ECONOMIC RETURNS OF DISABILITY REDUCTION IN AGEING SOCIETIES: EVIDENCE FROM JAPAN AND THE PHILIPPINES

Michael R.M. Abrigo, Rikiya Matsukura, Naohiro Ogawa, and Yasuyuki Sawada

Abstract

As populations age globally, the economic implications of non-fatal health conditions become increasingly important for policy planning. While research has established links between mortality improvements and economic growth, the macroeconomic impact of reducing disability burden remains poorly quantified. This study examines how changes in years lived with disability (YLD) contributed to economic growth in Japan and the Philippines, representing different stages of demographic transition, and assesses the vulnerability of these gains to health system shocks. We analyzed cause-specific and all-cause YLD rates from the 2021 Global Burden of Disease Study for populations aged 15-79 years from 1990 to 2021. Temporal trends across 22 disease categories were isolated using age-period decomposition. We combined health data with National Transfer Accounts age-specific labor income estimates in an extended growth accounting framework to quantify how morbidity and mortality changes affected labor income per capita through productivity and support ratio channels. Musculoskeletal and mental disorders dominated disability burden in both countries throughout the study period. Age-adjusted YLD rates declined substantially through 2019, driven by reductions in injuries and communicable diseases, despite increased burden from diabetes, neoplasms, and maternal-neonatal conditions. Declining YLD rates increased labor productivity by 35.1% in the Philippines and 20.1% in Japan since 1990. Despite partial offsetting from reduced support ratios due to population ageing, net health improvements contributed 34.2% and 4.0% increases in labor income per capita, respectively. The COVID-19 pandemic reversed these gains, causing productivity setbacks equivalent to 10-20 years of progress. Investments in disability reduction yield substantial economic returns beyond traditional longevity gains, with implications for health policy prioritization in ageing societies. The dramatic pandemic reversals highlight the fragility of health-dependent economic progress and emphasize the need for resilient health systems capable of managing chronic disease burdens and emerging health threats.

JEL Codes: I15, I18, J11, J24, O47

No external funding was received for this research, and the author(s) have no relevant or material financial relationships to disclose under the NBER policy.

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1. Introduction

Over the past three decades, population health in many countries has undergone substantial transformation, marked by declining mortality, rising life expectancy, and shifting disease burdens from communicable to non-communicable conditions. While these epidemiological transitions have contributed to improved survival and longevity, they have also led to an increasing share of the health burden attributable to morbidity, particularly in the form of chronic disability. Years lived with disability (YLD), a component of the disability-adjusted life year metric, provides a vital lens through which to assess the non-fatal health burden across populations and time. Yet the economic implications of these morbidity trends remain poorly quantified, particularly their effects on labor productivity and income per capita.

Understanding the implications of morbidity trends is particularly important in countries undergoing rapid demographic and epidemiological change. Japan, with one of the world's most aged populations, has experienced a long-standing transition toward chronic disease and degenerative conditions. In contrast, the Philippines remains in an earlier stage of the demographic transition, grappling with a dual burden of persistent communicable disease and emerging non-communicable conditions. How these different patterns of disease and disability influence macroeconomic performance, particularly through impacts on labor productivity and economic support ratios, remains an open empirical question.

Recent literature has established robust links between health improvements and economic growth, though much of this work focuses on mortality-based indicators. Seminal contributions by Bloom, Canning, and Sevilla (2004) and Weil (2007) demonstrate that improvements in life expectancy can generate substantial gains in labor productivity and per capita income through multiple channels, including increased labor supply, human capital accumulation, and savings. However, these analyses typically use aggregate measures of population health such as life expectancy at birth, which primarily reflect mortality rather than morbidity patterns. Acemoglu and Johnson (2007) use cross-country variation in mortality improvements driven by global health interventions to estimate the causal effect of life expectancy on income per capita. Somewhat surprisingly, they find that while life expectancy gains led to substantial population growth, the effects on income per capita were limited or even negative in the short to medium run. This finding highlights the importance of distinguishing between different dimensions of population health and their potentially divergent effects on economic outcomes.

The demographic dividend literature has emphasized the role of changing age structures in driving economic growth. Lee and Mason (2010) distinguish between the "first demographic dividend," arising mechanically from a favorable ratio of workers to dependents as fertility declines, and the "second demographic dividend," resulting from increased savings and capital accumulation as populations age. Mason et al. (2017) document how these demographic dividends have contributed substantially to economic growth across Asia over the past half-century. Mason, Lee, and Jiang (2016) extend this framework to incorporate human capital accumulation alongside savings behavior, showing that improvements in education and health can amplify the economic benefits of favorable demographic change. More recently, Ogawa et al. (2021) identify a "third demographic dividend" or "silver dividend" arising from increased

labor force participation and productivity among the elderly population. Yet this framework has not been systematically extended to incorporate the effects of disability reduction on labor productivity.

The specific contribution of disability reduction to productivity growth remains understudied. This gap is particularly relevant in rapidly aging societies, where chronic disease management and disability prevention may yield substantial economic returns even as longevity gains plateau. Moreover, temporal trends in YLD are shaped by complex age, period, and cohort dynamics that are not easily captured in standard cross-country growth regressions. Disentangling these effects is critical for both health system planning and economic policymaking.

In this study, we provide a comparative assessment of trends in YLD in Japan and the Philippines from 1990 to 2021, using age-period decomposition methods to isolate temporal patterns in disease burden across 22 major causes. We further quantify the contribution of changes in morbidity and longevity to labor income per capita using an extended economic growth decomposition framework developed by Mason, Lee, and Jiang (2016). By separately characterizing trends in disability burden and quantifying their macroeconomic implications, we aim to better understand how evolving patterns of morbidity contribute to changes in labor income in two countries at different stages of demographic and epidemiological transitions.

Our analysis yields several key findings. First, musculoskeletal and mental disorders dominated disability burden in both countries throughout the study period. Age-adjusted YLD rates declined substantially through 2019, driven by reductions in injuries and communicable diseases, despite increased burden from diabetes, neoplasms, and maternal-neonatal conditions. Second, declining YLD rates increased labor productivity by 35.1% in the Philippines and 20.1% in Japan since 1990. Despite partial offsetting from reduced support ratios due to population aging, net health improvements contributed 34.2% and 15.4% increases in labor income per capita, respectively. Third, the COVID-19 pandemic reversed these gains dramatically, causing productivity setbacks equivalent to 10-20 years of progress. These findings highlight both the substantial economic returns to disability reduction and the fragility of health-dependent economic gains.

Our work makes several contributions to the literature. First, we provide the first joint analysis of cause-specific disability trends and their macroeconomic consequences in countries at different stages of demographic transition. Second, we demonstrate that investments in disability reduction yield substantial economic returns beyond traditional longevity gains, with important implications for health policy prioritization. Third, we document how major health system shocks can rapidly reverse decades of accumulated health capital, with profound implications for long-run economic growth. Finally, our comparative analysis of Japan and the Philippines illustrates how the economic returns to health improvements vary systematically with a country's stage of demographic and epidemiological transition.

The remainder of this paper proceeds as follows. In Section 2, we present our conceptual framework, extending standard growth accounting to incorporate health capital measured by YLD. This is followed in Section 3 with a description of our data sources and econometric methods, including the age-period decomposition and growth accounting frameworks. In Section 4, we present our main results on disability trends, the economic returns to health improvements, and pandemic impacts. In the last section, Section 5, we conclude with a

discussion of policy implications of our findings, compare our results to previous literature, and consider limitations.

2. Conceptual Framework

This section presents our analytical framework for quantifying the contribution of disability reduction to labor income growth. We extend standard growth accounting methods to incorporate health capital, measured through years lived with disability (YLD), alongside the demographic effects captured by changing age structures. Our framework follows Mason, Lee, and Jiang (2016) in decomposing income growth into productivity and demographic components, while introducing YLD as a direct measure of population health capital.

2.1. Standard growth accounting

Our starting point is a standard growth accounting decomposition that separates changes in economic well-being into demographic and productivity components. This approach, rooted in the National Transfer Accounts (NTA) framework, recognizes that income per capita can grow either because the ratio of workers to consumers improves, i.e., a pure demographic effect, or because workers become more productive, i.e., through behavioral or technological shifts. By explicitly modeling both channels, we can isolate the contribution of health improvements, measured through disability reduction, from the mechanical effects of changing population age structures.

Consider the following decomposition of labor income per effective consumer, YL/N, into the product of labor income per effective worker, YL/L, and the support ratio, L/N:

$$\frac{YL}{N} = \left(\frac{YL}{L}\right) \times \left(\frac{L}{N}\right)$$

where YL represents aggregate labor income, L is the effective number of workers, and N is the effective number of consumers. The effective number of consumers is calculated as the sum of the age-specific population $P(a,t)$ in period t weighted by a fixed age profile, $w_C(a)$, that accounts for age-specific variations in consumption patterns:

$$N = \sum_a w_c(a) \cdot P(a,t)$$

Following the National Transfer Accounts convention, we set $w_C(a)$ as the ratio of age-specific per capita consumption relative to the simple average of per capita consumption for ages 30 to 49, which we designate as prime-age adults. The effective number of workers, L, is calculated similarly, but using a fixed age profile, $w_L(a)$, that captures age differences in labor force participation, hours worked, and productivity:

$$L = \sum_a w_L(a) \cdot P(a,t)$$

The aggregate labor income is calculated as the sum of age-specific aggregate labor income, $YL(a,t) = yl(a,t) \cdot P(a,t)$, where $yl(a,t)$ is the age-specific NTA labor income per person.

Taking growth rates, we can approximate the growth in labor income per effective consumer as the sum of the growth rates of labor productivity and of the support ratio:

$$g\left(\frac{YL}{N}\right) \approx g\left(\frac{YL}{L}\right) + g\left(\frac{L}{N}\right)$$

where $g(\cdot)$ is the growth rate operator. This decomposition allows us to conceptually isolate the contribution of demographic change, captured by the growth in support ratio (commonly known as the "first demographic dividend"), from that due to human capital operating through labor productivity growth.

Labor productivity growth can operate through two distinct channels: the intensive margin (labor income per worker) and the extensive margin (labor force participation). For example, human capital improvements may increase how much workers earn per unit of time worked (productivity per worker) and may also affect decisions to participate in the labor force. These channels may reinforce or offset each other depending on institutional factors, labor market conditions, and social norms. While such decompositions can be performed and have been undertaken in related work, for our purposes it suffices to recognize that human capital operates through both margins in affecting aggregate labor productivity.

2.2. Health and education as determinants of labor productivity

The demographic transition affects labor income per capita through two offsetting forces. During the early transition phase, declining fertility creates a favorable age structure. Fewer children relative to working-age adults means the effective number of workers grows faster than the effective number of consumers, generating $g(L/N) > 0$. This positive support ratio effect, commonly referred to as the first demographic dividend, occurs mechanically as age structure shifts, holding fixed the age patterns of consumption and productivity.

As the transition matures, however, this demographic dividend eventually becomes a drag. Lower fertility combined with rising longevity produces population aging, increasing the number of elderly consumers relative to workers. The support ratio then declines, $g(L/N) < 0$, placing downward pressure on income per capita. This demographic headwind motivates the search for alternative growth drivers.

One such driver is human capital accumulation. Demographic transitions often coincide with investments in health and education, raising productivity per worker. This mechanism, which has been explored by Lee and Mason (2010) as part of the second demographic dividend, can offset or even reverse the negative effects of population aging. While the second dividend framework also emphasizes savings-driven capital deepening, we focus here specifically on human capital's role in raising labor productivity.

To formalize the relationship between human capital and labor income, we specify an earnings function:

$$\ln yl(a,t) = \beta_s \cdot s(a,t) + \beta_h \cdot h(a,t) + \mu_a + \mu_c + \varepsilon(a,t)$$

where s is the average years of schooling, h is the effective share of healthy population (calculated as the complement of the age-specific YLD rate per population), and ε is the model residual with the usual stochastic properties to allow unbiased estimation. Instead of including a quadratic function of age, as in the standard Mincerian equation, we include age-fixed effects, μ_a, to account for time-invariant factors that may influence specific age groups (e.g., mandatory retirement age), as well as generation-fixed effects, μ_c, to capture the contribution of common experiences, living conditions, and other shocks that may be shared within a generation.

The parameters β_s and β_h capture the marginal returns to human capital; specifically, the growth in labor income per capita from expansions in average years of schooling and in the share of the healthy population, respectively. These parameters represent semi-elasticities, wherein β_s gives the percentage change in labor income per capita for each additional year of schooling, while β_h gives the percentage change for each percentage point increase in the healthy population share.

Based on our earnings function, assuming parameter homogeneity across time, we may derive the expected aggregate labor income in any period t in response to changes in the average years of schooling and in the effective share of healthy population as:

$$E[YL|\Delta s, \Delta h] \approx \sum_a E[yl(a,t_0) \cdot \exp(\beta_s \cdot \Delta s(a,t) + \beta_h \cdot \Delta h(a,t))] \cdot P(a,t)$$

where the marginal returns to human capital are replaced by estimates from a regression model fitted to country-specific data, and Δ is a difference operator for variables in period t relative to some base year t_0. This expression closely resembles the endowment effect in Oaxaca-Blinder decompositions, where differences in human capital endowments over time are weighted by parameter estimates in a pooled regression model.

By comparing the predicted labor income under observed changes in health and education to a counterfactual scenario where these remain at baseline levels, we can quantify the contribution of human capital expansion to labor productivity growth. The growth in labor income per effective consumer can then be decomposed as:

$$g\left(\frac{YL}{N}\right) \approx g\left(\frac{YL}{L}|\Delta h\right) + g\left(\frac{YL}{L}|\Delta s\right) + g\left(\frac{L}{N}\right)$$

where the first two terms capture productivity growth attributable to health and education improvements, respectively, and the third term captures the demographic dividend (or drag) from changing age structures.

2.3. Role of fertility, mortality and momentum in aggregate growth

The support ratio growth $g(L/N)$ captures the net effect of all demographic forces on the balance between effective workers and consumers. To understand which specific demographic mechanism drives these changes, we conceptualize the support ratio as responding to three distinct forces, namely, fertility, mortality, and population momentum.

Fertility directly affects the support ratio by altering the relative size of younger (dependent) versus working-age cohorts. In the early stages of demographic transition, declining fertility reduces the child dependency ratio, mechanically increasing the support ratio, i.e., the classic first demographic dividend. This effect operates with a lag, as reduced birth cohorts typically take 15-20 years to fully translate into a higher ratio of workers to dependents.

Mortality affects the support ratio primarily through its impact on the elderly population. Improvements in adult and old-age mortality extend life expectancy, increasing the number of elderly consumers relative to workers. While such longevity gains are socially desirable and contribute to welfare, they can exert downward pressure on the support ratio in mature demographic transitions. The magnitude of this effect depends on the age pattern of mortality decline. Reductions in working-age mortality may even increase the support ratio, while reductions in old-age mortality generally decrease it.

Population momentum captures the continued evolution of age structure due to the lagged effects of past demographic change, even when current vital rates remain constant. For example, a country that recently experienced rapid fertility decline will continue to see its age structure shift toward older ages for decades, as small birth cohorts replace larger cohorts at older ages. This momentum operates independently of current fertility and mortality levels and can be either positive or negative depending on the historical trajectory of vital rates.

By constructing counterfactual population structures that isolate each of these forces, we can decompose support ratio growth as:

$$g\left(\frac{L}{N}\right) = g\left(\frac{L}{N}|\Delta f\right) + g\left(\frac{L}{N}|\Delta m\right) + g\left(\frac{L}{N}|f_0, m_0\right)$$

where m and f refer to age-specific mortality and fertility rates, respectively.

This decomposition reveals how different demographic mechanisms contribute to the economic support ratio. In countries experiencing rapid fertility decline (such as the Philippines in recent decades), the fertility component dominates support ratio growth. In countries with mature demographic transitions (such as Japan), mortality improvements that extend life at older ages reduce the support ratio, even as they increase overall welfare. Momentum effects can persist for decades and may amplify or dampen the effects of current demographic change.

The complete decomposition of labor income per effective consumer growth thus incorporates both human capital and demographic components:

$$g\left(\frac{YL}{N}\right) \approx g\left(\frac{YL}{L}|\Delta h\right) + g\left(\frac{YL}{L}|\Delta s\right) + g\left(\frac{L}{N}|\Delta f\right) + g\left(\frac{L}{N}|\Delta m\right) + g\left(\frac{L}{N}|f_0, m_0\right)$$

This framework allows us to quantify not only the total contribution of demographic change to income growth, but also to identify the specific demographic mechanisms at work and how they interact with human capital accumulation.

2.4. Comprehensive health accounting

Our analytical framework makes three key contributions. First, it distinguishes between the productivity and demographic channels through which population health affects economic

outcomes. Improvements in health, measured by reductions in YLD, directly increase labor productivity by enabling healthier workers to earn more per unit of time worked. This operates through the $g(YL/L|\Delta h)$ term.

Second, the framework recognizes that health also affects economic outcomes through mortality, which alters the population age structure and thus the support ratio. While morbidity affects productivity, mortality affects demography. Declining mortality at working ages increases the support ratio, while declining mortality at older ages decreases it. These effects operate through the $g(L/N|\Delta m)$ term.

Third, by separately identifying these channels, our framework provides a more complete accounting of how population health contributes to economic growth than studies focusing solely on mortality-based indicators or solely on productivity effects. We can now quantify both the direct productivity gains from disability reduction and the indirect demographic effects of changing mortality patterns. This allows for a more nuanced assessment of health investments. For example, interventions that reduce disability at working ages may generate larger economic returns than interventions that primarily extend life at older ages, even if both improve overall population welfare.

That said, our framework does not capture all dimensions of health's economic impact. We do not model the second demographic dividend (savings effects), consumption benefits of improved health, or the welfare value of increased longevity beyond its income effects. We also do not account for spillover effects of health on educational investments or fertility decisions. Our framework thus provides a substantial but incomplete accounting of health's economic contributions, focusing specifically on the pathways through labor productivity and demographic structure.

The framework is particularly suited for comparing countries at different stages of demographic and epidemiological transition. In younger populations with high disability burden from communicable diseases and injuries (such as the Philippines), we expect large productivity gains from disability reduction. In older populations with low fertility and high life expectancy (such as Japan), we expect health improvements to operate more through mortality's demographic effects and through labor force participation among the elderly. The empirical analysis that follows tests these predictions.

3. Data and Methods

This section describes the data sources and analytical methods used to implement the conceptual framework presented in Section 2. We begin by describing our primary data sources, which combine health indicators from the Global Burden of Disease Study, economic life cycle estimates from the National Transfer Accounts Project, educational attainment from the Barro-Lee database, and demographic data from the United Nations. We then detail our empirical approach in three stages: first, the age-period decomposition used to isolate temporal trends in disability burden; second, the estimation of returns to health and education; and third, the growth accounting decomposition that quantifies how changes in morbidity, mortality, and human capital contributed to labor income growth in Japan and the Philippines over the past three decades.

3.1. Data sources

This study integrates data from multiple sources to construct a comprehensive picture of health trends, economic life cycles, and demographic change in Japan and the Philippines. Our primary data sources include the Global Burden of Disease (GBD) 2021 Study, the National Transfer Accounts (NTA) Project, the Barro-Lee educational attainment database, and the United Nations World Population Prospects (WPP).

We obtained annual estimates of YLD rates from the GBD 2021 Study for populations aged 15-79 years in Japan and the Philippines, covering the period 1990-2021. YLD quantifies non-fatal health burden by incorporating both the prevalence and severity of health conditions. Each condition is weighted by a disability weight ranging from 0 (perfect health) to 1 (health state equivalent to death), reflecting the magnitude of health loss. For the age-period decomposition of morbidity trends, we used cause-specific YLD rates disaggregated across 22 Level 2 GBD causes, broken down by five-year age groups. For the economic growth decomposition, we used all-cause YLD rates to construct the healthy population share, calculated as $h(a,t) = 1 - YLD(a,t)/P(a,t)$. The GBD Study provides uncertainty intervals reflecting sampling error, measurement error, and model uncertainty. To account for this uncertainty in our analysis, we performed Monte Carlo simulations by generating 1,000 draws from the distributions implied by reported means and 95% confidence intervals, assuming log-normal distributions.

Our economic life cycle data come from the National Transfer Accounts (NTA) Project, which provides standardized intergenerational accounts measuring age-specific production, consumption, and resource transfers, constructed consistently with the United Nations System of National Accounts. For Japan, NTA estimates are available for 1994 to 2019 in five-year intervals. For the Philippines, annual estimates span 1990-2019 constructed using similar methodology. We extracted age-specific labor income per capita and consumption per capita from the NTA Lifecycle Account. Labor income includes both wage income (with associated fringe benefits) and the labor share of self-employment income, net of personal taxes on workers. All NTA estimates were converted to constant 2019 PPP$ using country-specific consumer price indices and purchasing power parity conversion rates from the World Bank World Development Indicators.

Age-specific educational attainment data come from the Barro-Lee (2013) database, which provides average years of schooling by five-year age groups for populations aged 15-64, available every five years from 1950 to 2010. We extended this dataset to 2020 and ages 75-79 using cohort-based tracking for ages 30+ (assuming that individuals do not acquire additional schooling after age 29) and linear extrapolation for ages 15-29. We linearly interpolated between five-year intervals to generate an annual series by age group.

Finally, we obtained annual population estimates by single-year age groups, along with age-specific fertility and mortality rates, from the 2024 revision of the United Nations World Population Prospects. These data were used to construct the counterfactual population structures described in Section 2.3.

3.2. Age-period decomposition of YLD trends

To analyze temporal trends in cause-specific YLD rates while accounting for confounding due to age structure, we estimated age-period-cohort (APC) models. The fundamental challenge in APC analysis is the identification problem: age, period, and cohort are perfectly collinear

(cohort = period - age), making it impossible to separately identify all three effects without additional constraints.

We adopted an age-period (AP) specification in which period effects capture both temporal trends and cohort-related dynamics. This choice reflects both theoretical and practical considerations. Theoretically, for our purposes the key question is whether YLD rates have been improving or worsening over calendar time, abstracting from age structure, i.e., what period effects capture. Cohort effects, while conceptually distinct, are difficult to interpret in the context of disability trends, as they would reflect the accumulated health experiences of specific birth cohorts throughout their lives. Such effects are challenging to disentangle from life course aging patterns and may be driven by unmeasured period shocks experienced at different ages.

Practically, the AP specification offers a more parsimonious and robust approach than full APC models, which require arbitrary identifying restrictions (such as constraining specific cohort effects to zero or imposing linear trends). Our AP model allows period effects to absorb both pure calendar time trends and any systematic cohort patterns, providing a conservative estimate of temporal change in disability burden.

Specifically, we estimated the following log-linear model for each country-cause pair:

$$\ln YLD_{rate}(a,t) = \alpha_a + \gamma_t + \varepsilon(a,t)$$

where α_a represents age fixed effects, γ_t represents period fixed effects, and $\varepsilon(a,t)$ is the error term. Age effects capture the average YLD rate for each age group across all years, while period effects capture deviations from these age-specific averages in each year.

We estimated separate AP models for Japan and the Philippines across the 22 Level 2 GBD causes. To aggregate results to Level 1 (broad cause groups) and Level 0 (all causes), we computed YLD-weighted averages of the estimated period effects, using 1990 as the reference year.

To account for uncertainty in the underlying GBD estimates, we performed Monte Carlo simulations. For each of the 1,000 draws from the GBD uncertainty distributions, we re-estimated the AP models by country-cause pair. Final estimates represent the mean across simulations, with 95% uncertainty intervals derived from the 2.5th and 97.5th percentiles of the simulation distribution.

3.3. Estimating returns to health and education

We estimated the earnings function specified in Section 2.2 using a two-way fixed effects model that pools observations across age groups and years within each country. The sample includes working-age populations (ages 15-79) from available NTA data: 6 time points for Japan (1994-2019, five-year intervals) and 30 for the Philippines (1990-2019, annual). This unbalanced panel reflects differences in NTA data availability. We estimate separate models for Japan and the Philippines to account for specificities between these countries.

Standard errors were clustered by age group and birth cohort to account for within-group correlation in residuals. To propagate uncertainty from the GBD estimates used to construct the healthy population share $h(a,t)$, we re-estimated the earnings function for each of the 1,000

Monte Carlo draws, yielding distributions for the estimated parameters that incorporate measurement error in the health variable.

3.4. Growth decomposition calculations

We implemented the decomposition framework from Section 2 to quantify the contribution of health, education, and demographic change to labor income growth. Using the estimated returns to human capital from Section 3.3, we constructed counterfactual labor income series holding each factor constant at its 1990 baseline while allowing others to evolve as observed.

For the support ratio decomposition into fertility, mortality, and momentum components, we constructed counterfactual population structures using the cohort-component method as conceptualized in Section 2.3. Specifically, we applied 1990 fertility rates with observed mortality (fertility counterfactual), 1990 mortality rates with observed fertility (mortality counterfactual), and calculated momentum by holding fertility and mortality constant at 1990 rates.

For each counterfactual scenario, we recalculated the effective number of workers L and consumers N using the NTA age profiles $w_L(a)$ and $w_C(a)$ as weights. The contribution of each component was calculated as the difference between observed outcomes and the relevant counterfactual, providing a time series of contributions for each year relative to 1990. We computed cumulative growth contributions by compounding annual growth rates. All calculations were repeated for each Monte Carlo draw to generate uncertainty intervals.

4. Results and Discussion

This section presents our main empirical findings on disability trends and their economic consequences in Japan and the Philippines between 1990 and 2021. We begin by documenting the evolution of years lived with disability across major disease categories, showing how the burden has shifted from communicable diseases and injuries toward non-communicable chronic conditions. We then quantify the economic returns to disability reduction, demonstrating that declining YLD rates generated substantial labor productivity gains that, in both countries, were sufficient to offset or complement the effects of changing demographic structures. Finally, we examine how the COVID-19 pandemic reversed decades of accumulated health gains, underscoring the fragility of health-dependent economic progress.

4.1. Trends in disability burden, 1990-2021

Figure 1 presents YLD rate per 100,000 population by disease groups for individuals aged 15-79 years in Japan and the Philippines in 1990 and 2019. Over the past three decades, musculoskeletal and mental disorders consistently ranked as the leading contributors to YLD burden in both countries. In 2019, these two categories jointly accounted for 42.7% (95% CI 41.6-44.4) of total YLD in Japan and 34.1% (31.7-37.4) in the Philippines.

Despite this similar ranking, the absolute burden of musculoskeletal disorders was substantially higher in Japan, with a YLD rate of 4,407 (3,026-6,248) per 100,000 population, compared with 1,866 (1,254-2,645) in the Philippines. Across most non-communicable disease (NCD) categories, Japan reported higher unadjusted YLD rates than the Philippines in 2019. The largest between-country differences were observed for diabetes and kidney diseases (rate

difference: 679 per 100,000; 95% CI 234-1,119), followed by musculoskeletal disorders (2,541; 1,519-3,858) and cardiovascular diseases (480; 162-823).

In contrast, the Philippines exhibited higher YLD rates for communicable, maternal, neonatal, and nutritional (CMNN) diseases, particularly maternal and neonatal disorders, where the YLD rate was 458 (368-568) per 100,000 compared with Japan's 48 (38-62). Similarly, the Philippines had substantially higher YLD rates from HIV/AIDS and sexually transmitted infections (158 vs. 22 per 100,000) and from other infectious diseases (99 vs. 25 per 100,000). These patterns reflect the countries' different stages of epidemiological transition, with Japan having largely completed the shift toward chronic degenerative conditions while the Philippines continues to face a dual disease burden.

Turning to temporal trends, Figure 2 presents the estimated period effects from our age-period models, showing how age-adjusted YLD rates evolved by cause from 1990 to 2021. These estimates isolate changes in disability burden over calendar time, abstracting from changes in population age structure. Both countries experienced marked declines in YLD rates from injuries. In Japan, the age-adjusted YLD rate from injuries declined by approximately 35% between 1990 and 2019, while the Philippines saw a reduction of roughly 25% over the same period. These improvements likely reflect advances in injury prevention, emergency medical care, and rehabilitation services. Transport injuries, in particular, showed consistent downward trends in both countries, though more pronounced in Japan.

Communicable diseases also showed substantial declines, particularly in the Philippines where CMNN conditions remain more prevalent. The age-adjusted YLD rate from tuberculosis in the Philippines declined by approximately 40% between 1990 and 2019. Maternal and neonatal disorders showed more modest improvements in the Philippines, with YLD rates declining by about 15% over three decades.

The picture was less favorable for non-communicable diseases. Diabetes and kidney diseases exhibited the steepest upward trends in both countries. In Japan, the age-adjusted YLD rate from diabetes increased by approximately 60% between 1990 and 2019, while the Philippines experienced a doubling over the same period. Neoplasms also showed rising YLD rates, with increases of roughly 40% in Japan and 30% in the Philippines. These trends likely reflect both genuine increases in disease prevalence and improvements in diagnosis and survival that extend the period individuals live with these conditions.

Cardiovascular diseases showed divergent patterns between countries. In Japan, age-adjusted YLD rates from cardiovascular diseases remained relatively stable, while the Philippines experienced a modest increase of approximately 20% between 1990 and 2019. Mental and substance use disorders showed relatively flat trends in both countries, though with substantial year-to-year variation. A notable outlier is HIV/AIDS and sexually transmitted infections in the Philippines, where the age-adjusted YLD rate more than doubled between 1990 and 2019. This increase reflects the country's rising HIV epidemic, which has seen new infections increase substantially since 2010 despite declining trends in most other countries in the region.

The COVID-19 pandemic caused a sharp reversal in these generally favorable trends. Between 2019 and 2021, all-cause age-adjusted YLD rates increased by approximately 15% in Japan and 25% in the Philippines. This surge was driven primarily by the direct health burden of COVID-19 itself, but also by disruptions to health services for other conditions, mental health impacts of the pandemic, and indirect effects of social and economic upheaval. The magnitude

of these increases effectively reversed approximately 10 years of progress in Japan and more than 20 years in the Philippines, representing setbacks that are considerably more severe than those from previous health or economic crises.

4.2. Economic returns to disability reduction

Table 1 presents estimates from our earnings function relating labor income per capita to years lived with disability, controlling for age and generation-cohort fixed effects. The estimates reveal a statistically significant negative association between YLD rates and labor income in both countries ($p<0.01$). Specification (3), which includes both age and cohort fixed effects, shows that each percentage point increase in the healthy population share raises labor income per capita by 0.43% in Japan and 0.39% in the Philippines.

While the point estimates are relatively similar between countries, the underlying mechanisms and implications differ substantially. Japan's disability burden is concentrated among older age groups and dominated by degenerative conditions such as musculoskeletal disorders. The Philippines, in contrast, has higher YLD rates among working-age populations driven substantially by communicable diseases, injuries, and maternal-neonatal conditions. Despite Japan's higher absolute YLD rates, the comparable parameter estimates suggest that disability reduction generates meaningful productivity gains in both settings, though operating through somewhat different age and disease patterns.

The robustness of these estimates across specifications is noteworthy. Specification (1) includes only age fixed effects, yielding larger coefficient magnitudes (-0.62 in Japan, -0.72 in the Philippines). Adding generation-cohort fixed effects in specification (2) moderates these estimates somewhat, while specification (3), which additionally controls for educational attainment, yields our preferred estimates. The stability of results across specifications, along with the substantial within-age R-squared in specification (3), suggests that the relationship between disability and labor income is not merely capturing life-cycle patterns or cohort effects, but reflects a genuine association between health and productivity.

Applying these estimated returns to observed changes in YLD rates between 1990 and 2019 allows us to quantify the contribution of disability reduction to labor productivity growth. Declining YLD rates increased labor productivity by 35.1% in the Philippines and 20.1% in Japan over this period. The larger productivity gains in the Philippines reflect more substantial declines in YLD rates, particularly from communicable diseases and injuries that affect working-age populations. In Japan, productivity gains were driven by modest but sustained YLD reductions from injuries and some communicable diseases, partially offset by increasing disability from diabetes and neoplasms.

Educational expansion provides an interesting contrast. In the Philippines, rising average years of schooling contributed an additional 18.3% to labor productivity growth between 1990 and 2019. In Japan, where average schooling was already high at baseline and showed little subsequent change, education contributed negligibly to productivity growth over this period. The combined effect of health and education improvements thus raised labor productivity by more than 50% in the Philippines over three decades, while health alone drove Japan's 20% productivity gain.

An important temporal pattern emerges from examining these contributions over time (Figure 3). In the Philippines, the annual contribution to productivity growth from health improvements

peaked in the early 2000s at approximately 1.5% per year but has since decelerated to virtually nil by 2016-2019. This deceleration reflects both the slowing pace of YLD rate reductions and the increasing prominence of chronic NCDs, which may have different productivity implications than the communicable diseases and injuries that dominated earlier improvements. Japan, in contrast, shows a generally increasing contribution from health improvements over the study period, though with substantial waves. The contribution exhibited a marked trough of -1.15% in 1997-1998 before recovering and ultimately peaking at 3.2% in 2017-2018. This increasing trend in Japan, where population aging has concentrated disability burden at older ages, suggests that health improvements can continue to generate substantial productivity returns even as societies age, potentially through mechanisms such as extended working lives and improved functional capacity among the elderly.

4.3. Demographic change and the support ratio

Figure 3 presents the complete growth decomposition of labor income per effective consumer, showing contributions from health improvements (through productivity), educational expansion (through productivity), and demographic change (through the support ratio). Between 1990 and 2019, the Philippines continued to benefit from the first demographic dividend. The support ratio increased by approximately 28%, adding roughly 0.8% to annual income per capita growth. This reflects the country's ongoing fertility decline from 4.1 children per woman in 1990 to 2.4 in 2019, which mechanically increased the ratio of working-age to dependent populations.

Japan, in contrast, experienced a substantial demographic drag. The support ratio declined by approximately 14% between 1990 and 2019, subtracting roughly 0.5% from annual income per capita growth. This reflects Japan's advanced population aging, with the share of elderly (65+) rising from 12% in 1990 to 29% in 2019.

Decomposing the support ratio changes into fertility, mortality, and momentum components reveals the underlying demographic forces at work. In the Philippines, fertility decline contributed an estimated 32% increase to the support ratio between 1990 and 2019. However, this was partially offset by mortality improvements that extended life at older ages (reducing the support ratio by approximately 8%) and by negative momentum effects (approximately -3%) reflecting the delayed impact of past demographic patterns. In Japan, the support ratio decline was driven primarily by mortality improvements extending elderly life (reducing the support ratio by roughly 18%), amplified by negative momentum effects (-5%) from the aging of large baby boom cohorts. Fertility, already low in 1990, contributed little additional change to the support ratio.

The net effect on labor income per effective consumer combines productivity gains from human capital with demographic effects from the changing support ratio. In the Philippines, health improvements contributed 34.2% to income per capita growth between 1990 and 2019, with the positive support ratio effect amplifying overall gains. In Japan, health improvements contributed 15.4%, more than offsetting the negative demographic drag from population aging. In both countries, therefore, productivity growth from disability reduction proved sufficient to counteract or complement demographic forces affecting income per capita.

These findings demonstrate that morbidity operates through a different channel than mortality in affecting economic outcomes. While mortality improvements extended life and contributed to population aging (reducing the support ratio, especially in Japan), morbidity reductions

directly enhanced labor productivity without these offsetting demographic effects. This distinction helps explain why our estimated economic returns to health improvements are substantially larger than those found in studies focusing primarily on mortality-based health indicators.

4.4. Fragility of health-dependent economic gains

The COVID-19 pandemic's impact on YLD rates translated directly into productivity reversals. Between 2019 and 2021, the surge in disability burden reduced labor productivity by an estimated 8.2% in the Philippines and 4.1% in Japan. These productivity losses effectively reversed approximately 10 years of accumulated gains in Japan and more than 20 years in the Philippines.

This dramatic reversal underscores a critical vulnerability in health-dependent economic growth: major health system shocks can rapidly erode decades of accumulated health capital. Unlike physical capital, which depreciates gradually, or human capital embodied in education (which persists even during disruptions), health capital can deteriorate rapidly when populations experience sudden increases in morbidity. The differential impact between countries is noteworthy. The Philippines' larger productivity reversal reflects primarily the more severe pandemic impact on YLD rates combined with the Philippines' greater reliance on health-driven productivity growth in its overall economic performance, at least until 2015. Countries with weaker health systems and higher baseline disability burdens may be particularly vulnerable to pandemic-induced productivity shocks.

These findings carry important implications for understanding the relationship between health and economic development. First, they suggest that investments in disability reduction yield substantial economic returns beyond their direct welfare benefits. Health systems that successfully manage chronic diseases, prevent injuries, and maintain functional capacity among working-age and elderly populations can meaningfully offset the economic challenges of population aging. Second, the specific nature of disability matters for economic returns. Our results suggest that health improvements concentrated among working-age populations and targeting high-disability conditions generate larger productivity gains.

Third, the pandemic's dramatic reversal of productivity gains highlights the importance of health system resilience. Surge capacity, robust disease surveillance, and the ability to maintain essential health services during crises are not merely health imperatives but also economic priorities. The economic returns to pandemic preparedness may substantially exceed conventional estimates that focus only on direct disease costs. Fourth, the slowing pace of health-driven productivity growth in both countries, but especially in the Philippines, suggests either diminishing returns or the need for renewed efforts. In the Philippines, the rising burden from NCDs like diabetes and the resurgent HIV epidemic point to areas where additional investments could reverse the productivity growth deceleration.

Our findings both complement and extend previous research on health and economic growth. The substantial productivity gains we document from disability reduction are considerably larger than the effects typically estimated in studies focusing on mortality-based health indicators. Acemoglu and Johnson (2007), for example, found limited or even negative short-run effects of life expectancy gains on income per capita. Our results suggest that morbidity reduction may generate larger and more immediate economic returns than mortality reduction, particularly when disability declines occur among working-age populations. Our framework's

ability to separate health's productivity effects (through morbidity) from its demographic effects (through mortality) helps reconcile these apparently conflicting findings. Mortality improvements that primarily extend elderly life may reduce the support ratio while generating limited productivity gains. In contrast, morbidity reduction at working ages directly enhances productivity without the offsetting demographic effects.

The heterogeneity in returns between Japan and the Philippines provides additional insights. The larger returns in the Philippines are consistent with health being a more binding constraint on productivity in developing economies. As countries develop and health improves, the marginal productivity of further health gains may diminish, a pattern analogous to diminishing returns to education at high levels of attainment. This has implications for understanding how the economic value of health investments may vary across development stages.

5. Conclusion

This study provides a comparative analysis of disability trends and their macroeconomic consequences in countries at different stages of demographic and epidemiological transition. By combining detailed morbidity data from the Global Burden of Disease Study with age-specific economic accounts from the National Transfer Accounts Project, we quantify how changes in years lived with disability contributed to labor income growth in Japan and the Philippines between 1990 and 2021. Our analytical framework extends standard growth accounting to separately identify health's effects through both productivity (morbidity reduction) and demography (mortality change), providing a more complete picture of health's economic contributions than previous studies focusing solely on mortality-based indicators.

Our main findings demonstrate substantial economic returns to disability reduction. Declining YLD rates increased labor productivity by 35.1% in the Philippines and 20.1% in Japan between 1990 and 2019. When combined with demographic effects, health improvements contributed 34.2% to income per capita growth in the Philippines and 15.4% in Japan. These productivity gains were sufficient to offset the negative demographic drag from population aging in Japan and to amplify the positive first demographic dividend in the Philippines. The magnitude of these effects considerably exceeds estimates from previous studies focusing on mortality-based health measures, suggesting that morbidity reduction may generate larger and more immediate economic returns than mortality decline.

The sources of these productivity gains varied between countries in ways that reflect their different stages of development. The Philippines benefited primarily from disability reductions among working-age populations driven by declining communicable diseases and injuries. Japan's gains came despite population aging concentrating disability at older ages, potentially operating through extended working lives and improved functional capacity among the elderly. Importantly, Japan showed generally increasing contributions from health improvements over the study period, peaking at 3.2% annual productivity growth in 2017-2018, while the Philippines experienced deceleration from 1.5% to 0.8% annually.

A critical finding concerns the fragility of health-dependent economic gains. The COVID-19 pandemic reversed decades of progress, reducing labor productivity by 8.2% in the Philippines and 4.1% in Japan between 2019 and 2021. This effectively erased 10 to 20 years of accumulated health capital, underscoring the vulnerability of productivity growth to major health system shocks.

Our findings carry several implications for health policy in aging societies. Investments in disability reduction yield substantial economic returns beyond their direct welfare benefits. Health systems that successfully manage chronic diseases, prevent injuries, and maintain functional capacity can meaningfully offset the economic challenges of population aging. The distinction between morbidity and mortality effects matters for policy prioritization. While longevity improvements may reduce the support ratio in aging societies, disability reduction directly enhances productivity without these offsetting demographic effects. This suggests that interventions targeting functional capacity and quality of life may generate particularly strong economic returns.

The specific nature of disability also matters for economic impact. Health improvements concentrated among working-age populations and targeting high-disability conditions generate larger productivity gains. In the Philippines, reductions in communicable diseases and injuries affecting working-age populations drove substantial productivity growth. In Japan, even modest YLD reductions translated into meaningful economic gains despite the concentration of disability at older ages, potentially operating through extended working lives and improved functional capacity among the elderly.

The pandemic's reversal of productivity gains highlights the critical importance of health system resilience. Surge capacity, robust disease surveillance, and the ability to maintain essential health services during crises are not merely health imperatives but also economic priorities. The economic returns to pandemic preparedness may substantially exceed conventional estimates that focus only on direct disease costs. Countries with weaker health systems and higher baseline disability burdens may be particularly vulnerable to pandemic-induced productivity shocks, as evidenced by the Philippines' larger reversal.

The slowing pace of health-driven productivity growth in the Philippines, contrasted with Japan's increasing trend, suggests important lessons. Rising burden from non-communicable diseases like diabetes and the resurgent HIV epidemic in the Philippines point to areas where renewed investments could reverse the productivity growth deceleration. Japan's experience demonstrates that health improvements can continue to generate substantial and even growing productivity returns in advanced aging societies, potentially through mechanisms involving elderly workforce participation and functional capacity maintenance.

Several limitations warrant acknowledgment. Our analysis assumes that the relationship between YLD and labor income remains constant over time and across age groups in our main specification. In reality, the productivity impact of specific health conditions may vary with economic structure, technological change, and the availability of workplace accommodations.

While our framework captures health's effects through both productivity and demography, we do not model several other channels through which health affects economic outcomes. We do not account for health's effects on educational investment decisions, savings behavior, or the consumption benefits of improved health beyond its income effects. Our estimates thus provide a substantial but incomplete accounting of health's economic value, focusing specifically on the pathways through labor productivity and demographic structure.

Our NTA data availability differs substantially between countries. Annual observations for the Philippines but only six time points for Japan limit our ability to examine short-run dynamics and may affect the precision of our Japanese estimates. The unbalanced panel also complicates

direct cross-country comparisons, though our main results appear robust to alternative specifications.

The COVID-19 pandemic's full economic impact extends beyond the direct YLD effects we capture. Disruptions to education, labor markets, and social connections may have longer-term consequences for human capital and productivity that are not yet visible in our 2019-2021 analysis window. Future research should examine these delayed effects as more data become available.

Finally, while our framework allows us to quantify the economic contribution of observed health improvements, we remain agnostic about the causes of these improvements and the costs of achieving them. We cannot assess whether observed health investments were economically efficient, only that they generated measurable productivity returns. A complete cost-benefit analysis would require detailed accounting of health system expenditures and careful attribution of health improvements to specific interventions.

Despite these limitations, our findings demonstrate that population health plays a critical and quantifiable role in economic development, operating through channels distinct from those emphasized in previous literature. The substantial productivity gains from disability reduction, the ability of these gains to offset demographic headwinds, and their vulnerability to health system shocks all underscore the economic importance of sustained investments in population health. As more countries enter advanced stages of demographic transition, understanding and leveraging the productivity returns to disability reduction will become increasingly important for maintaining economic growth and shared prosperity.

References

Acemoglu, D., and S. Johnson. 2007. Disease and Development: The Effect of Life Expectancy on Economic Growth. *Journal of Political Economy*, 115(6): 925-985.

Barro, R. J., and J. W. Lee. 2013. A New Data Set of Educational Attainment in the World, 1950–2010. *Journal of Development Economics*, 104: 184-198.

Bloom, D. E., D. Canning, and J. Sevilla. 2004. The Effect of Health on Economic Growth: A Production Function Approach. *World Development*, 32(1): 1-13.

GBD 2021 Collaborators. 2022. Global Burden of Disease Study 2021 (GBD 2021) Results. Institute for Health Metrics and Evaluation (IHME). https://vizhub.healthdata.org/gbd-results/

Lee, R., and A. Mason. 2010. Fertility, Human Capital, and Economic Growth Over the Demographic Transition. *European Journal of Population*, 26: 159-182.

Mason, A., R. Lee, and J. X. Jiang. 2016. Demographic Dividends, Human Capital, and Saving. *The Journal of the Economics of Ageing*, 7: 106-122.

Mason, A., R. Lee, M. R. M. Abrigo, and S. H. Lee. 2017. *Support Ratio and Demographic Dividends: Estimates for the World*. Population Division Technical Paper No. 2017/1. New York: United Nations.

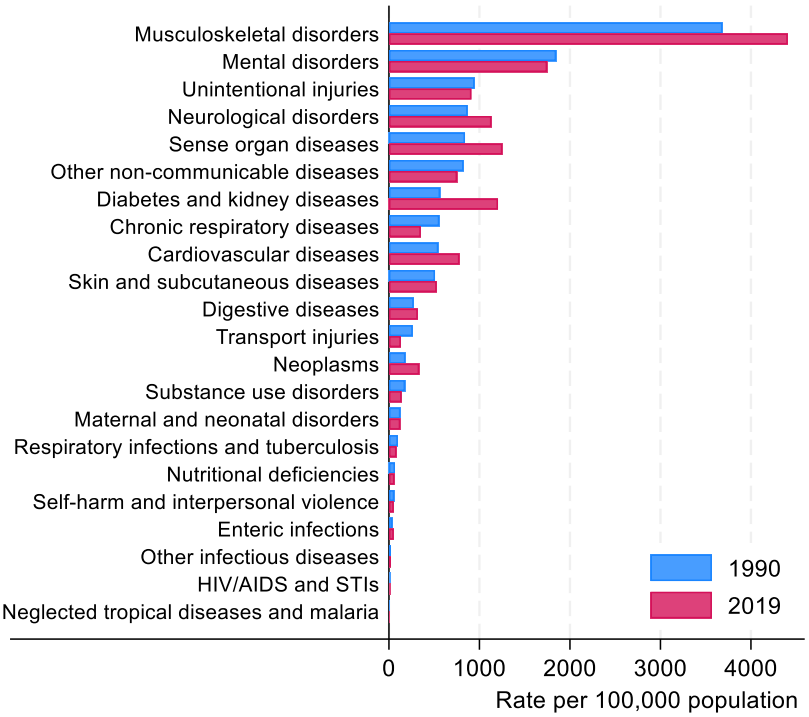
Ogawa, N., N. Mansor, S. H. Lee, M. R. M. Abrigo, and T. Aris. 2021. Population Ageing and the Three Demographic Dividends in Asia *Asian Development Review*, 38(1): 32-67.

United Nations, Department of Economic and Social Affairs, Population Division. 2024. *World Population Prospects 2024 Revision*. Online database. https://population.un.org/wpp/

Weil, D. N. 2007. Accounting for the Effect of Health on Economic Growth. *Quarterly Journal of Economics*, 122(3): 1265-1306.

Figure 1. Years lived in disability per 100,000 population among aged 15 to 74 years

A. Japan



B. Philippines

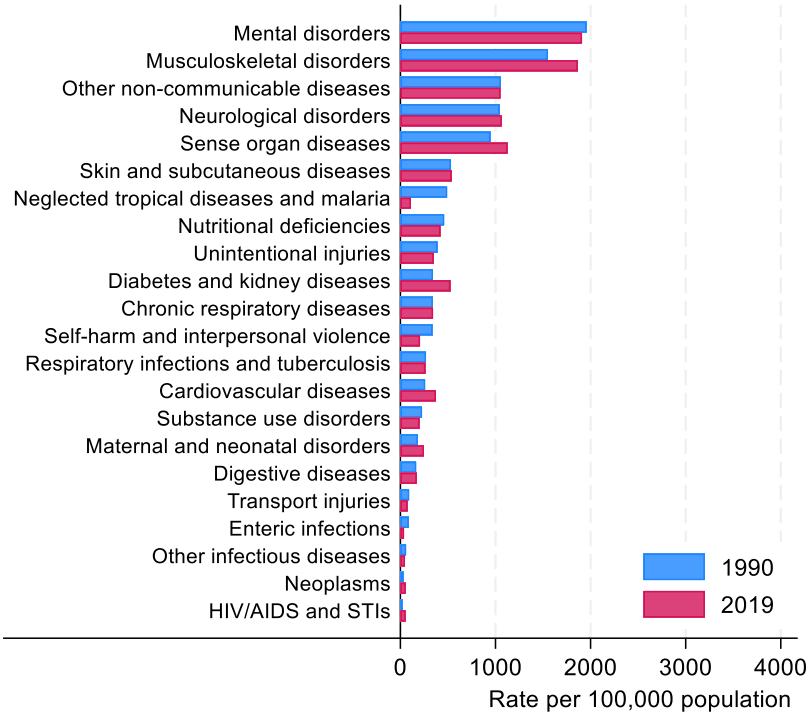
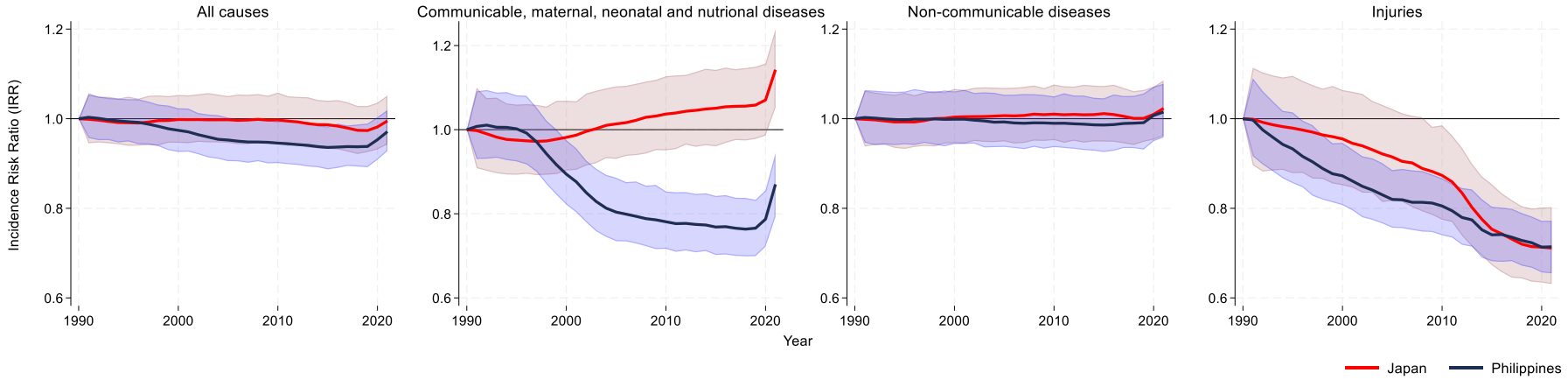
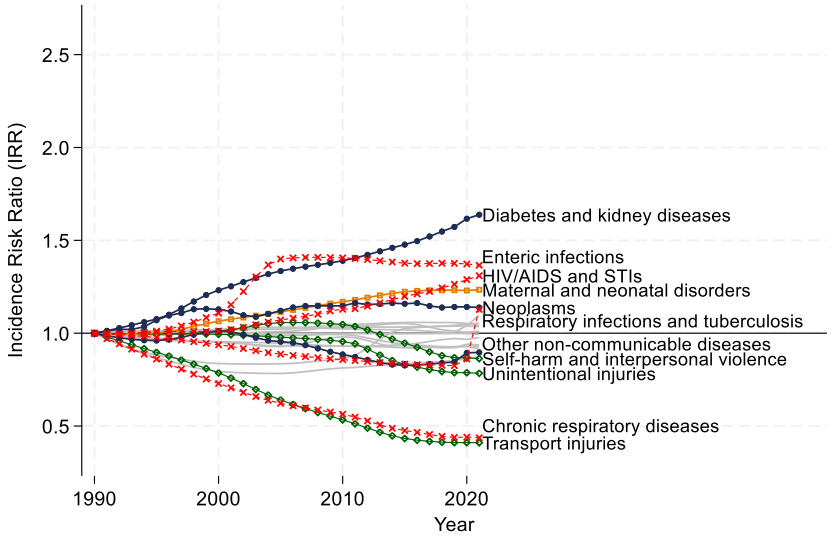


Figure 2. Period-cohort effects on YLD rate by cause among aged 15 to 74 years

A. Broad causes



B. Japan



C. Philippines

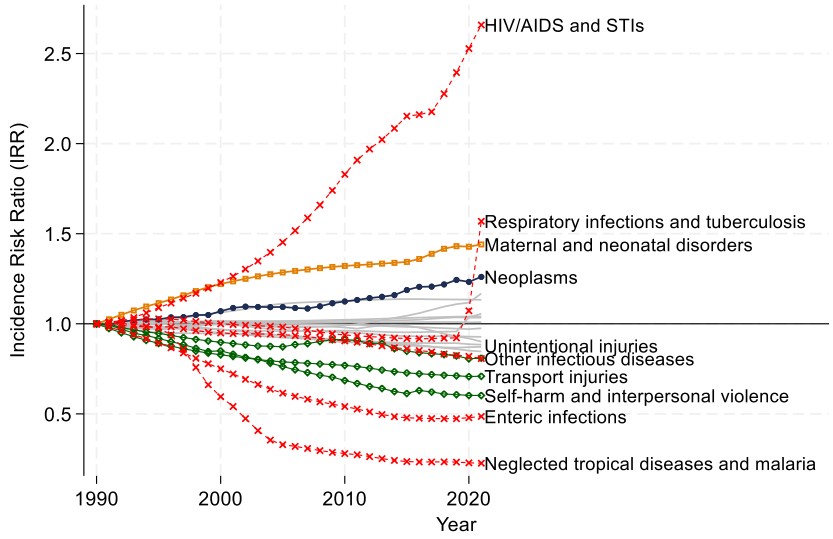


Figure 3. Contribution of health in per capita labor income growth

A. Japan



B. Philippines



Table 2. Returns to health

	(1)	(2)	(3)
A. Japan			
Years lived in disability (per 100 population)	−0.624***	−0.603***	−0.430***
	(0.063)	(0.099)	(0.066)
Observations	389	389	389
Adj. R-sq. (overall)	0.918	0.917	0.940
Adj. R-sq. (within-age)	0.068	0.065	0.326
BIC	373	379	276
B. Philippines			
Years lived in disability (per 100 population)	−0.715***	−0.459***	−0.385***
	(0.040)	(0.041)	(0.034)
Observations	1,950	1,950	1,950
Adj. R-sq. (overall)	0.964	0.973	0.977
Adj. R-sq. (within-age)	0.599	0.690	0.742
BIC	-1,993	-2,488	-2,811
Included covariates			
Age FE	Yes	Yes	Yes
Average years of schooling		Yes	Yes
Birth cohort FE			Yes