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The Long-Run Effects of Non-Communicable Disease Shocks

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CONFLICT OF INTEREST

The authors have no conflict of interest.

ETHICAL STATEMENT

No ethical approval was needed for the conduct of this study.

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Abstract

The health shocks literature typically does not take into account temporal patterns of loss since the time of the shock. This limits understanding of the long-run impact of health shocks and the capacity of individuals to cope over time. This paper estimates the dynamic effects of a non-communicable disease shock on the economic well-being of working age individuals in China up to six years after onset. We find that after a period of temporal loss, individuals and their families can insure consumption against the average non-communicable disease shock over the long-run. However, we observe significant heterogeneity according to the persistence of the disease, value of household wealth and health insurance status. Individuals with consistent onset, with below median wealth, and without health insurance are least equipped to smooth consumption over the long-term.

Keywords: non-communicable disease; health shocks; consumption; health expenditure; income; China

JEL codes: I12, I14, I15, I3, C23

1. Introduction

Health shocks are among the most burdensome of risks facing households due to the double burden of treatment-related costs and loss of income from reduced productivity and labour supply (Krishna, 2010; Wagstaff and Lindelow, 2014). The literature has predominantly focused on contemporaneous or short-run effects of health shocks. However, as noted by Grossman (1972), health has critical dynamic components that evolve over the life course. This raises important questions about both the impact of health shocks and the capacity of households to cope over time. It is important to identify health shocks that may have large long-run effects. Furthermore, it is conceivable that at the time of onset, individuals and their households may be able to cope relatively easily with the financial risks of a health shock. However, as shocks persist, then they may have to resort to other more costly coping mechanisms. It has clear implications for policy. If households are less equipped to cope with the financial risks associated with health shocks over the long-run, then the future welfare costs and thus welfare gain from increasing social insurance against severe and chronic health shocks may be large (Chetty, 2006; Chetty and Looney, 2006).

In this paper, we estimate the dynamic effects of the onset of a non-communicable disease (NCD) on the economic welfare of working age adults in China for up to six years after onset. Using five rounds of the China Family Panel Studies (CFPS) survey (2010-2018), we estimate the effects of NCD onset on consumption expenditure and key financial risks, including health expenditures and earnings. We estimate dynamic effects for three NCD group categories as defined by the disease chronicity: persons with consistent onset; persons with one-off onset; persons with all other irregular patterns. Our results show that after a period of temporal loss, individuals and their families can insure consumption against the average NCD shock over the long-run. However, we observe significant heterogeneity according to the persistence of the disease, value of household wealth and health insurance status. Individuals with consistent onset, with below median wealth, and without health insurance are least equipped to smooth consumption over the long-term.

We draw upon several threads of the health shocks literature.[1] Much of the earlier literature has focused on shocks to earnings, productivity and other labour market outcomes. Because households 'smooth' consumption in response to income fluctuations, other studies have focused on consumption as a measure of economic well-being rather than income (e.g. Dercon, 2002; Morduch, 1995; Townsend, 1994). These studies have focused on whether households can insure consumption in the event of a health shock. A key conclusion of reviews of the literature is that the adverse effects of health shocks depend upon the specific health measure (Currie and Madrian, 1999; Strauss and Thomas, 1998). For instance, Gertler and Gruber (2002) show that when health is measured in terms of illness symptoms, households could insure consumption whereas when physical functional limitation measures are used the hypothesis of full insurance is rejected. The conclusion from this and other studies (e.g. Cochrane, 1991) is that minor and perhaps more predictable health conditions are insured, but major conditions are less able to be fully insured.

Following Chetty and Looney (2006) who show that consumption is not an adequate indicator for welfare since households may maintain consumption because of risk aversion, recent studies have paid increasing attention to the risk-coping strategies employed in the

[1] We use the term 'health shocks' loosely to mean changes in health status.

face of a health shock (Islam and Maitra, 2012; Khan et al., 2015; Liu, 2016; Mitra et al., 2016; Mohanan, 2013; Sparrow et al., 2014). For instance, households are found to rely on borrowing, selling productive assets, receiving transfers from relatives or friends, and reducing investments in human capital. Existing studies have also found that the capacity of households to cope with the financial consequences of health shocks varies across the population. In particular, poor, low educated and rural households are least able to insure consumption due to credit and asset constraints (Genoni, 2012; Mitra et al., 2016; Sparrow et al., 2014). Contemporaneous effects of health shocks on household economic outcomes and coping mechanisms as reported in the existing literature are inferred to compromise the long-run well-being of individuals and households. However, the empirical evidence on the long-term effects of health shocks on household welfare from low-and-middle-income countries is relatively weak and is where we seek to make a contribution.

A smaller strand of the literature examines temporal or longitudinal losses of ill-health. These studies provide additional important insights on how individuals and their families fare over the longer run (Charles, 2003; Cheng et al., 2018; Jones et al., 2018; Meyer and Mok, 2019; Polidano and Vu, 2015; Stephens, 2001). Recognising that the dynamic patterns of ill-health since onset (or offset) are not consistent across individuals, studies typically estimate dynamic effects for different groups of individuals defined by the chronicity of ill-health. Studies are concentrated in OECD country contexts and are limited in the type of health shock and outcomes under study. Most papers examine dynamic labour market effects associated with disability onset.

Our study contributes to the health shocks literature in several ways. We adopt a NCD measure as our health shock measure in the context of China. This is important because empirical studies have shown that risk-aversion can vary depending upon the scale of the shock and context (Chetty, 2006). The current literature uses a range of health measures but with limited focus on NCDs.[2] There is a considerable gap given the rising prevalence and incidence of NCDs worldwide. There are several potential advantages to examining the impact of NCDs on economic outcomes. By definition, NCDs have a prolonged course and require a long-term systematic approach to treatment (World Health Organization, 2005). NCDs may therefore capture more severe and chronic health conditions with large long-run effect on well-being. Our particular measure is a doctor diagnosed disease so is less prone to heterogeneity in perceptions about own health status (Bound, 1991; Strauss and Thomas, 1998).

2. Background

NCDs represent the greatest share of the global burden of disease, accounting for close to three-quarters of global deaths (GBD Causes of Death Collaborators, 2018). Of these deaths, the vast majority stem from large transitional economies, such as China. In 2017, 8.6 million people died from NCDs in China, comprising nearly 90 percent of total deaths (IHME, 2017).

[2] Kumara and Samaratunge (2017) investigate the impact of NCD incidence on household consumption in Sri Lanka, without identifying NCDs as an unexpected shock to households. Cheng et al. (2018) investigate the short term dynamic effects of a new chronic conditions on household economic welfare in Singapore. However, they focus on the short-run impact up to 12 month after the onset of health shock and in a well-developed setting where social health insurance schemes differ from that of low-and-middle-income countries. In addition, the effects of health shock on economic outcomes associated with the chronicity of the defined health shock has not been examined.

The rapid rise of NCDs in China has been fuelled by unprecedented demographic change and economic development (World Health Organization, 2015; Yang et al., 2013).

Over the last four decades, China has achieved remarkable progress in combating infectious disease and reducing child mortality, transitioning from a high mortality and high fertility country to a low mortality and low fertility country. This has contributed to changing population age structures and an increase in the incidence of age-related NCDs. Alongside demographic change, social and economic development has brought urbanisation and changed lifestyles which have resulted in the behavioural risk factors for NCDs becoming widespread. According to the Global Burden of Disease study, the leading risk factors for death and disability in China are dietary risks of low fruit and high sodium consumption, tobacco use, high blood pressure, air pollution and high body-mass index (IHME, 2019).

The rising burden of NCDs changes the health needs of the population in China. Individuals and households with NCDs need to have access to quality health services without financial hardship. In 2009, China launched a major health-care reform with an aim to move towards universal health coverage (State Council, 2009). This comprised public hospital reform, a primary health care based integrated delivery system, and a multi-level social health insurance scheme. In spite of near universal health coverage, the proportion of out-of-pocket payments remain high at over 30% in 2013 (Fang et al., 2019).

The literature on the economic impact of health shocks, and NCDs in particular, in China is small given the scale of the issue. Studies typically rely upon cross-sectional data, limited outcome variables and include a wide range of health measures rather than just NCDs. With a few exceptions the majority of papers do not address unobserved heterogeneity. Using four rounds of the China Health and Nutrition Survey over the period 1991-2000 and fixed effects regressions, Lindelow and Wagstaff (2005) examine the impact of a health shock, as measured by the worsening of self-rated health of the household head, on medical spending, income and labour supply. The authors find a health shock leads to a 5-6 percent reduction in income and labour supply and a 9 percent increase in medical spending. They find further evidence that the poor benefit from in-kind transfers from family and friends in the event of a health shock. However, the transfers comprise only a small portion of total income and are insufficient to insure the adverse effects of the health shock on income.

Using the same dataset over seven waves from 1993-2011 and first-differenced regressions, Liu (2016) examines the impact of a different health shock, as measured by changes in the number of days unable to carry out daily activities of the household head and spouse, on household income, food consumption and medical spending. Contrary to the Lindelow and Wagstaff (2005) study, households can fully insure household income (and food consumption) in the face of a health shock and associated increase in out-of-pocket medical expenditures. However, there is a negative impact on individual earnings which is consistent with the earlier study finding of reduced labour supply. The paper investigates several coping mechanisms through which households insure consumption and income. A health shock on the household head or spouse leads to a decrease in school enrolment and productive investments and an increase in child labour. Human capital effects are muted by access to health insurance leading the author to conclude that health insurance has an important role to play in crowding out potentially costly coping mechanisms.

Our paper builds on this earlier work in several important aspects. First, the China Health and Nutrition Survey used in previous studies has limited geographical coverage and economic

variables. The data is representative for only 9 of 33 provinces and includes only information on food consumption (as measured by macronutrients) and thus offers a partial measure of household welfare. Furthermore, the health shocks measures in previous studies are self-reported and may reflect less severe and exogenous health shocks.[3] We draw upon nationally representative longitudinal data that includes detailed consumption expenditures data and an alternative health shock measure defined by the onset of a doctor-diagnosed disease. Moreover, in contrast with previous studies in China, we estimate the temporal loss patterns against the time of onset of the health shock to provide additional insights into the impact of health shocks and the capacity of individuals and their households to manage them over time.

3. Data and Descriptive Statistics

This paper uses data from the available five waves of the China Family Panel Studies (CFPS) survey, covering a sample period of eight years from 2010-2018. The CFPS is a nationally representative, biennial longitudinal survey implemented by the Institute of Social Science Survey (ISSS) of Peking University, China. It is designed to document changes in the economic, as well as non-economic, well-being of the Chinese households and individuals for the purpose of public policy analysis (Xie et al., 2017). In the baseline 2010 survey, the CFPS interviews approximately 14,800 households and 33,600 adults. Our sample is restricted to a balanced panel of working aged individuals (aged 16-52 years in the first wave).[4] This includes 9469 individuals who provide information in all five waves.

We identify NCD-affected individuals based on the question: *During the past six months, have you had any doctor-diagnosed chronic disease*; and, the self-reported doctor diagnosis of the disease. Specifically, we identify individuals as living with NCDs if their diagnosed diseases are classified within the `Group II Diseases' as per the WHO ICD-10 code (World Health Organization, 2016). Like other studies that do not have information on the date of the onset of the health condition, we define NCD onset from the first reporting in the data waves of a doctor diagnosed NCD. Specifically, we define onset as the first positive report of a doctor diagnosed NCD preceded by negative report in previous waves. To the extent that dynamic patterns of onset differ across individuals, we classify persons according to definitions of chronicity as applied in the literature (Jones et al., 2018; Meyer and Mok, 2019):[5] (i) *Consistent onset;* persons who always report an NCD after onset; (ii) *One-time onset;* persons who never report an NCD after onset; (iii) *Irregular onset;* all other patterns of NCD reporting after onset. As shown in Table 1, approximately 19% of the onset sample experience consistent onset, 51% experience one-off onset and 30% experience irregular onset.

[Table 1]

[3] As reported by Liu (2016) the correlation between the current health shock and the first- and second-lagged health shocks are -0.66 and -0.31, respectively. This implies that the health shocks measure is mean-reverting and transitory.

[4] We restrict analysis to the sample in all five waves due to our definitions on the dynamic patterns of NCD onset. We limit our sample to persons aged between 16 and 52 years in the first wave and thus a maximum of 60 years in the fifth wave to fully capture financial risks associated with income shocks. The mandatory retirement age in China is 60 years for men and 55 years for women. This applies to urban employment only; adults working in farming in rural areas are not subject to a specific retirement age and generally continue working as long as they are physically able.

[5] We impose the additional restriction that persons must be in the sample for at least one wave after onset.

For the analysis on the impact of a *new* doctor diagnosed NCD and to ensure a common starting point, our definition of NCD onset necessitates that we restrict the sample to persons with no reported NCDs in the first wave.[6] Since our focus is on the impact of NCD onset rather than exit, we remove individuals that report an NCD from the beginning until the end of the sample frame as well as those that exit consistently within the sampling frame. To the extent that decisions and behaviours on labour supply and expenditures can be pooled at the level of the household, we drop from the sample non-NCD individuals from NCD households. After deletions for missing data on key demographic variables, the final sample used in the analysis consists of 1,874 persons with NCDs and 3,028 persons without NCDs from non-NCD households. Table 2 describes the NCD and non-NCD sample in the first wave (pre-onset). The NCD sample before diagnosed are those with older age, more likely to be female and have a lower education level compared to the non-NCD sample.

The CFPS collects rich economic information, variables that are available in few other microeconomic surveys. The survey collects detailed information on consumption expenditures including food and non-food items, out-of-pocket health expenditures, household and individual earnings, and assets. Appendix A provides detailed information on definitions of these variables and the NCD shock variable. Table 2 describes the economic situation of the NCD sample (before diagnosed) and the non-NCD sample. Consumption expenditures and earnings are similar across sub-samples with the exception of the consistent onset group who experience comparatively lower levels. Health expenditures are noticeably higher for the NCD sample whereas wealth holdings are higher for the one-time onset and irregular onset groups.

[Table 2]

4. Empirical Methodology

To estimate the temporal changes in economic outcomes associated with NCD onset, we start with the following Poisson fixed effects model for person *i* in period *t*:[7]

$$y_{it} = exp\left(\alpha_i' + \gamma'_t + \beta' X_{it} + \sum_k \delta_k' N_{kit}\right) + \varepsilon_{it}' \qquad (1)$$

where y_{it} is the outcome of interest (such as non-health consumption expenditure) for individual *i* in period *t*, α_i is an individual fixed effect, γ_t is an indicator variable for period *t;* X_{it} is a vector of time-varying independent variables including age, age-squared, marital status, individual Hukou status,[8] education level, indicator variables for the household head and whether the household moved since prior wave; and ε_{it} is an error term. N_{kit} is an indicator variable representing the period since NCD onset. Throughout this study, we

[6] Although we restrict the sample, there is no selection bias because we are interested in the question of the effect of NCD onset conditional on being free of NCDs.

[7] Poisson fixed effects models are better suited to deal with zero and small non-zero outcomes which is particularly an issue for the individual earnings variable where many people with NCDs do not report positive earnings (Wooldridge 2010).

[8] The Hukou registration system in China divides the population into agricultural (rural) and non-agricultural (urban) sectors, which determines access to a range of resources, services and opportunities The CFPS follows household members when they move to a different place which may lead to the change of Hukou status. Therefore, we include Hukou as time-varying variable.

include indicator variables for one period before onset, the period of onset, and three periods after onset [$k \in (-1,3)$]. For example, N_{kit}, takes the value 1 in the period of the onset (k_0) and 0 otherwise. Each period since onset represents two calendar years.

With the inclusion of an individual fixed effect, the coefficients of interest δ_k measures the proportional change in the outcome variable *k* periods away from the year of onset relative to the value more than one period before onset.[9] Following the approach in the literature (Charles, 2003; Jacobson, 1993; Meyer and Mok, 2019), we include the non-NCD sample (as defined in the previous section) to improve the precision on the estimates on the control variables.

Because the persistence of NCDs will differ among individuals post-onset, we estimate an alternate specification in which we replace the indictor for any NCD onset with a set of indicators for three groups of different disease chronicity as previously defined:

$$y_{it} = exp\left(\alpha_i' + \gamma'_t + \beta' X_{it} + \sum_g \sum_k \delta_k'^g N_{kit}^g\right) + \varepsilon_{it}' \qquad (2)$$

where N_{kit}^g is an indicator variable that equals one if in period *t*, individual *i* belongs to NCD onset group *g* (consistent, one-time, irregular) and is *k* periods from the year of onset. The associated coefficient δ_k^g measures the change in the dependent variable *k* periods from the year of onset for those in NCD chronicity group *g* relative to the value more than one period and up to three periods before onset.

The empirical analysis concentrates on financial risk outcomes including non-health consumption expenditures, health expenditures and earnings. All outcomes are collected at the household level and enter in the equations in per capita form with the exception of earnings which are collected at the household and person level.[10] We use both household earnings per capita and individual earnings to examine the extent to which households can insure earnings through labour substitution. All of the outcome variables are reported in 2010 Chinese Yuan, and adjusted for inflation using the Consumer Price Index.

Standard errors are clustered at the individual level and adjusted for heteroskedasticity. In the maximum-likelihood estimator for Poisson, it is important to estimate heteroscedasticity-robust standard errors due to the underlying variance assumption (Wooldridge, 2010).

5. Results

We first examine whether individuals and their families can insure consumption overtime against a NCD shock and examine sources of financial risk in health spending and loss of

[9] Technically, the interpretation is given by *exp(β)-1*.

[10] We do not include household composition variables in the model because they are potentially endogenous to the health shock variable. However, the results are qualitatively unchanged in alternate specifications of household level outcomes and the inclusion of household size controls (as well as per capita outcomes with household composition controls). Results are available from the authors upon request.

earnings. We then examine heterogeneous effects by wealth and insurance status followed by robustness checks of the exogeneity of the health shock variable.

5.1 Consumption expenditures

Table 3 presents the estimated coefficients from equations (1) and (2), and represent proportional changes in economic outcomes relative to the value more than one period prior to onset of the NCD-affected individuals. Panel A shows the changes in outcomes for the average NCD onset group, and Panels B, C and D show the changes for three NCD chronicity groups.
Columns 1-3 of Table 3 report estimates for total (non-health) consumption expenditures per capita and components food and non-food expenditures, and are represented diagrammatically in Figures 1-3.

For the all NCD onset sample, consumption expenditure drops marginally below expected levels in the year of onset (and the period before onset), recovers over the subsequent two periods before falling back below zero by the third period. Coefficients are individually and jointly insignificant at conventional levels of significance. The pattern is similar for non-food consumption expenditures. However, food consumption shows a different temporal loss pattern. Food consumption falls approximately 6 percent in the period prior to the shock, drops to 7 percent in the year of onset and recovers gradually thereafter but remains below historical levels. Three periods (six years) after the year of onset, consumption expenditure has fallen by 3 percent relative to historical values. The coefficients are statistically significant in the year of onset and prior period yet are insignificant in the periods after onset.[11] Overall, the results suggest that after a period of temporal loss, individuals and their households can recover levels of consumption over the long-run.

There exists significant heterogeneity in the ability to insure long-run consumption depending upon the persistence of the NCD shock. As anticipated, the impact on consumption is most pronounced for the consistent onset group. In the year of onset, consumption drops by 5 percent and after a period of recovery drops over the long-run by 15 percent. The effects are estimated less precisely owing to the small sample size and are individually and jointly statistically insignificant. The pattern is again similar in non-food expenditures whereas food expenditure effects are negative and increase in magnitude over time. In the period before onset, food consumption falls by close to 10 percent yet is not statistically significant from zero. By the year of onset, food consumption falls 16 percent, which is more than double that of the average NCD onset group. By the third period after onset, food consumption has fallen by 28 percent. All coefficients are significant at conventional levels with the exception of the first period after onset.[12] Overall, the results indicate that individuals and their households that experience a consistent NCD shock are less equipped to insure consumption over the long-run and is largely explained by drops in food consumption.

As to the remaining NCD onset groups, the results indicate that individuals and their households can insure consumption over the long-run. For the one-time onset group, consumption effects are negative in the period before onset and rise monotonically over time.

[11] The Wald statistic cannot reject the hypothesis that either all of the post-onset coefficients are jointly equal to zero or are equal.
[12] An F-test cannot reject the null that all coefficients from the year of onset are equal (*p-value* = 0.34) and rejects the null hypothesis that all coefficients are equal to zero (*p-value* = 0.09).

By the second period after onset, the effects are positive and continue into the third period which suggests that individuals and households have been able to recover and exceed historical levels of consumption within four to six years after onset. The recovery is fuelled by a rise in non-food spending in the second period and a rise in food expenditures in the third period. In contrast, for the irregular onset group, the coefficients are positive and increasing in magnitude before falling below zero in the third period. The pattern is driven by non-food spending with food-expenditure effects remaining flat over time. For both groups, the coefficients are largely statistically insignificant.
[Table 3]
[Figures 1-3]

5.2 Health expenditures

Figure 4 shows temporal patterns in health expenditures per capita against a NCD shock (the corresponding coefficients and standard errors are shown in Column 4 of Table 3). The figure shows that for the average NCD shock, health spending increases in the period before onset, jumps in the year of onset and declines over the remaining periods. In the year of onset health spending rises by close to 50 percent and by the third period (six years) returns to expected levels. The figure also shows changes in health spending for different NCD onset groups. For persons with consistent disease onset we observe relatively larger increases in health spending, with an increase of 64 percent in the year of onset. By the second period after onset, this onset group's health spending is estimated to increase by 70 percent. It still remained over one-third above historical levels by the third period. Formal tests are unable to reject the null hypothesis of equality of the post-onset coefficients. In contrast, the one-time onset group experiences a jump in health spending in the year of onset which declines rapidly thereafter. By the third period after onset (six years) health spending falls below expected levels. The irregular onset group follows similar temporal pattern in health spending to the consistent onset group but at a smaller level of magnitude.

[Figure 4]

5.3 Earnings

Figures 5 and 6 depict the dynamic effects of NCD onset on earnings at the household per capita and individual level (the corresponding coefficients and standard errors are shown in Columns 5-6 of Table 3). The period-by-period impacts on earnings for the entire NCD onset sample oscillate around zero which suggests that households are able to insure total earnings in the face of a loss in individual earnings from the member newly diagnosed with a NCD. As shown in Figure 6, individual earnings fall about 4 percent on average by the period prior to onset and 8 percent in the year of onset. Six years after onset, annual individual earnings have fallen by approximately 10 percent compared with historical levels. The changes in total household earnings per capita display far less volatility than in individual earnings suggesting a degree of household labour substitution following a NCD shock of an adult member.

Once again we observe significant heterogeneity in the change in average earnings by disease chronicity. During the year of onset and two periods after onset, household earnings drop largest for the consistent onset group, falling by approximately 4 percent. This is in response to sharp falls in individual earnings in the post-onset period. In the year of onset individual earnings falls by 12 percent and after a brief period of recovery fall further in subsequent periods. By the third period after onset, individual earnings had fallen by close to 30 percent

relative to more than one period before onset. However, the coefficients are estimated imprecisely and are not statistically significant from zero.

The one-time onset group experiences similar temporal loss patterns to the full sample since they represent one half of onset cases. However, they experience a relatively large and statistically significant drop in individual earnings in first period after onset of over 20 percent. In spite of this large negative individual earnings shock, total household earnings per capita dip below zero in the period after the earnings shock but remain largely unaffected. The irregular onset group on the other hand do not experience any drop in individual earnings since onset. However, household earnings per capita fall below zero in the later periods since which may reflect changes in the amount or type of work undertaken by other household members due to caregiving responsibilities. The post-onset coefficients for both earnings outcomes are not individually or jointly significant.

[Figures 5-6]

5.4 Rich versus poor

The impact of health shocks can be particularly severe for poor households because the costs of treatment can be high relative to income, and there are constraints which may limit the use of asset, formal credit and income diversification (Dercon, 2002). In addition, the health shock may be more severe and persistent given low-quality treatment or a lack of treatment altogether. We examine the heterogeneous effects for subsamples of household wealth. Specifically, we divide the sample into individuals with the total value of household assets at baseline higher or lower than the median denoted as asset 'rich' and 'poor'.[13] We present results for the entire NCD onset sample only since the number of observations in the late post-onset periods for the consistent onset group are too low to generate reliable estimates. Results are presented diagrammatically in Figure 7 for select outcomes; the estimated coefficients and standard errors for all outcomes are presented in Appendix Table 1.

The results illustrate significant differences in the long-term economic impacts of the average NCD shock among the rich and poor. As shown in Figure 7, changes in household consumption expenditures among the poor are negative and increase slightly over time whereas for the rich they are positive and increase more dramatically before falling back to zero. The results suggest that individuals from poor households are less able to smooth consumption over the long-run. However, the coefficients for both the poor and rich subsamples are statistically insignificant with the exception of the large positive coefficient on the second post-onset period for the rich sample which is significant at the 5 percent level.[14] As shown further in Appendix Table 1, for both subsamples the effects are driven primarily by later period changes in non-food expenditures.

With respect to health expenditures, the figure illustrates that prior to the year of onset both the rich and the poor experience an increase in health spending. In the year of onset, the poor and the rich experience a 56 percent and 47 percent increase in health spending compared to historical levels, respectively. The pattern for the subsequent two periods (2-4 years after

[13] The total value of household assets includes housing and land assets, financial assets (e.g., savings, stock, funds, bonds) and productive assets including agricultural machinery, business assets and durable goods.

[14] An F-test of the null hypothesis that all post-onset coefficients are zero is rejected for the rich sample (*p-value* = 0.08) but cannot be rejected for the poor sample (*p-value* = 0.52).

onset) is different for the poor and the rich. Health spending remains high for the poor, increasing by 36 percent and 52 percent in the following two periods. The rich, experience a significant drop and continues the downward trend. Over the long-run health spending returns to close to expected levels for both subsamples. The coefficients for both subsamples are jointly significant in the post-onset period at the one percent level. The results suggest that over the short to medium term the poor spend cumulatively more than the rich as a fraction of historical spending in the event of a NCD shock.

Temporal patterns in earnings losses also differ among the rich and poor. The poor experience larger period-on-period falls in individual earnings following a NCD shock with earnings falling by as much as 15 percent in the short and medium term before returning to pre-onset levels in the long-term. For the rich, the trough in the post-onset period is 9 percent and is not statistically significant from zero. The results suggest that the poor are less equipped to insure individual earnings over the medium term. Interestingly, total household earnings (adjusted for household size) are less impacted among the poor with the coefficients consistently above zero whereas for the rich they are below zero and deepen over time. For both subsamples, the post-onset coefficients are jointly insignificant. Taken together the results suggest that the poor may be better equipped to substitute labour within the household.

[Figure 7]

5.5 Health insurance

Public health insurance has expanded rapidly over the past two decades in China (Liu and Zhao, 2012; Liu, 2016). To the extent that health insurance lessens the financial risks associated with a NCD shock, our results might mask important differences between the insured and uninsured. Figure 8 displays dynamic patterns against an average NCD shock for key economic outcomes by health insurance status. We use health insurance status at baseline to address potential problems of reverse causation. Approximately 85 percent of the NCD onset sample were insured at baseline.[15] The estimated coefficients and standard errors are presented in Appendix Table 2.

For the insured sample, aggregate consumption expenditure is close to unchanged in the onset period (and period before onset) and rises over the medium term before falling back to expected levels in the long-run. In contrast, among the uninsured, consumption expenditures start to fall in the period before onset and drops more substantially over the long-run. Six years after onset, consumption has fallen close to one-quarter against historical levels. As shown in Appendix Table 2, the longer term effects for both the insured and uninsured are driven by larger changes in non-food relative to food spending.

Similarly, temporal patterns in financial risks of health spending and earnings associated with the health shock differ according to insurance status. Health spending jumps in the year of onset for the insured and declines thereafter whereas for the uninsured the trend is the mirror image with health expenditures rising from the period before onset. The effects for the uninsured are estimated less precisely owing to the smaller sample. Individual earnings of the insured drop by 5-9 percent in the post-onset period but household earnings remain unaffected and increase in the long-run. In stark contrast, the uninsured experience a large

[15] 91 percent of people who reported to have health insurance at baseline remained covered over the sample frame and 32 percent who did not have insurance remain uncovered.

drop in individual earnings of close to 30 percent in the year of onset which recovers slightly and household earnings decrease at an increasing rate over time.

Overall, the results suggest that health insurance plays a protective role in individual well-being over the long-run through the mitigation of both health expenditures and loss of individual earnings associated with the NCD shock. It is important to remember that the findings relate to the average NCD shock of which around one-half of cases are one-time onset. Because the insured sample represents the vast majority (85%) of the overall NCD onset sample, the results by insured onset group are similar to those presented above. As shown in Appendix Table 3, temporal losses are greatest for the insured consistent onset group who experience a drop in food expenditures alongside a significant rise in health spending over the duration of the disease. These results suggest that insurance plays less of a protective role for more chronic conditions.

[Figure 8]

5.6 Robustness checks

The causal identification of our results rests on the assumption that the arrival and the timing of arrival of health shock is exogenous. There are several threats to this assumption. First, if the health shock follows a period of deteriorating health then the 'shock' may be planned and accounted for in the consumption decision in period before onset with no change in consumption in the period of onset, causing a spurious association between the health shock and consumption. Second, economic shocks, such as job loss, in the previous (or current) period may affect both changes in health and outcomes in the current period. Third, an individual's report of a doctor-diagnosed disease is related to the use of health care which may vary systematically with observed and unobserved characteristics.

Our estimation strategy includes effects for the period two years prior to onset which provides some insight as to whether changes in health or labour force transition may be planned. Indeed, we do observe departures from expected levels of food consumption expenditures and health expenditures in the period prior to onset. There is no indication of earning shocks prior to the health shock, however. More formally, to assess the extent to which health is deteriorating prior to the shock, we estimate equations (1) and (2) using a binary outcome of poor general health and a linear probability model. We use a common measure of self-reported health (SRH) and construct an indicator variable equal to 1 if in poor health and equal to 0 if in good health.[16] We present results diagrammatically for the full NCD onset sample and by asset rich and poor subsamples (Figure 9). The coefficients and corresponding standard errors for the full onset sample and onset groups are presented in Appendix Table 4.

As shown in Figure 9, there is a significant jump in the probability of reporting poor health in the year of onset which is preceded by a relatively small increase in the period before onset. The pattern is the same irrespective of whether the household is asset rich or poor, and for whether the NCD onset is persistent or transitory in nature (Appendix Table 4). For the consistent onset group, the effect is negative and statistically insignificant in the period prior to onset, and holds for the rich and poor subsamples. This is consistent with the view that

[16] For SRH, poor health is equal to 1 if "unhealthy" or "fair" and equal to 0 if "relatively healthy" "very healthy" or "extremely healthy".

more severe health shocks are likely to occur more suddenly and unexpectedly. It is further reassuring that the pattern of poor SRH after NCD onset tracks the duration of the disease as shown by the subgroup analysis in Appendix Table 4. Taken together the results suggest that it is the onset of the NCD which is largely driving poor health and not vice-versa.

[Figure 9]

Whilst there is no hitherto indication of a shock to earnings prior to the year of the NCD, we examine this further by regressing NCD onset on lagged earnings conditional on the included covariates in equation (1). We restrict the sample to individuals that report NCD onset over the sample period as previously defined. If past income shocks such as through job displacement affect current health, then we should see a negative relationship between the health shock and changes in lagged earnings. As shown in Appendix Table 5, the coefficient on the natural logarithm of lagged individual earnings is *positive*, very small in magnitude and only marginally significant. Subsample analysis reveals that the effect derives from the rich sample. Effects associated with changes in lagged household earnings per capita are statistically insignificant. Across the NCD onset groups estimated effects are statistically insignificant except for the (poor) consistent onset group. Once again the coefficients are positive and small in magnitude. Overall, the results suggest that potential bias arising from past economic shocks is not a concern.

For the measurement error associated with self-reported doctor-diagnosed NCD, our specification to estimate the temporal changes in economic outcomes associated with NCD onset includes individual fixed effects, which address the time-invariant unobserved characteristics. In addition, to the extent that wealth is an important determinant of health care utilisation, the finding that the effects of NCD on poor health do not differ across rich and poor subsamples suggests further that measurement error is minimal.

Another concern relates to the possibility that major health shocks shift preferences. Observed correlations between the health shock and changes in consumption may be attributed to changes in preferences rather than the disease itself. We follow other studies and apply an implicit test for the existence of state dependence (Gertler and Gruber, 2002; Gertler et al., 2009; Sparrow et al., 2014). The basic idea is that state dependence should not depend on the financial ability to self-insure consumption. As illustrated in Section 5.4, this is not what we observe in the sample under study with the rich demonstrating greater ability to smooth consumption in the face of a health shock relative to the poor. Consistent with other studies in less developed country contexts, this suggests that the effect of illness on economic well-being is operating through the budget constraint as distinct to state dependence (Gertler and Gruber, 2002; Gertler et al., 2009; Sparrow et al., 2014).

Since we are dealing with longitudinal data, there remains the potential for attrition bias. The primary concern is that probability of attrition is systematically related to the onset of a doctor diagnosed NCD. To examine this, we regress a binary attrition variable on the NCD indicator and the complete list of covariates for the baseline sample. There is no evidence that attrition is correlated with the NCD indicator: the coefficient estimates is small in magnitude and statistically insignificantly different from zero.[17]

[17] The attrition indicator equals to 1 if the individuals cannot be tracked in any of the subsequent survey rounds and to 0 if remained in all five waves. The estimated coefficient on the NCD variable is -0.0035 with a standard error 0.008.

6. Discussion and conclusion

This paper studies the long-run adverse effects on economic well-being associated with onset of a NCD shock. We use longitudinal data for the period 2010-2018 from a sample of working aged persons (16-60 years) in China. The paper makes two primary contributions to the health shocks literature. First, the health shock variable as measured by the onset of a NCD has received little attention in spite of the rapid rise in global prevalence and incidence. NCDs may capture more major and persistent health conditions with adverse consequences for well-being. Second, we estimate temporal loss patterns up to six years after the year of onset to examine the long-term impacts of the health shock. The vast majority of the existing literature particularly from low-and-middle-income country contexts estimates contemporaneous or short-term effects.

We find that after a period of temporal loss individuals and their families in China can insure consumption against the average NCD shock over the long-run. The main source of financial risk is a large increase in out-of-pocket health spending in the year of onset which declines with time. Individual earnings drop by around 10 percent and remain flat over time but per capita household earnings are largely unaffected. Consistent with the findings of Liu (2016), this suggests a degree of household labour substitution following a NCD shock of an adult member. The results may also reflect income smoothing mechanisms taken prior to the shock such as through conservative production or employment choices and diversifying economic activities (Morduch, 1995). Whilst it is difficult to disentangle income smoothing from consumption smoothing mechanisms, we find little evidence of deteriorating health or economic shocks before the onset of the NCD which may suggest that the results are more likely from post-onset labour supply response.

Whilst we find that the average Chinese working-age individual and their household can insure long-run consumption against the average NCD shock, it masks significant heterogeneity in the response of consumption to the duration of the disease as well as different means to smooth consumption across the population. Similar to studies in high-income country settings (Charles, 2003; Meyer and Mok, 2019), we find that individuals and households in China are significantly less able to insure long-term (food) consumption expenditures against a persistent health shock which is driven by large persistent shocks to both out-of-pocket health spending and individual earnings. However, the earnings loss is reasonably well self-insured by households over time.

We find that health spending increases significantly in the year of onset and remains above historical levels in subsequent periods for the insured sample in line with other studies in China that health insurance has not reduced out-of-pocket health expenditures (e.g. Liu and Zhao, 2012; Wagstaff et al., 2009; Yip and Hsiao, 2009). Consistent with Liu (2016), we also find some evidence that over the long-run health insurance mitigates the financial risks on health expenditures and loss of individual earnings associated with NCD shocks. However, it offers significantly less financial protection against persistent NCD shocks which captures a dimension of disease severity. Benefit packages differ across schemes and regions yet typically households incur a certain share of high health care costs (Fang et al., 2019; Liu, 2016). Whilst recently there exists catastrophic medical insurance (or critical illness insurance), the eligibility criteria for this insurance (out-of-pocket expenditures exceeds the average disposable income per capita in the local area) and cost sharing rate (currently 50%)

does not vary by the patient's disease severity or economic status (Fang et al., 2019). Our results suggest that further financial protection targeted to individuals and households who are less able to self-insure major and more permanent chronic conditions may lead to important welfare gains.

Consistent with the health shocks literature from other developing country settings (Genoni, 2012; Khan et al., 2015; Sparrow et al., 2014), we find that individuals with low underlying levels of wealth are less able to insure health shocks as measured by a new doctor diagnosed NCD. We observe this to be the case over the long-run which represents a new finding in the literature. Specifically, individuals with below median level of monetary wealth at baseline experience relatively large period-on-period increases health spending and drops in earnings as a proportion of their levels more than one period prior to the onset of the NCD. The deeper drop in individual earnings for the asset poor may relate to different job profiles that rely more heavily on strength and endurance, and therefore good health (Strauss and Thomas, 1998). As shown in Appendix Table 6, there is a higher concentration of the poor living in rural areas and working in the informal sector which supports this idea. At the same time, household earnings are relatively less impacted by the health shock which may reflect more flexible working arrangements associated with informal employment. Overall, the main source of financial risk facing the poor in the event of a NCD shock is increased health spending over the short-to-medium term.

Overall, the results of this paper show that after a period of temporal loss individuals and their families in China can insure consumption against the average NCD shock over the long-run. However, we observe significant heterogeneity that individuals with consistent onset, with below median wealth, and without health insurance face higher financial risks and are least equipped to smooth consumption over the long-term. The results indicate that it is important to examine the impacts of health shocks over time and by chronicity. This particularly relates to developing country settings where insurance and credit markets are partial or incomplete. Our results are subject to the caveat of small sample sizes, particularly for the sub-onset groups and subsamples in the later periods from onset. While many coefficients are statistically insignificant, the magnitude and temporal patterns of the results suggest that they are informative and warrant discussion (Abadie, 2020).

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Tables and Figures

Table 1. NCD onset patterns of working age population

	Cases	%
Consistent onset	358	19.1%
One-time onset	954	50.9%
Irregular onset	562	30.0%
All onset	1,874	100.0%

Source: CFPS 2010-2018

Table 2 Summary statistics by NCD onset groups, at baseline (2010)

			Onset groups		
	Non-NCD	All Onset	Consistent	One-time	Irregular
Age	37.35	41.01	42.65	39.70	42.19
	(0.16)	(0.19)	(0.39)	(0.28)	(0.3)
Female	0.54	0.62	0.66	0.61	0.63
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
Urban Hukou	0.22	0.25	0.22	0.24	0.28
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Married	0.87	0.94	0.95	0.92	0.95
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Less than primary school	0.17	0.23	0.26	0.21	0.25
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Primary school	0.25	0.23	0.25	0.23	0.21
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Lower secondary school	0.37	0.32	0.32	0.33	0.31
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
Upper secondary school	0.15	0.16	0.11	0.17	0.16
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
College above	0.06	0.07	0.05	0.07	0.07
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Household head	0.43	0.41	0.43	0.41	0.40
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
Economic outcomes (per capita)					
Consumption (non-health) expenditures	6133.32	6030.71	5622.59	6090.70	6186.84
	(113.07)	(167.35)	(445.6)	(232.78)	(273.80)
Food expenditures	2366.81	2207.67	2122.33	2261.98	2170.30
	(39.36)	(49.51)	(131.17)	(71.91)	(73.46)
Non-food expenditures	3715.42	3841.70	3547.46	3836.39	4038.01
	(91.77)	(149.84)	(394.61)	(206.01)	(253.70)
Health expenditures	628.54	952.43	826.13	930.33	1069.68
	(38.80)	(62.59)	(80.54)	(94.10)	(123.70)
Household earnings	7800.03	7389.35	6728.28	7495.18	7631.04
	(144.37)	(211.82)	(458.6)	(320.34)	(343.98)
Individual earnings	10,681.05	10,252.88	8,584.86	11,135.88	9,842.25
	(283.61)	(553.46)	(702.92)	(1,009.09)	(554.23)
Household assets	60520.01	71,643.00	61846.95	74335.49	73264.42
	(1851.29)	(3590.96)	(6318.83)	(5663.94)	(5897.90)
Number of observations	3,028	1,874	358	954	562

Notes: Standard errors are in parentheses.
Source: CFPS 2010-2018

Table 3. The dynamic effect of NCD onset on economic outcomes

	Non-health consumption expenditures	Food consumption expenditures	Non-food consumption expenditures	Health expenditures	Household earnings	Individual earnings
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All NCD onset						
-1	-0.025	-0.060**	-0.016	0.240***	0.019	-0.041
	(0.035)	(0.029)	(0.052)	(0.084)	(0.031)	(0.057)
0	-0.022	-0.068**	-0.01	0.486***	0.028	-0.079
	(0.039)	(0.032)	(0.057)	(0.102)	(0.034)	(0.059)
1	0.016	-0.033	0.023	0.292***	0.007	-0.130**
	(0.042)	(0.035)	(0.062)	(0.108)	(0.036)	(0.063)
2	0.082	-0.050	0.128*	0.365***	-0.023	-0.046
	(0.053)	(0.038)	(0.075)	(0.128)	(0.041)	(0.069)
3	-0.047	-0.026	-0.082	0.039	0.026	-0.102
	(0.067)	(0.048)	(0.095)	(0.158)	(0.058)	(0.092)
Panel B: Consistent NCD onset						
-1	0.009	-0.096	0.059	0.317***	0.022	0.080
	(0.077)	(0.061)	(0.116)	(0.115)	(0.061)	(0.094)
0	-0.054	-0.159**	-0.016	0.635***	-0.003	-0.124
	(0.089)	(0.064)	(0.133)	(0.156)	(0.066)	(0.104)
1	0.043	-0.086	0.093	0.599***	-0.035	-0.037
	(0.111)	(0.065)	(0.164)	(0.158)	(0.063)	(0.090)
2	0.058	-0.137*	0.146	0.702***	-0.038	-0.154
	(0.153)	(0.077)	(0.238)	(0.232)	(0.092)	(0.125)
3	-0.151	-0.282*	-0.092	0.345	0.073	-0.293
	(0.125)	(0.145)	(0.179)	(0.316)	(0.216)	(0.262)
Panel C: One-time NCD onset						
-1	-0.066	-0.068*	-0.075	0.178	0.013	-0.086
	(0.044)	(0.038)	(0.065)	(0.117)	(0.041)	(0.085)
0	-0.017	-0.050	-0.008	0.469***	0.040	-0.097
	(0.046)	(0.040)	(0.067)	(0.136)	(0.044)	(0.085)
1	-0.025	-0.025	-0.041	0.133	0.029	-0.225***
	(0.046)	(0.045)	(0.066)	(0.133)	(0.049)	(0.087)
2	0.081	-0.045	0.126	0.106	-0.013	-0.057
	(0.070)	(0.049)	(0.099)	(0.155)	(0.052)	(0.097)
3	0.019	0.022	0.000	-0.096	0.082	-0.122
	(0.101)	(0.068)	(0.139)	(0.215)	(0.078)	(0.132)
Panel D: Irregular NCD onset						
-1	0.072	0.042	0.068	0.220	0.028	0.040
	(0.058)	(0.052)	(0.086)	(0.179)	(0.061)	(0.092)
0	0.032	0.018	0.010	0.324*	0.030	0.040
	(0.059)	(0.052)	(0.081)	(0.174)	(0.063)	(0.108)
1	0.115*	0.047	0.116	0.265	-0.002	0.060
	(0.064)	(0.052)	(0.092)	(0.181)	(0.063)	(0.106)
2	0.141*	0.041	0.154	0.451**	-0.027	0.043
	(0.072)	(0.054)	(0.099)	(0.195)	(0.067)	(0.097)
3	-0.038	0.049	-0.129	0.023	-0.024	0.012
	(0.085)	(0.063)	(0.123)	(0.215)	(0.084)	(0.131)

Note: Coefficient estimates are from the fixed effects Poisson models. Standard errors are clustered by person and are reported in parentheses. *, **, *** denote significance at the 10, 5, and 1% level, respectively. Controls for age, age squared, education, marital status, an indicator of urban/rural Hukou, indicator of household head, indicator of whether household moved since prior wave and a set of time period fixed effects are included in all specifications but are not reported.
Source: CFPS 2010-2018

Figure 1. The dynamic effect of NCD onset on consumption expenditures

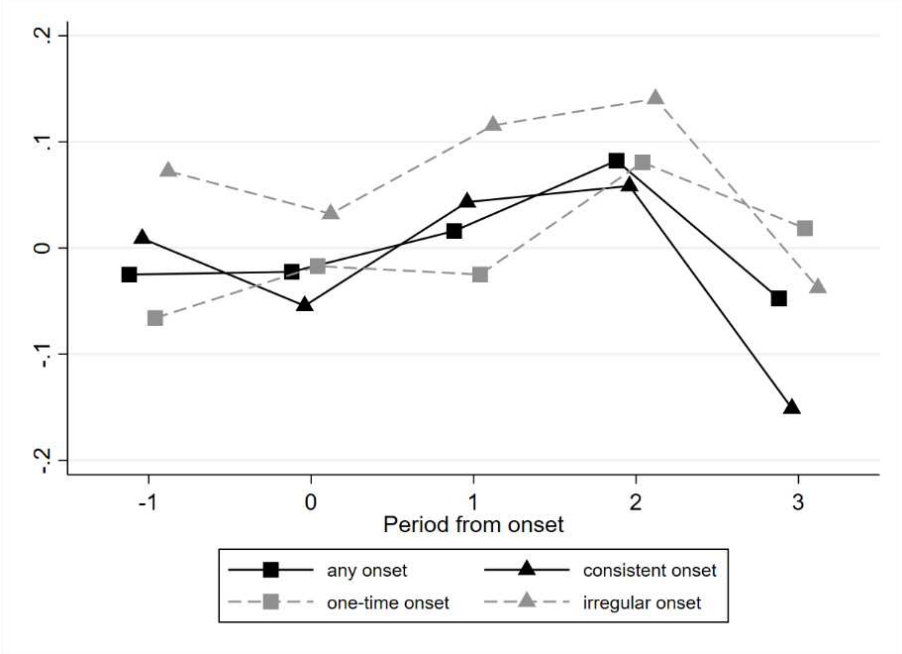


Figure 2. The dynamic effect of NCD onset on food expenditures

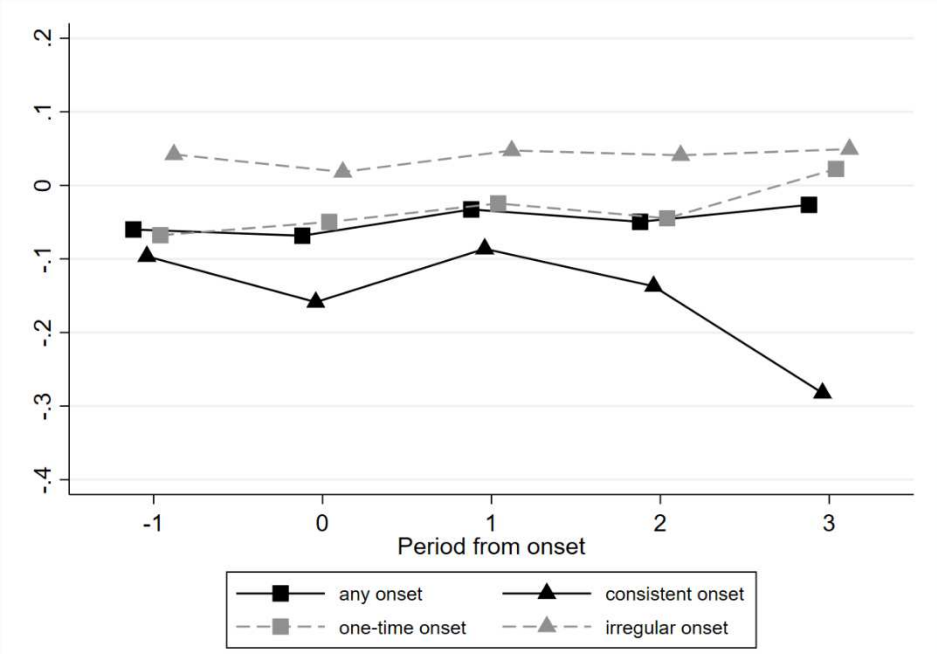


Figure 3. The dynamic effect of NCD onset on non-food expenditures

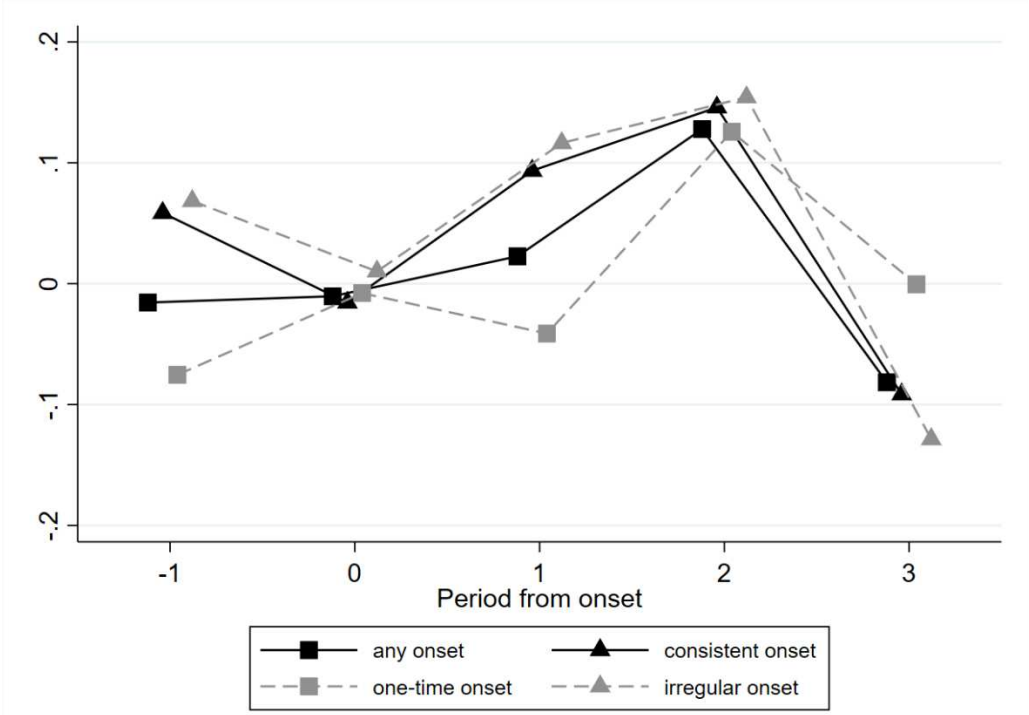


Figure 4. The dynamic effect of NCD onset on health expenditures

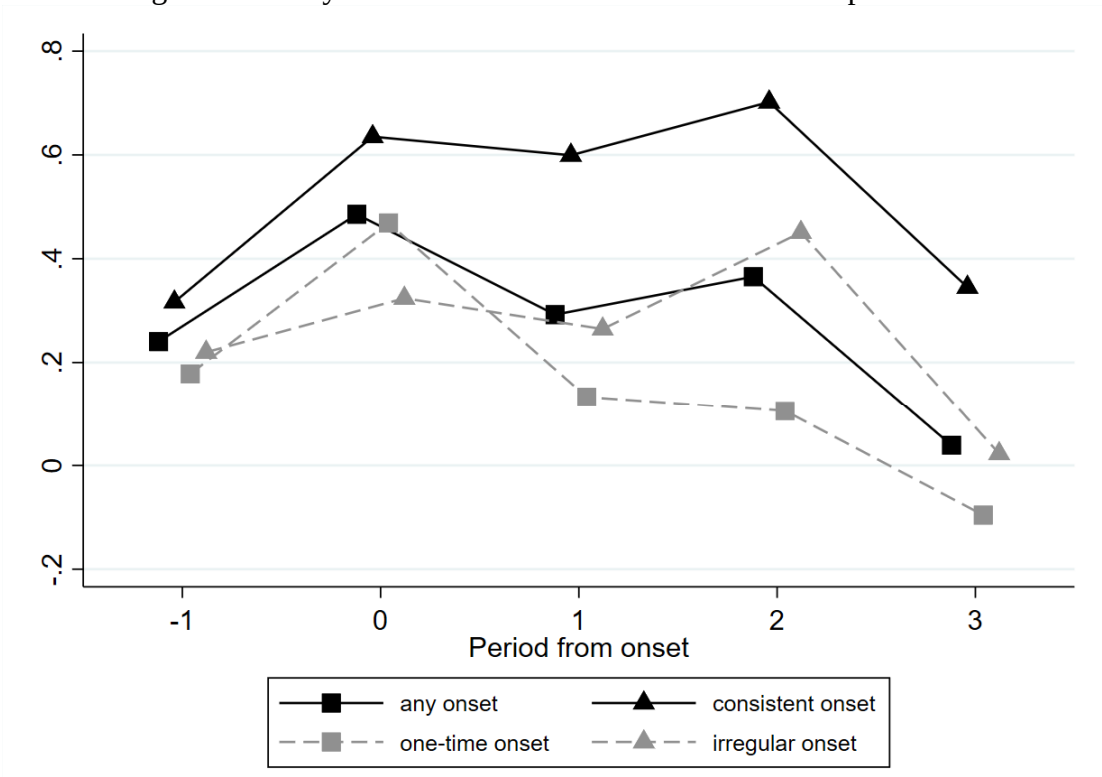


Figure 5. The dynamic effect of NCD onset on household earnings

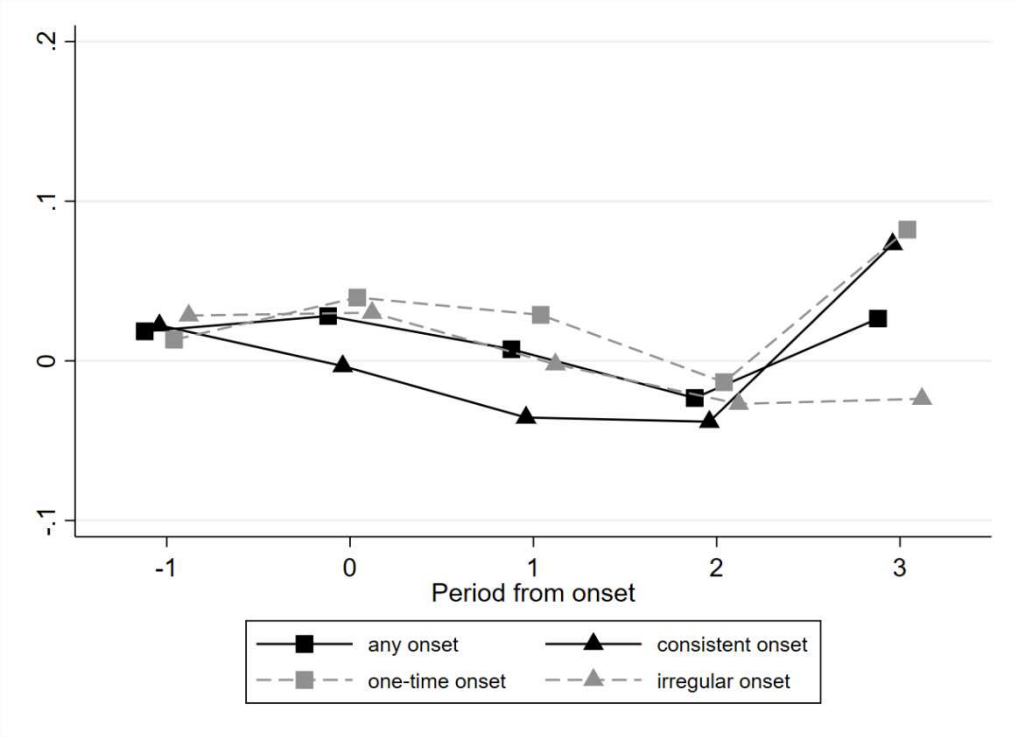


Figure 6. The dynamic effect of NCD onset on individual earnings

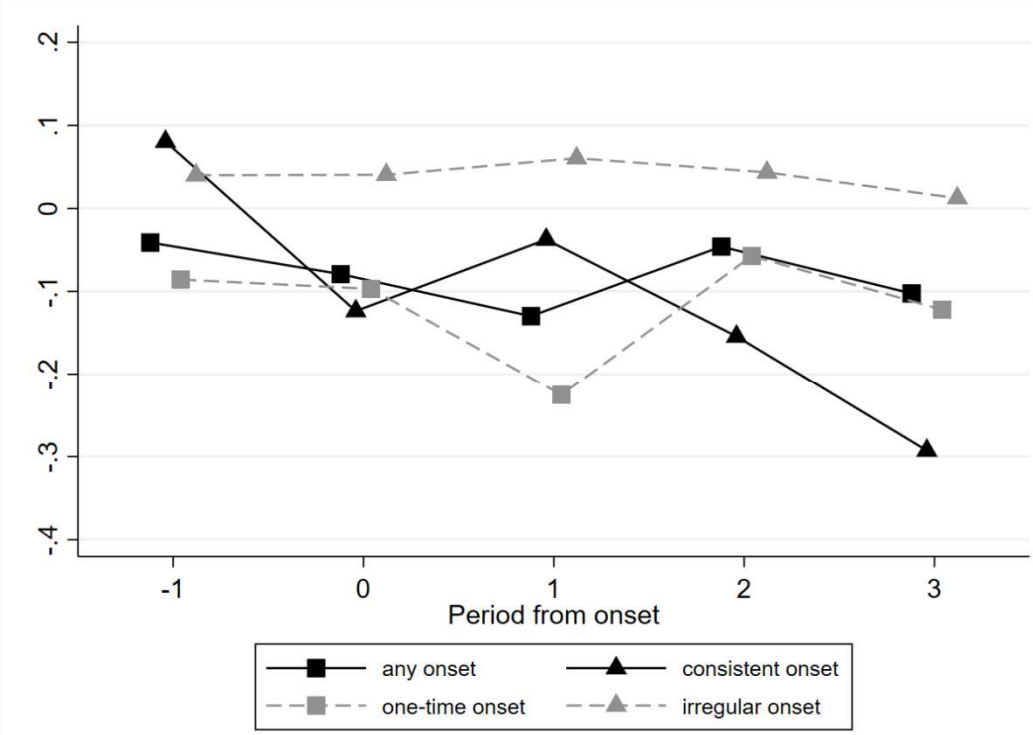


Figure 7. The dynamic effect of NCD onset on economic outcomes, by household wealth

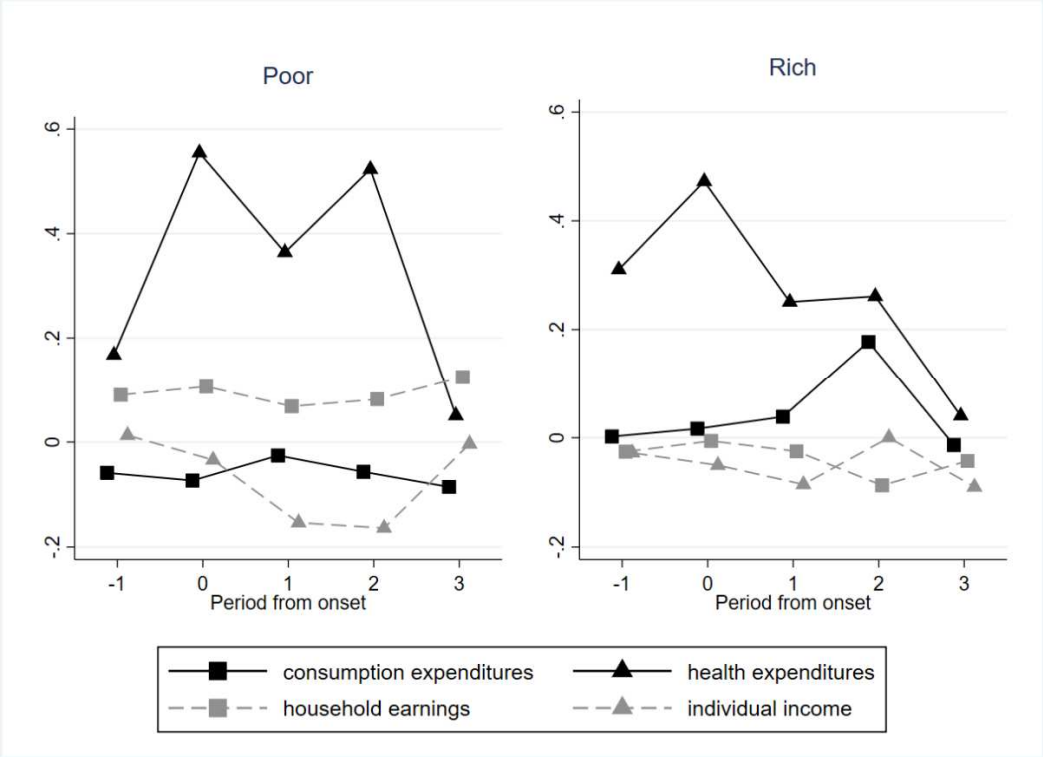


Figure 8. The dynamic effect of NCD onset on economic outcomes, by health insurance status

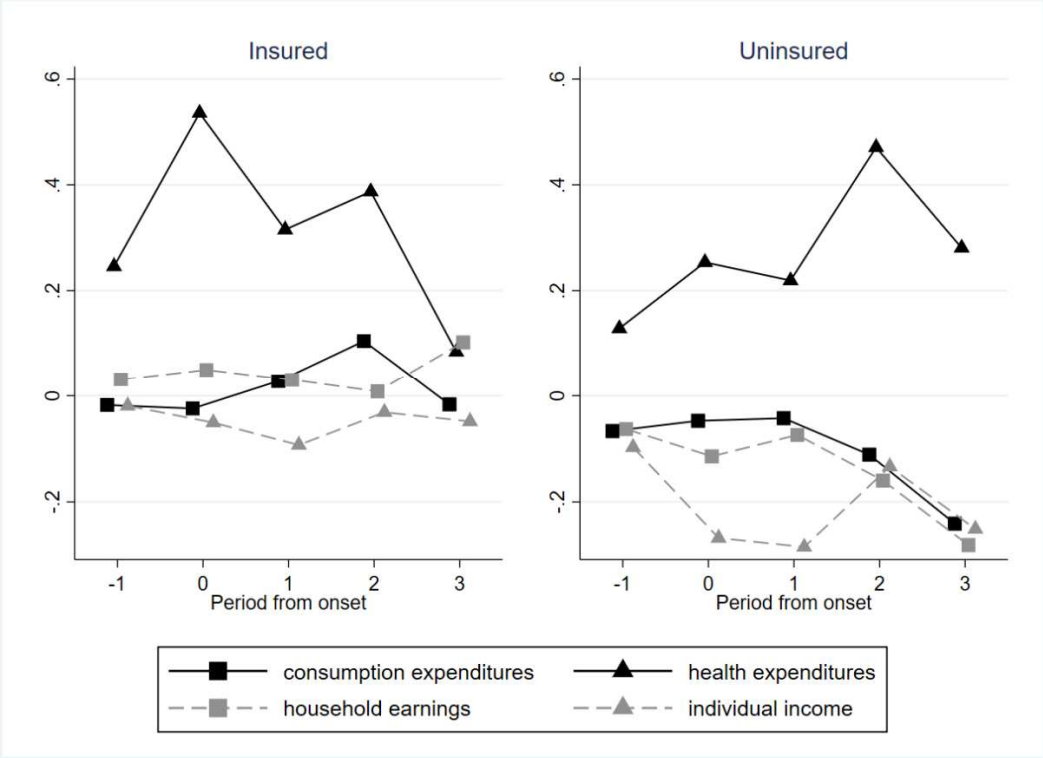
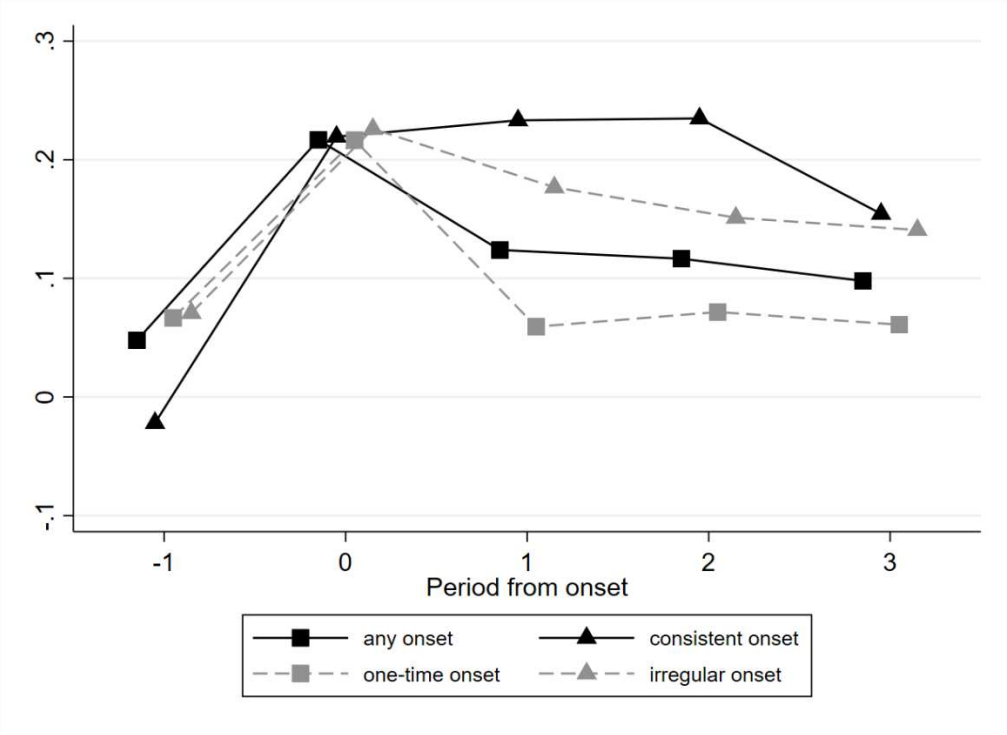


Figure 9. The dynamic effect of NCD onset on poor self-reported health



Appendix A. Construction and definition of key variables

NCD shock

We identify NCD-affected individuals based on the question: “During the past six months, have you had any doctor-diagnosed chronic disease”; and, the self-reported doctor diagnosis of the disease. Each respondent who answered “Yes” to the first question was asked to select the type of disease from the Disease Codebook, and the two most serious diseases were recorded if there were more than one. We adopt the definition of NCDs determined by the National Health and Family Planning Commission, following the classification of "Group II Diseases" as per the ICD-10 code (World Health Organization, 2016). Specifically, NCDs include circulation system diseases (such as heart diseases, stroke), cancer, diabetes and other endocrine diseases, chronic lung disease, nervous system diseases, digestive system diseases, genitourinary system disease, eye and ear diseases, skin, muscle and skeleton related disease and congenital anomalies.

Non-health consumption expenditures. Our measure of household consumption expenditure includes total non-health consumption expenditures, food expenditures, non-food expenditures. The food spending in the questionnaire is based on one-month recall period, while others are based on a mix of one-month and one-year recall period. Food consumption includes food purchased in the market place and the market value of home produced and consumed food. For the non-food consumption, we include daily used commodities and necessities, utilities, transportation and communication, clothing, education and entertainment. We exclude health expenditures; expenses on infrequent “lumpy” event such as marriages, births and funerals; charitable contributions, gifts and remittances to others (Deaton and Zaidi, 2002; Haughton and Khandker, 2009)

Out-of-pocket health expenditures. Out-of-pocket health expenditures include total household expenditures on medical care and other health care expenditures in the past year. It excluded that is reimbursed or reimbursable by health insurance.

Household earnings. In CFPS, household income segments include wage income, operating income including business and farming income (including the value of the products consumed by the families), transfer income, property income and other income. To ensure the comparability between the baseline and the follow-up waves, CFPS generated a set of income variables in the follow-up waves that were comparable to those in 2010 (Xie et al., 2017). In this study, earned income includes all wage income, operating income including net agriculture income and non-agriculture self-employed income of the household earned over the past one year.

Individual earnings. CFPS collects individual-level earnings in the adult questionnaire, including potential sources of formal employment, business, agricultural-related (farming, fishing, forestation, livestock). It includes earnings from business operation and agricultural work for own household and employed by others.

Appendix Table 1. The dynamic effect of NCD onset on economic outcomes, by wealth status at baseline

	Non-health consumption expenditures		Food consumption expenditures		Non-food consumption expenditures		Health expenditures		Household earnings		Individual earnings	
	Wealth		Wealth		Wealth		Wealth		Wealth		Wealth	
	<Median (1)	>Median (2)	<Median (3)	>Median (4)	<Median (5)	>Median (6)	<Median (7)	>Median (8)	<Median (9)	>Median (10)	<Median (11)	>Median (12)
Panel A: All NCD onset												
-1	-0.059	0.002	-0.066	-0.059	-0.058	0.024	0.168	0.310**	0.090**	-0.026	0.013	-0.028
	(0.049)	(0.049)	(0.041)	(0.041)	(0.079)	(0.070)	(0.107)	(0.128)	(0.040)	(0.040)	(0.075)	(0.061)
0	-0.073	0.017	-0.072	-0.058	-0.074	0.037	0.555***	0.473***	0.106**	-0.006	-0.034	-0.050
	(0.053)	(0.054)	(0.045)	(0.045)	(0.083)	(0.078)	(0.133)	(0.146)	(0.048)	(0.043)	(0.086)	(0.065)
1	-0.026	0.039	-0.042	-0.025	-0.032	0.051	0.364**	0.251*	0.068	-0.025	-0.154*	-0.085
	(0.061)	(0.059)	(0.053)	(0.047)	(0.093)	(0.084)	(0.149)	(0.147)	(0.046)	(0.049)	(0.085)	(0.074)
2	-0.057	0.177**	-0.029	-0.061	-0.09	0.272**	0.523***	0.261	0.082	-0.087	-0.164	0.000
	(0.066)	(0.075)	(0.060)	(0.050)	(0.096)	(0.105)	(0.183)	(0.168)	(0.055)	(0.055)	(0.115)	(0.084)
3	-0.086	-0.013	-0.024	-0.033	-0.143	-0.037	0.051	0.04	0.124	-0.043	-0.004	-0.090
	(0.085)	(0.094)	(0.074)	(0.062)	(0.123)	(0.134)	(0.230)	(0.211)	(0.081)	(0.078)	(0.157)	(0.110)

Note: Coefficient estimates are from the fixed effects Poisson models. Standard errors are clustered by person and are reported in parentheses. *, **, *** denote significance at the 10, 5, and 1% level, respectively. Controls for age, age squared, education, marital status, an indicator of urban/rural Hukou, indicator of household head, indicator of whether household moved since prior wave and a set of time period fixed effects are included in all specifications but are not reported. We divide the sample into individuals with the total value of household assets at baseline higher or lower than the median denoted as asset 'rich' and 'poor'.
Source: CFPS 2010-2018

Appendix Table 2. The dynamic effect of NCD onset on economic outcomes, by health insurance (HI) status at baseline

	Non-health consumption expenditures		Food consumption expenditures		Non-food consumption expenditures		Health expenditures		Household earnings		Individual earning	
	With HI	No HI	With HI	No HI	With HI	No HI	With HI	No HI	With HI	No HI	With HI	No HI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: All NCD onset												
-1	-0.017	-0.067	-0.051	-0.085	-0.009	-0.066	0.246***	0.129	0.031	-0.063	-0.019	-0.097
	(0.037)	(0.104)	(0.032)	(0.076)	(0.054)	(0.164)	(0.093)	(0.186)	(0.032)	(0.096)	(0.063)	(0.148)
0	-0.024	-0.047	-0.064*	-0.117	-0.013	-0.039	0.536***	0.254	0.05	-0.114	-0.051	-0.268*
	(0.042)	(0.113)	(0.035)	(0.086)	(0.060)	(0.176)	(0.106)	(0.251)	(0.035)	(0.105)	(0.065)	(0.160)
1	0.028	-0.042	-0.022	-0.105	0.038	-0.055	0.315***	0.219	0.03	-0.074	-0.093	-0.285*
	(0.046)	(0.122)	(0.037)	(0.103)	(0.066)	(0.186)	(0.110)	(0.279)	(0.039)	(0.106)	(0.070)	(0.151)
2	0.105*	-0.111	-0.035	-0.104	0.155*	-0.154	0.387***	0.471	0.008	-0.16	-0.031	-0.134
	(0.058)	(0.124)	(0.041)	(0.106)	(0.083)	(0.185)	(0.133)	(0.313)	(0.044)	(0.109)	(0.074)	(0.194)
3	-0.016	-0.241*	0.011	-0.138	-0.045	-0.394**	0.084	0.281	0.102	-0.281*	-0.048	-0.251
	(0.075)	(0.127)	(0.053)	(0.122)	(0.105)	(0.190)	(0.165)	(0.457)	(0.063)	(0.153)	(0.100)	(0.238)

Note: Coefficient estimates are from the fixed effects Poisson models. Standard errors are clustered by person and are reported in parentheses. *, **, *** denote significance at the 10, 5, and 1% level, respectively. Controls for age, age squared, education, marital status, an indicator of urban/rural Hukou, indicator of household head, indicator of whether household moved since prior wave and a set of time period fixed effects are included in all specifications but are not reported. We use health insurance status at baseline.

Source: CFPS 2010-2018

Appendix Table 3. The dynamic effect of NCD onset groups on economic outcomes conditional on being insured at baseline

	Non-health consumption expenditures	Food consumption expenditures	Non-food consumption expenditures	Health expenditures	Household earnings	Individual earnings
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Consistent NCD onset						
-1	0.054	-0.086	0.131	0.333***	0.062	0.141
	(0.079)	(0.068)	(0.113)	(0.122)	(0.061)	(0.089)
0	0.001	-0.150**	0.079	0.719***	0.055	-0.073
	(0.092)	(0.070)	(0.131)	(0.154)	(0.067)	(0.108)
1	0.129	-0.053	0.214	0.563***	0.025	0.025
	(0.108)	(0.071)	(0.154)	(0.167)	(0.063)	(0.095)
2	0.145	-0.091	0.268	0.719***	0.022	-0.070
	(0.163)	(0.083)	(0.250)	(0.244)	(0.096)	(0.128)
3	-0.017	-0.185	0.083	0.426	0.168	-0.195
	(0.130)	(0.159)	(0.182)	(0.373)	(0.233)	(0.255)
Panel C: One-time NCD onset						
-1	-0.097**	-0.058	-0.130*	0.144	0.005	-0.084
	(0.047)	(0.040)	(0.069)	(0.134)	(0.045)	(0.096)
0	-0.057	-0.039	-0.076	0.536***	0.036	-0.069
	(0.050)	(0.043)	(0.073)	(0.150)	(0.047)	(0.096)
1	-0.037	-0.022	-0.061	0.167	0.026	-0.217**
	(0.051)	(0.047)	(0.074)	(0.141)	(0.054)	(0.100)
2	0.046	-0.054	0.075	0.133	-0.021	-0.07
	(0.081)	(0.051)	(0.114)	(0.171)	(0.059)	(0.105)
3	0.022	0.058	-0.008	0.013	0.146*	-0.049
	(0.117)	(0.077)	(0.158)	(0.225)	(0.085)	(0.144)
Panel D: Irregular NCD onset						
-1	0.114*	0.042	0.13	0.247	0.074	0.077
	(0.064)	(0.058)	(0.094)	(0.200)	(0.063)	(0.100)
0	0.051	0.011	0.047	0.274	0.089	0.067
	(0.062)	(0.057)	(0.085)	(0.199)	(0.065)	(0.119)
1	0.108	0.053	0.106	0.284	0.06	0.124
	(0.067)	(0.056)	(0.097)	(0.194)	(0.064)	(0.116)
2	0.201**	0.068	0.231**	0.430**	0.057	0.087
	(0.079)	(0.060)	(0.108)	(0.211)	(0.064)	(0.106)
3	0.003	0.078	-0.075	-0.024	0.085	0.049
	(0.093)	(0.068)	(0.134)	(0.234)	(0.086)	(0.142)

Note: Coefficient estimates are from the fixed effects Poisson models. Standard errors are clustered by person and are reported in parentheses. *, **, *** denote significance at the 10, 5, and 1% level, respectively. Controls for age, age squared, education, marital status, an indicator of urban/rural Hukou, indicator of household head, indicator of whether household moved since prior wave and a set of time period fixed effects are included in all specifications but are not reported. We use health insurance status at baseline. The dynamic effects of all NCD onset groups are reported in Appendix Table 2 (Panel A).

Source: CFPS 2010-2018

Appendix Table 4. The dynamic effect of NCD onset on poor self-reported health

	Full sample	Poor sample	Rich sample
Panel A: All NCD onset			
-1	0.048***	0.053**	0.035
	(0.015)	(0.021)	(0.023)
0	0.217***	0.226***	0.203***
	(0.017)	(0.024)	(0.025)
1	0.124***	0.108***	0.135***
	(0.018)	(0.025)	(0.026)
2	0.117***	0.106***	0.130***
	(0.020)	(0.029)	(0.030)
3	0.098***	0.065*	0.137***
	(0.027)	(0.039)	(0.040)
Panel B: Consistent NCD onset			
-1	-0.022	-0.022	-0.037
	(0.029)	(0.038)	(0.050)
0	0.219***	0.222***	0.208***
	(0.031)	(0.040)	(0.054)
1	0.233***	0.233***	0.220***
	(0.032)	(0.040)	(0.055)
2	0.235***	0.223***	0.229***
	(0.040)	(0.054)	(0.063)
3	0.154**	0.207**	0.073
	(0.075)	(0.105)	(0.112)
Panel C: One-time NCD onset			
-1	0.067***	0.076***	0.054*
	(0.020)	(0.029)	(0.028)
0	0.217***	0.230***	0.201***
	(0.022)	(0.031)	(0.031)
1	0.059***	0.040	0.077**
	(0.022)	(0.032)	(0.032)
2	0.072***	0.083**	0.068*
	(0.026)	(0.037)	(0.038)
3	0.061*	0.015	0.108*
	(0.037)	(0.051)	(0.056)
Panel D: Irregular NCD onset			
-1	0.071**	0.064	0.066
	(0.035)	(0.051)	(0.049)
0	0.226***	0.216***	0.230***
	(0.036)	(0.053)	(0.051)
1	0.177***	0.126**	0.214***
	(0.035)	(0.051)	(0.049)
2	0.151***	0.096*	0.207***
	(0.038)	(0.055)	(0.054)
3	0.141***	0.087	0.205***
	(0.045)	(0.065)	(0.063)

Note: Coefficient estimates are from the fixed effects linear models. Standard errors are clustered by person and are reported in parentheses.

*, **, *** denote significance at the 10, 5, and 1% level, respectively. Controls for age, age squared, education, marital status, an indicator of urban/rural Hukou, indicator of household head, indicator of whether household moved since prior wave and a set of time period fixed effects are included in all specifications but are not reported.
Source: CFPS 2010-2018

Appendix Table 5. The effect of past earnings on current NCD status

	Full sample	Poor sample	Rich sample
Full sample			
Log of lagged household earnings per capita	0.001	0.002	-0.001
	(0.001)	(0.002)	(0.002)
Log of lagged individual earnings	0.001*	0.001	0.002*
	(0.001)	(0.001)	(0.001)
Panel A: All NCD onset sample			
Log of lagged household earnings per capita	0.001	0.005	-0.006
	(0.003)	(0.004)	(0.005)
Log of lagged individual earnings	0.003	0.002	0.005
	(0.002)	(0.003)	(0.003)
Panel B: Consistent NCD onset sample			
Log of lagged household earnings per capita	0.004	0.013**	-0.010
	(0.004)	(0.006)	(0.006)
Log of lagged individual earnings	0.006**	0.008**	0.002
	(0.003)	(0.004)	(0.004)
Panel C: One-time NCD onset			
Log of lagged household earnings per capita	0.001	0.005	-0.007
	(0.004)	(0.006)	(0.006)
Log of lagged individual earnings	0.001	0.002	0.000
	(0.003)	(0.004)	(0.004)
Panel D: Irregular NCD onset			
Log of lagged household earnings per capita	-0.002	-0.007	0.006
	(0.006)	(0.008)	(0.010)
Log of lagged individual earnings	0.002	-0.005	0.008
	(0.004)	(0.006)	(0.005)

Note: In each panel, each cell presents the coefficient estimates in a separate OLS regression. Standard errors (in parentheses) are clustered at the individual level. Regressions include age, age squared, marital status, and education level, indicator variables for the household head and whether the household moved during the sample frame, individual fixed effects and time fixed effects.
Source: CFPS 2010-2018

Appendix Table 6. Summary statistics among NCD onset sample, by wealth and insurance status at baseline (2010)

	Poor	Rich	Insured	Uninsured
Age	41.12	40.94	41.36	41.36
	(0.25)	(0.28)	(0.19)	(0.43)
Female	0.64	0.60	0.62	0.66
	(0.02)	(0.02)	(0.01)	(0.03)
Urban Hukou	0.17	0.34	0.21	0.42
	(0.01)	(0.02)	(0.01)	(0.03)
Married	0.94	0.93	0.95	0.94
	(0.01)	(0.01)	(0.01)	(0.02)
Less than primary school	0.32	0.14	0.24	0.20
	(0.02)	(0.01)	(0.01)	(0.02)
Primary school	0.26	0.19	0.23	0.20
	(0.01)	(0.01)	(0.01)	(0.02)
Lower secondary school	0.29	0.35	0.31	0.38
	(0.02)	(0.02)	(0.01)	(0.03)
Upper secondary school	0.12	0.20	0.15	0.16
	(0.01)	(0.01)	(0.01)	(0.02)
College above	0.02	0.12	0.07	0.05
	(0.00)	(0.01)	(0.01)	(0.01)
Household head	0.41	0.41	0.42	0.41
	(0.02)	(0.02)	(0.01)	(0.03)
Household moved since prior wave	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Health insurance coverage	0.84	0.87	1.00	0.00
	(0.01)	(0.01)	(0.00)	(0.00)
From poor household (household per capita wealth lower than median) in 2010	1.00	0.00	0.52	0.58
	(0.00)	(0.00)	(0.01)	(0.03)
Unemployed/retired	0.44	0.33	0.35	0.55
	(0.02)	(0.02)	(0.01)	(0.03)
Formal sector	0.14	0.34	0.24	0.19
	(0.01)	(0.02)	(0.01)	(0.02)
Informal sector	0.42	0.33	0.41	0.26
	(0.02)	(0.02)	(0.01)	(0.03)
Economic outcomes (per capita)				
Consumption (non-health) expenditures	3980.40	8275.59	5991.94	6122.51
	(163.93)	(287.61)	(175.96)	(526.85)
Food expenditures	1580.23	2890.29	2193.79	2229.91
	(42.76)	(87.75)	(55.2)	(110.3)
Non-food expenditures	2406.33	5426.69	3831.71	3828.34
	(146.51)	(262.97)	(156.53)	(486.02)
Health expenditures	851.05	1071.11	954.43	843.07
	(65.19)	(114.03)	(68.08)	(127.58)
Household earnings	4399.31	10535.92	7441.10	6729.98
	(137.67)	(356.19)	(227.35)	(550.29)
Individual earnings	6085.27	13926.34	10312.29	9914.95

	(297.53)	(652.4)	(623.97)	(1053)
Number of observations	960	859	1570	276

Notes: Standard errors are in parentheses.
Source: CFPS 2010-2018