	0.08	0.16	203.9
Below 20	-0.82	-0.81	11.4
60+	0.93	1.28	353.6

Table 2. Forgone Income due to Excess Mortality as a Percentage of GDP

Discount Rate (percent)	Forgone Income as a Percentage of 1990 GDP	Forgone Income as a Percentage of 1995 GDP
4	2.7	4.7
10	1.8	3.0

Table 3. OLS Estimates of the Effect of Population Growth on Economic Growth, 1965-90

Dependent Variable: Growth rate of real GDP per capita, 1965-90

Independent Variable	Constrained Regression	Unconstrained Regression
Log of Life Expectancy, 1960	**2.37 (1.07)**	**0.46 (1.14)**
GPOP	**-.56 (.18)**	**-1.58 (.58)**
GEAP, ages 15 to 45	**.46 (.19)**	**1.19 (.40)**
GEAP ages 45 to 60	**.54 (.19)**	**.79 (.28)**
Log of GDP, 1965	-1.58 (.27)	-0.36 (.12)
Log Years of Secondary Schooling, 1965	.44 (.18)	0.06 (.20)
Natural Resource Abundance	-3.40 (1.42)	-0.74 (1.65)
Openness	1.55 (.47)	1.95 (.50)
Quality of Institutions	.15 (.09)	0.03 (.09)
Access to ports (landlocked)	-.55 (.34)	-0.16 (.38)
Average Government Savings	.15 (.03)	.14 (.03)
Located in the Tropics	-1.13 (.39)	-1.12 (.44)
Ratio of Coastline Distance to Land Area	.26 (.15)	.43 (.17)
Constant	-5.29 (4.15)	0.18 (4.87)

Note: Sample includes 77 countries. Standard errors reported in parentheses.

Table 4. The Effect of the Change in Demographic Variables on Economic Growth.

Variable	Regression Coefficient (from Table 3, Column 1)	Change in Demographic Variable in Russia 1989-1995	Effect on Economic Growth (in percent)
Log of Life Expectancy	2.37	-0.08	-0.19
Growth in Total Population	-0.56	-0.17	0.10
Growth in Economically Active Population Aged 15 to 45	0.46	-0.11	-0.05
Growth in Economically Active Population Aged 45 to 60	0.54	-0.32	-0.17
Total			**-0.31**

[1] Life expectancy improved somewhat between 1995 and 1997, with a rise of 2.5 years among males and 2.0 years among females.

[2] Brainerd (1996).

[3] Data on age-specific death rates and population by age-group are taken from Avdeev and Monnier (1996) and Goskomstat (1996b).

[4] The estimated trend does not incorporate data from 1986-89, as the fluctuations in life expectancy during this period do not appear characteristic of the Russian experience, and have been attributed to specific policy initiatives, namely, the implementation and subsequent cessation of Gorbachev's anti-alcohol campaign.

[5] These estimates will be slightly inaccurate because the observed age structure in each year from 1991 to 1995 will incorporate the effects of that part of the crisis that has already occurred. However, our rough calculations suggest that this source of bias is extremely small.

[6] Shkolnikov (1997) calculates 1.3 million excess deaths between 1989 and 1994, while Shkolnikov, Cornia, Leon, and Mesle (1998) calculate 2.1 million excess deaths between 1992 and 1995. Vishnevsky and Shkolnikov (1997) report a significantly higher estimate of 3.1 million excess deaths among males alone between 1991 and 1995.

[7] Brainerd 1996.

[8] The cost of illness calculation procedures have bifurcated into two alternative approaches that are often referred to as the willingness to pay approach and the human capital method. Willingness to pay calculations attempt to deduce (by survey or revealed preference) the monetary value that individuals place on incremental variations in their risk of illness, harm, or death. These methods are most relevant in situations characterized by choice (for example, at

what price are air-bags demanded). In the case of the Russian mortality crisis, the etiology appears to be complex, with numerous facets lacking obvious components of decisionmaking. Furthermore, the willingness to pay method may be even further confounded by such causes of death as suicide, where decisionmaking takes on a central role. For these reasons, the most logical choice to calculate the cost of illness associated with the excess mortality appears to be the human capital method, which we pursue in this section.

[9] This calculation is based on wage data from a household survey conducted by the All-Russian Center for Public Opinion Research in Moscow in May 1991. We convert these wages to 1990 rubles using the May 1991 consumer price index. Data on labor force participation rates are taken from Goskomstat's labor force survey. We assume an absolute retirement age of 74; however, the fact that in Russia most women retire at the age of 55 and most men at the age of 60 is taken into account by the sudden decline in labor force participation rates after these ages.

[10] GDP data are taken from World Development Indicators (1997). In order to express these values as a percentage of 1995 GDP, they were converted to 1995 rubles using the consumer price index.

[11] Cornia and Paniccia (1995, pg. 39).

[12] See RLMS data.

[13] There is however, a discussion in Rice (1966), on the incorporation of the value of housework into this calculation.

[14] Hodgson and Meiners (1982).

[15] For a more complete discussion of these issues, and some formulae that may be used to convert estimated lost income to lost output, see Bloom and Mahal (1993).

[16] See, for example, Iversen, Andersen, Andersen, Christoffersen, and Keiding (1987); Morris and Cook (1991); Moser, Goldblatt, Fox, and Jones (1990).

[17]For example, Barro and Lee (1994); Barro and Sala-i-Martin (1995); Mankiw, Romer, and Weil (1992); Sachs and Warner (1995).

[18] As life expectancy enters the regression as an initial condition intended to capture the effects of health status, we look at how much life expectancy changed from 1989 to 1995, assuming that this indicates how much the initial condition has been lowered as a result of the crisis.

[19] Brainerd (1996).

[20] Russian Economic Trends (1997).

[21] The current social security tax of 28 percent being levied on Russian employers is already believed to be creating significant distortions within the system.

[22] See Ivanov (forthcoming) for a numerical evaluation of the effects of the crisis on the Russian pension system.

[23] Pritchett and Summers (1996, pg. 843) find that "wealthier nations are healthier nations." Using an instrumental variables approach to account for possible reverse causation, they find that the pure income effect on health is significant.

[24] Asian Development Bank (1997); Barro and Barro (1996); Meltzer (1995).

[25] Incentives for direct foreign investment might also be expected to increase with improvements in health.

[26] This is consistent with the literature on poverty traps. See, for example, Lewis (1954) or Murphy, Shleifer, and Vishny (1989).

[27] Field (1995).

[28] A further analysis of the macroeconomic relationship between health status and economic growth can be found in Bloom and Malaney (forthcoming). For a discussion of the microeconomic relationship see Strauss and Thomas (forthcoming).