The Role of Health Status on Income in China

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Abstract

The economic benefits from improving health status are obvious, yet there remains a lack of agreement on how to quantify and compare the benefits and the accompanied costs. In our study, we extend Liu et al. (2008)'s study on the role of health status on income in China and examine whether their conclusions still hold under new specifications and in a broader time horizon. Our results show a larger impact of health status on income after replacing household income with individual income. We find this effect becomes even more pronounced in the 2000s. Moreover, our results show an inverted-U relationship between age and income, which is an improvement over Liu et al. (2008)'s work and is in line with other empirical studies. By admitting the endogeneity issue, we find the impact of health status becomes even larger after instrumenting health status. The results of GMM estimation, which allows for efficient estimation under heteroskedasticity of unknown form, are consistent the IV estimations.

Key Words: Health; Income; China; CHNS
JEL Classification: I10; I12; J24

Introduction

Health, as a form of human capital, is a crucial determinant of labor productivity. Economic theory suggests that labor productivity can be represented by real wage rate in competitive markets, so health outcome and income might be potentially associated. The investigation of the impact of health status on income level is important because of the potential linkages between healthy workers, labor productivity, and national economic prosperity. China has experienced an economic boost recently due to structural reforms and technological innovations. A striking feature of China's structural reforms is the utilization of the extensive internal migration where most migrants leave their farmlands for urban areas and engage in non-agricultural activities. Therefore, we observe an expansion of labor-intensive manufacturing sectors and a shrinkage of traditionally agricultural sectors in recent years. The labor-related work largely demands labor productivity, and more precisely, health condition of workers. Yet to our knowledge, few studies focus on the contribution of health to economic growth. Liu et al. (2006) have conducted a pioneering work in this field, using sample drawn from China Health and Nutrition Survey (CHNS) to estimate the effect of health on household income. They find household income is strongly affected by the health of its members, especially for the case of rural residents. However, as suggested by Liu et al. (2006) themselves, their work has several limitations.

In our study, we attempt to overcome those limitations and examine whether the conclusions still hold under new specifications and in a broader time horizon. Firstly, Liu et al. (2006) use household-level income instead of individual-level income because of data constraint at that time. We argue that household income may not be a proper measure since households may reallocate labor supply by adjusting time and resources to compensate for the financial loss in response to one household member's illness. Therefore, even if a household member falls sick, the household productivity measured by household income could still remain the same. Now the updated data source enables us to employ individual income instead of household income to properly capture the effect of health status on individual productivity.

Secondly, Liu et al. (2006) use fixed-effects estimation to overcome the endogeneity issue due to unobserved individual characteristics. However, several other potential econometric issues may still persist. For instance, the causal path of the linkage between health status and income is ambiguous. The role of income in the determination of health status has been confirmed by a large literature (see Judge et al. 1998, Case et al. 2002), which suggests that the effect should not be negligible. In our study, we carefully address this issue by adopting instrumental variable (IV) strategy. However, it is well known that IV estimation is inefficient in the presence of heteroskedasticity. Therefore, we adopt Generalized Methods of Moment (GMM) to estimate the model as a robustness check in the end.

The main purpose of this paper, is to reexamine the causal relationship between health and income with emphasis on Chinese data. Besides the attempt to improve upon earlier works, we were motivated by the following factors to revisit this issue. Firstly, since China has undergone large sectoral shift in the 2000s, with a plethora of internal migration workers from rural areas to urban areas seeking labor-intensive work, we are interested in the effect of health status on income in the 2000s. Therefore, we not only replicate Liu et al. (2006)'s study using data from years of 1991, 1993 and 1997 under new econometric specifications, but also use more recent data from years of 2000, 2004 and 2006 to check whether the results still hold in a broader time horizon. Secondly, the justification of more health insurance coverage is another reason for our interest in the role of health on income productivity. Health insurance is designed to encourage health care utilization, reduce financial risk and promote health. If the positive association between physical health and earnings is confirmed, then more insurance coverage, as a means to promote health, could be justified as a way to reduce the income disparity caused by illness.

After replacing household income by individual income and using improved estimation techniques, we find a larger impact of health status on income. This effect carries on and becomes even more pronounced in the 2000s. Moreover, our results show an inverted-U relationship between age and income, which is an improvement over Liu et al. (2006)'s work and is in line with other empirical studies.

This paper is organized as follows. Section 2 provides a literature review on the identification issues and estimation strategies in this line of research as well as relevant empirical findings. Section 3 explains the data source and variables. In section 4, we provide a thorough explanation of the methodologies applied in this paper. We present our empirical results and shed light on the findings in section 5. Section 6 concludes the paper.

Literature Review

As suggested by Glick and Sahn (1998), empirical work on health and income must confront two major issues: the conceptualization and measurement of health status and the simultaneous relationship between health and income. We may expect that the magnitudes of the estimated effect are sensitive both to the choice of health outcome measures and to the particular identification assumptions.

With respect to health status, it is difficult to pin down its exact magnitude, as health status is multidimensional and sometimes imperfectly measured. Furthermore, different dimensions of health might affect labor productivity in different ways. Currie and Madrian (1999) summarize measures of health status that pertain to work ability. Studies on developed countries mostly use self-reported health status, health limitations or utilization of medical. For studies on developing countries, researchers focus on measures of nutritional status, the presence or absence of health conditions, utilization of care or activities of daily living. In this study, we use a subjective measure (self-perceived health status) to describe a person's general health condition. Since self-perceived health status might be subject to measurement error, we use generalized method of moments (GMM) to address this econometric issue.

The reason why health variable must be treated as an endogenous choice is explained by theoretical deduction and this treatment has been accepted from empirical points of view.

Becker (1964) firstly states that investing in health capital is analogous to investing in other forms of human capital, such as education. Based on that, Grossman (1972) develops a model where consumers maximize an intertemporal utility function containing the elements of stock of health, consumption of other goods, leisure, a vector of exogenous taste shifters, a vector of permanent individual specific taste shifters, and a shock to preferences under several constraints. Health capital is viewed as endogenously determined with the justifications as follows. Individuals make investments to increase health capital through medical care or proper exercise. Individuals obtain the benefits from health capital through more productive activities. Income is closely related with these processes through the means or productive benefits of the investments.

Considering the simultaneity in income and health, previous studies use different instrumental variable strategies to deal with endogeneity issue in health variable. Examples of the instruments include water quality or sanitation services (Zhang, 2011). But those instruments are measured at the community level, which might be weakly related with individual health. Furthermore, since individuals might pre-select certain locations (see Rosenzweig and Wolpin, 1988), these instruments may not be proper. Some studies go beyond the two-stage least squares method to deal with endogeneity and measurement error in self-reported health status. Haveman et al. (1994) use Hansen's generalized method of moments techniques to estimate a three-equation simultaneous model in order to obtain the reliable estimates of the interrelationships among health, working-time and wages. One caveat in this kind of study is that health status may influence wages through other channels, such as discrimination against individuals with poor health. Wage discrimination induced the loss of earnings by $346 million in 1984, as studied by Baldwin and Johnson (1994).

Despite the limitations, a plethora of evidence suggests the existence of economic benefits of health. For example, Smith (1999) uses the Health and Retirement Survey to show that people with new diseases experience a decrease in their household's wealth from $3,620 to $25,371. Wang et al. (2006) demonstrate that bad health diminishes household investment in human capital, physical capital for farm production, as well as for other consumptions. Liu et al. (2008) find the impact of health on income is more pronounced in rural area and suggest that investing in rural health might be a potential way to narrow the income gap between rural and urban areas in China. Thomas and Strauss (1997) find wage increases due to improvements in several dimensions of health for males and females in Brazil. For instance, taller men and women earn more. Wages of males increase with higher BMI, especially among less-educated ones. Levels of calorie and protein intakes per capita are positively associated with wages of market-workers, but not the self-employed ones.

The link between health and labor market outcome is also influenced by socio-demographic factors. Previous studies mostly emphasize the labor supply issue in this aspect. Since labor supply is directly related to income, the impact of health on labor supply can be partially interpreted as the economic return to health. Parsons (1980) finds that the participation rates of older working age black men are lower than those of white men. Bound et al. (1995) conduct a more refined research and find that 30% to 44% of the gap between the participation rates of older black men (0.7) and white men (0.84) can be explained by demographic factors, such as age and education, and by health measures. In contrast, black women have a higher labor force participation rate than white women. Given the same health and demographic factors as the white women, more than a third of black women would reenter the labor force (see Bound et al. 1996).

Data Issue

We collect data from China Health and Nutrition Survey (CHNS). This survey adopts a multistage, random cluster process and gathers sample in nine provinces: Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou. It is designed to analyze the effects of health and nutrition polices in the context of social and economic transformation in China. The individuals in the sample come from counties that vary significantly in economic development, geography, and public resources. We use data from years of 1991, 1993, 1997, 2000, 2004, and 2006 and combine them into two groups: 1991-1997 and 2000-2006. Analysis of the first group can be deemed as a replication, while analysis of the second group can be seen as an extension of Liu et al.

(2008)'s work. One big difference is that we employ individual income instead of household income to properly capture the effect of health status on individual productivity.

We use self-perceived health status as a measure of health status. Self-perceived general health status has four ordered categories: 1: poor (reference category), 2: fair, 3: good, 4: excellent. Income is measured as the total individual income inflated to 2009. Ages are grouped into 5-year category from age 26 to 65. 18-25 is the reference category. We have "no education" as a reference category, and we group the other educational attainment as elementary school, low middle school, high middle school and higher education. For the location variable, we have Heilongjiang as a reference category. We include year effects as well. For the following four binary variables: gender, marital status, urban status and insurance status, we have female, unmarried, rural and uninsured recorded as reference categories respectively. For the group of years 1991-1997, we have 14054 observations in total. While for the group of years 2000-2006, there are 16505 observations in total. We perform analysis for each group separately.

Methodological Issues

Pooled OLS Regression

We firstly approach this issue by using the simplest pooled OLS regression. The model is specified as follows with the disturbance term consists of only the random component.

$$Y_{it} = \alpha h_{it} + \beta X_{it} + \varepsilon_{it} \quad (1)$$

where h_{it} is the health outcome, Y_{it} represents individual income, X_{it} is a vector of covariates and ε_{it} is the disturbance term. Pooled OLS regression allows us to take advantages of the finite-sample properties of OLS instead of relying on the asymptotic properties. However, OLS requires strict assumptions that our data may not satisfy. For instance, income may have a reverse causality on health status. We may omit some important variables in our equation so that the errors may not have an expected value of zero. We may have measurement error in the self-reported health status variable. If any of these identification issues happen, we may obtain an inconsistent and biased OLS estimator.

Individual Fixed-effects Model

We include the time-invariant unobserved individual effect to correct for the omitted variable bias that might happen in OLS modeling. The use of individual fixed-effects model can solve part of the endogeneity issue from individual income. The following is the proposed model.

$$Y_{it} = \alpha h_{it} + \beta X_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

This model is similar as the one specified under OLS estimation except we add the time-invariant individual effect μ_i. We cannot directly observe μ_i, but we can get rid of this time-invariant unobserved individual effect by subtracting the mean values of the variables on a given individual. However, one thing to note is that some variables such as gender, location and urban status are time-invariant covariates and cannot be estimated. We suspect that the unobserved effect is correlated with X_{it}, so we use fixed-effects instead of random-effects strategy to estimate the coefficients.

Instrumental Variable Strategy

Although individual fixed-effects model can solve the endogeneity issue rising from omitted variable bias, there are some other problems such as reverse causality and measurement error unaddressed. Fortunately, instrumental variable strategy allows consistent estimation under those circumstances. The following two conditions must be met in order to satisfy the validity of the instrument. First the instrument must be correlated with the endogenous variable "health status". Second, the instrument must be uncorrelated with the outcome (individual income)'s residuals. Given the availability of the dataset, we employ "difficulty in running a kilometer" as an instrumental variable for "health status". This instrument is plausibly valid in this setting since it is correlated with health status, but uncorrelated with individual income's residuals.

So the system of equations is:

First stage: $h_{it} = \alpha Z_{it} + \beta X_{it} + \varepsilon_{it}$ (3)

Second stage: $Y_{it} = r \hat{h}_{it} + \beta X_{it} + u_{i□}$ (4)

where Z_{it} is the instrument for health status. After instrumenting the endogenous variable health status, r captures the treatment effect of health status on income.

Generalized Method of Moments

Although IV estimation can address many econometric issues, it is inefficient under the presence of heteroskedasticity (Baum and Schaffer 2003). Therefore, we use the generalized method of moments (GMM) to further address this issue. The introduction of GMM is usually attributed to Hansen (1982) where he demonstrated that GMM can be seen as a general framework for econometric inference since IV estimator in any linear or nonlinear models, with time series or panel data can be deemed as a special GMM estimator. As its name suggests, GMM is based on moment functions where it has zero expectation in the population when parameterized at the true value. In our estimation, we adopt the most common choice by using the feasible efficient two-step GMM estimator. The procedures are illustrated as follows (see Baum and Schaffer 2003). First, we use IV to estimate the equation. Second, we use the formed residuals to get the optimal weighting matrix $\widetilde{W}$. Finally, we calculate the GMM estimator and its asymptotic variance.

Empirical Results

Ordinary Least Squares Regression and Individual Fixed-Effects Model

As suggested by Liu et al. (2006), the empirical model is rooted in a straightforward income production approach with health outcome as a form of human capital. We have a vector of control variables, e.g. region of residence, gender, age, education, marital status, urban status and health insurance. At first, we use OLS to obtain a rough estimation as a benchmark. We consider the hypothesis that health and income are strongly associated with each other at the individual level after controlling for other variables. At a starting point, we approach health as an exogenous variable and have a standard specification in a linear form. Since we also concern about the endogeneity issue and suspect this issue may come from the unobservables, such as family background, we follow Liu et al. (2006)'s approach and pursue fixed-effects estimation at the individual level. However, there is still a threat to the validity of individual fixed-effects (IFE) model if reverse causality exists, that is, if income shock has an impact on health shock. Therefore, we adopt instrumental variable strategy to deal with this issue later.

Table 1 reports the OLS and IFE findings. The first column is the OLS estimation results for the panel of 1991-1997. The third column is the OLS estimation results for the panel of 2000-2006. Assuming the exogenous nature of health status, we find that individual income increases as health status is improved. In the 1991-1997 panel, those in "Fair", "Good" and "Excellent" health status respectively earn 796, 1127, and 1397 Renminbi more per year than those in "Poor" health status. We also find that the impact of health status on income increases over time. In the 2000-2006 panel, the earning premia increase to be 1252, 1871 and 2073 Renminbi respectively. We also find that income increases with age at beginning, but after mid-40s, income drops as the individual gets older. Therefore we can see an inverted-U relationship between age and income. Education is positively correlated with income. As education increases, individuals are expected to receive more income. Compared with people with no education, elementary-school educated people earn 382 Renminbi more. If they have low middle school, high middle school or higher education, they may expect to have 958, 965 or 1385 Renminbi more per year in 1990s. The earning premia for people with these four categories of educational attainment increase to be 610, 1880, 3902 and 8755 per year in the 2000s. People with health insurance earn more, 746 Renminbi more in 1990s and 2155 Renminbi more in 2000s. So do married people, with 551 and 397 earning premia in 1990s and 2000s. Male has a higher income than female. The premium increases from 918 in 1990s to 2825 in 2000s. People with health insurance earn more than people without health insurance.

The second and fourth columns report the IFE results in 1990s and 2000s respectively. Compared IFE with OLS, we find that the patterns these two estimation elicited are similar. In general, individual income increases, as health status gets better. Males earn more than females. Education is positively related to income. Married people have more income than the rest. Individuals with health insurance have more income. Although IFE corrects for the error caused by unobserved individual effects, the OLS perform better than IFE estimation, with more significant results. Considering both OLS and IFE results, our hypothesis that income and health status are positively correlated is sustained.

Instrumental Variable Strategy and Generalized Methods of Moment

By admitting the endogeneity issue, we find the impact of health status becomes even larger after instrumenting health status. The instrument for health status is "difficulty in running a kilometer". Table 2 presents results of instrumental variables regressions for the panel of 1991, 1993 and 1997 years. As compared to OLS estimates, the IV strategy generates stronger impact of health status on income. For the significant estimates of the variables gender, education, marriage and insurance, IV estimations are similar as OLS results in terms of signs and magnitudes. Hausman test is used to determine whether the estimated coefficients in OLS and IV are systematically different. The calculated test statistic is 16.37 (Prob.>0.0373), therefore we reject the null hypothesis so that the difference between OLS and IV is systematic.

Table 3 reports results of instrumental variables regression for the panel of 2000, 2004 and 2006 years. The IV estimations are the same with OLS results in terms of the signs of coefficients. Under IV estimation, the effect of health status on income is stronger (2802.23 compared with 636.87). The other coefficients are similar in magnitude. Hausman test statistic is 29.73 (Prob. >0.00), which suggests that the difference in coefficients is systematic. Although IV strategy can be seen as an improvement over IFE model to deal with reverse causality, it still has another omnipresent problem: heteroskedasticity. To further address heteroskedasticity issue, we adopt Generalized

Methods of Moment (GMM) to estimate the model again. The advantage of GMM is that it allows for efficient estimation under heteroskedasticity of unknown form.

We report GMM results of 1990s in table 4. The results are comparable with the IV estimations. Health status and income are positively correlated, and the estimated coefficient is 1019.78, which is significant. Males earn 673.01 Renminbi more than females. Income increases with educational attainment. Married people have 914.64 more income. People with health insurance have more income. Below we provide stand-alone test results for underidentification, weak identification and overidentification in the GMM context.

For the equation to be estimable, it needs to be identified. Rejection of the null hypothesis represents the absence of an underidentification issue. The Anderson Canonical Correlation LM statistic of underidentification test is 91.13 and the corresponding p-value is 0. Therefore, we are confident that there is no underidentification issue. However, it is still notable that a weak-instrument problem might exist if the correlations between the endogenous regressors and the excluded instruments are nonzero but small. The null hypothesis is that the estimator is weakly identified so that it is subject to bias. The Cragg-Donald Wald F statistic of weak identification test is 94.90, which exceeds the critical value of 10% maximal IV sizes. Therefore we conclude that the instrument does not suffer from the specified bias. At last, the Sargen statistic, which is calculated from overidentification test of instrument is 0. It indicates that equation is exactly identified.

We present GMM results of 2000s in table 5. The results are comparable with the IV estimations. The impact of health status on income is 2594.85, which is highly significant. Compared to 1990s, the income gap between males and females enlarges from 673.01 to 1546.16. Education plays a more important role, with the estimated coefficient to be 2339.86. People with health insurance have 3019.04 more Renminbi per year. For the identification tests results, Anderson Canonical Correlation LM statistic is 231.55 with P-value equal to 0, suggesting that there is no underidentification issue. Cragg-Donald Wald F statistic gives weak identification test result, which is 254.63. It implies the instrument is not weak. Sargen statistic is 0, which indicates that the equation is exactly identified.

Concluding Remarks

Despite Liu et al. (2006)'s pioneering work in estimating the impact of health on income, we find that the issues of using household-level income, reverse causality and error in measuring health status would cast doubt on the validity of the estimates. To avoid the criticism, we obtain the estimates of the individual income on health using instrumental variables techniques and further use GMM to conduct a robustness analysis to ensure the estimation efficiency under the presence of heteroskedasticity.

We find the impact of individual health has a much greater impact on individual-level income than household-level income. This result confirms our argument in the beginning that household income may not be a proper measure since households may reallocate labor supply by adjusting time and resources to compensate for the financial loss in response to one member's illness. Therefore, household-level income may be less influenced by individual's health. The IV estimates show an even larger effect of health on income compared with OLS and IFE results, implying that ignoring reverse causality and measurement error may result in a downward biased estimate. GMM results are reported for robustness purposes. The signs and magnitudes are similar as IV estimates.

We compare the estimates across the groups of 1991-1997 and 2000-2006. The impact of health on income increases dramatically, showing that health plays a more and more important role in determining income. It also implies that public health measures should be implemented to prevent the declining of health and to keep up individual productivity. Moreover, our findings also imply that health insurance, as a means to promote health, could be justified as a way to reduce the income disparity caused by illness. Beyond the scope of our current analysis, we suggest that there might be some mediating factors in the relationship of income and health. Identifying these factors could be a potential contribution to the policy design and analysis in the future.

Table 1. OLS and IFE Estimations of Marginal Effects on Income

	1991-1997		2000-2006	
Variables	OLS coefficients	IFE coefficients	OLS coefficients	IFE coefficients
Perceived health status				
Fair	796.30***	645.96**	1,251.98**	1,270.25
Good	1,126.92***	811.07***	1,870.72***	1,436.89*
Excellent	1,396.76***	1,206.28***	2,072.74***	1,154.54
Age				
26-30	678.11***	621.05*	1,471.15***	1,532.04
31-35	1,164.93***	1,076.60**	2,375.96***	2,689.97
36-40	1,332.38***	1,738.21***	2,759.36***	3,431.55
41-45	1,404.09***	2,024.06**	3,097.80***	4,582.99
46-50	1,315.25***	2,097.77**	1,918.98***	4,076.21
51-55	717.97***	1,304.17	2,404.09***	4,736.52
56-60	262.71	838.75	1,265.37**	3,950.89
61-65	8.25	50.72	562.49	2,667.72
Gender				
Male	917.88***	-	2,825.05***	-
Education				
Elementary school	382.31***	47.92	609.84	217.47
Low middle school	957.53***	33.26	1,879.71***	-441.37
High middle school	964.53***	794.50	3,901.92***	-273.41
Higher education	1,385.26***	1,820.11	8,754.64***	3,957.71**
Marital status				
Married	551.33***	616.07**	397.41	101.70
Urban status				
Urban	-34.27	-	1130.59***	-
Insurance status				
Insured	746.26***	10.68	2,154.84	1,056.48**
Constant	-1283.33***	1131.96	-1493.79*	2204.40

Note:
1. ***, **, * denote 1%, 5% and 10% significance level respectively.
2. Data Source: China Health and Nutrition Survey

Table 2 OLS Regression, IV and Hausman Test Results

	1991-1997			
Variables	IV coefficients	OLS coefficients	Difference	S.E.
Perceived health status	851.41	436.41***	415.00	640.13
Age	-41.66	25.81	-67.46	66.37
Gender	698.43***	904.88***	-206.45	199.32
Education	542.47***	491.66***	50.81	96.31
Urban	-78.44	-260.12***	181.68	232.57
Marriage	914.04***	1255.57***	-341.52	273.84
Insurance	1250.27***	800.23***	450.04	227.50

Table 3. IV Regression, OLS and Hausman Test Results

	2000-2006			
Variables	IV coefficients	OLS coefficients	Difference	S.E.
Perceived health status	2802.23***	636.87***	2165.35	795.67
Age	80.54	88.44*	-7.90	267.58
Gender	1419.58***	2362.97***	-943.40	356.73
Education	2292.45***	2231.77***	60.68	158.42
Urban	839.68*	1086.48***	-246.80	387.56
Marriage	731.67	1354.75***	-623.09	500.48
Insurance	2931.59***	3838.37***	-906.78	316.04

Table 4. GMM Estimation Results

	1991-1997					
Variables	Coefficient	Std. Err.	z	P-value	95% Confidence Interval	
Perceived health status	1019.78*	624.13	1.63	0.10	-203.5	2243.06
Age	-42.52	68.42	-0.62	0.53	-176.62	91.57
Gender	673.01***	200.56	3.36	0.00	279.93	1066.10
Education	528.41***	100.32	5.27	0.00	331.79	725.04
Urban	-51.64	236.95	-0.22	0.83	-516.05	412.77
Marriage	914.64***	285.87	3.20	0.00	354.34	1474.93
Insurance	1315.72***	245.38	5.36	0.00	834.78	1796.65
Constant	-732.71	2025.37	-0.36	0.72	-4702.37	3236.94

Table 5. GMM Estimation Results

	2000-2006					
Variables	Coefficient	Std. Err.	z	P-value	95% Confidence Interval	
Perceived health status	2594.85***	757.42	3.43	0.00	1110.34	4079.36
Age	-16.77	271.10	-0.06	0.95	-548.11	514.57
Gender	1546.16***	386.54	4.00	0.00	788.55	2303.77
Education	2339.86***	182.04	12.85	0.00	1983.07	2696.65
Urban	794.39*	438.27	1.81	0.07	-64.6	1653.38
Marriage	761.82	563.62	1.35	0.18	-342.84	1866.49
Insurance	3019.04***	384.95	7.84	0.00	2264.55	3773.53
Constant	-4668.28	3208.86	-1.45	0.15	-10957.53	1620.98

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