THE IMPACT OF SELF-ASSESSED HEALTH ON LABOUR SUPPLY

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Abstract

Health has long been recognised as an influence on labour supply. To date there has been little New Zealand research on this topic. This paper uses census area unit level data from the 1996 Census to estimate the effects of changes in the prevalence of self-assessed disability and health problems on the labour force participation rate. The best results were obtained from questions asking about the effect of health on ability to carry out common everyday activities, and having a long-term disability. Despite the use of aggregate data the goodness of fit of the models was low (approximately 0.50). Coefficients on non-health variables were robust to changes in the specification of the health variable. The elasticity of labour force participation rates with respect to ill health varied between -0.02 and 0.02. The use of grouped data is less than ideal, and the impact of different corrections for this data structure is explored. The weighted least squares methods used in this paper have been argued to be inefficient if group sizes vary widely, and this is an area for future research with the current dataset. Future research directions with New Zealand survey data are suggested.

Keywords: *health, labour supply, grouped data.*

Health has long been recognised as having an impact on productivity. William Petty, for example, argued that the costs of treating the plague would be more than paid for by the additional taxes generated by having more people working (Petty 1662, quoted in Getzen 1997). More recently the extent to which changes in productivity are suitable as a measure of the value of improved health has been debated extensively by health economists (Drummond et al, 1997; Olsen, 1994; Posnett and Jan, 1996).

The theoretical bridge between an individual's labour market and health behaviour is the human capital approach. Applications of the human capital approach to health were largely developed in the early 1970's by Grossman (Grossman, 1972a; Grossman, 1972b), following on from the earlier work of Mushkin (1962). Participation in the labour market enables people to receive a return on investments they make in their health. The consumption aspects of health were recognised, but the investment aspects have received more attention, in Grossman's own work (Grossman and Benham, 1974) and that of others (eg. Gerdtham and Johannesson, 1997; Wagstaff, 1986; Wagstaff, 1993). But as Gerdtham and Johannesson note there is relatively little empirical work, and the estimates obtained have sometimes been contrary to the theoretical predictions of the model (Wagstaff, 1993).

The United States literature has two other key strands, which while they do not always engage Grossman directly, have obtained results consistent with the theory. Firstly, the labour supply decisions of people in poorer health are more sensitive to the level of disability benefit available (Haveman and Wolfe, 1984; Leonard, 1989; Parsons, 1980). Secondly, people in poorer health are more likely to retire earlier (Bazzoli, 1985; Bound et al, 1996).

New Zealand research

There is an extensive New Zealand literature on socioeconomic status and health, which is rooted firmly in an epidemiological approach (Barwick, 1992; Crampton and Howden-Chapman, 1997). Causation is assumed to run from labour market outcomes to health, rather than conversely. It is more plausible that outcomes are jointly determined, but even internationally this approach has not been common (Haveman et al, 1994). Published results from the 1992/93 Household Health Survey led Dixon (1996) to argue that "....there is reason to think that people with real or self-perceived health problems are over-represented among New Zealand's prime-aged non-participants" (p.85). This paper's modest aim is to explore this contention further, and hopefully stimulate further work in the field. The data available are not ideal, and there is no New Zealand work I am aware of with which to compare the results. But, there are several datasets in New Zealand, which could be used to better answer the question of how health affects labour supply.

Defining and measuring health

An extensive, but inconclusive, literature has addressed the question of exactly what is health, and thus how it can be measured. A conceptualisation due originally to Nagi (1969) distinguishes between five different dimensions of health. Pathology is a mobilisation of the body's defences and coping mechanisms. In theory, pathology should be objectively measurable in terms of abnormal cells or destroyed tissues, for example. Illness and sickness are behavioural characteristics, and are influenced by cultural factors as well as the characeristics of the pathogen (Schultz and Tansel, 1997). Impairment is physiological, anatomical or psychological loss relative to some norm. Functional limitations are defined as activity losses or restrictions resulting from impairment. Finally, disability is a behavioural pattern evolving when functional limitations interfere with an individual's ordinary daily activities. The word ordinary is quite crucial in shaping the concept of disability. Luft (1978) invites comparison of an unskilled labourer losing her non-writing arm to polio with a novelist suffering the same pathology. The example illustrates also how other components of an individual's human capital stock might affect the influence of any health changes on the labour market behaviour.

The multi-dimensional nature of health means there are potentially many metrics of the concept. Mortality indicators have been argued to be a good measure of health as they are not subject to self-reporting errors (Parsons, 1980). However, the impact of non-fatal impairments such as arthritis or mental illness, which could influence labour market behaviour will not be picked up (Anderson and Burkhauser, 1984). Diagnosis by a medical professional has also been argued to be an objective measure of health. A significant problem with diagnostic measures is that utilisation of health services is related to labour market outcomes. The development of diagnostic questions which can be administered in surveys is a promising development (Ettner et al, 1997).

In practice though, the most widely used measures of health are responses to survey questions on self-assessed health. Despite their wide application these measures are problematic. Many United States surveys have used the question "Do you have a health condition limiting the kind or amount of work you can do" (Bound, 1991). Using responses to this question as a measure of health led to large estimates of the effect of health on retirement decisions (see for example Sickles and Taubman, 1986). Unfortunately the question is also partly a measure of labour supply behaviour, so that the relationship between labour supply and health is at worst entirely tautological. Moreover, health problems may be perceived as a more socially acceptable reason for non-participation in the labour market than a preference for leisure at the prevailing wage rate. Recent United States studies have incorporated this criticism by modelling health as a latent variable, where the probability of reporting health limitations is a function of economic and demographic characteristics (Bound et al, 1996). Other components of human capital such as education and work experience had a strong influence on self-assessed health and disability (Bound et al, 1995a; Bound et al, 1995b).

Data

It is wise to bear these issues in mind throughout the rest of the paper. While the estimates obtained were not wildly variant, the unknown bias in the variables means results should be interpreted with caution.

The 1996 New Zealand Census included two questions on health. One of these was a screening question to determine the sample frame for the 1996/97 Disability Survey (Statistics New Zealand 1998), and asked:

> "Do you have any disability or handicap that is long-term (lasting 6 months or more)?", to which people could answer "Yes" or "No".

A further question asked:

> "Does a health problem, or a condition , you have (lasting 6 months or more) cause you difficulty with, or stop you doing: i) everyday activities that people your age can usually do; ii) communicating, mixing with others or socialising; iii) any other activity that people your age can usually do".

The three clauses were expressly designed to be answered independently. It is likely that the first option, everyday activity limitations, will pick up the broadest measure of health. Interestingly the question specifically asks people to compare their own health to that of others. United States surveys have largely moved away from this form of question, as the question conflates two ideas ideally kept separate; an individual's own health, and their perception of the norm for other people.

The number of people aged 15 and over answering positively to these questions within each census area unit (CAU) was obtained from Statistics New Zealand. This level of aggregation is not desirable, when the unit records are available; however the cost of using unit records was prohibitive. Data on demographic characteristics and labour force behaviour were obtained from Supermap 3.0 (Time Space Research Pty. Ltd 1997). A satisfactory measure of average income was not able to be derived from the Supermap database. The estimates of the regression equations below will have an omitted variables bias. As the coefficient on income should be positive, but income and ill-health are expected to be negatively correlated, the direction of the bias on the health variables will be indeterminate a priori (Kmenta, 1986). Descriptive statistics are presented in Table1.

There were 1774 census area units at the 1996 census. Not all were included in the final sample. All 85 oceanic (people on boats) or inlet units with populations of 0 or 3 (all figures supplied by Statistics New Zealand are randomly rounded to base 3) were excluded. A further 30 'mainland' area units were excluded because their population of potential labour force participants (people over 15) was zero. The rounding practice used by Statistics New Zealand creates some minor problems with other small area units. The

Table 1. Descriptive statistics

Variable description	Mean	Standard Deviation	Expected influence on labour supply
Labour force participation rate	0.733	0.078	
Fraction of population with no educational qualifications	0.671	0.217	negative
Fraction of population over 15 who are female	0.501	0.037	negative
Fraction of men who are married	0.806	0.071	positive
Fraction of women who are married	0.746	0.086	negative
Fraction of population aged 0-4	0.103	0.036	negative
Fraction of population aged 5-14	0.207	0.073	negative
Fraction of population aged over 65	0.142	0.069	negative
Fraction of population over 15 doing unpaid work	0.522	0.067	positive
Fraction of population with a disability	0.168	0.048	negative
Fraction of population with health problem;			
i) affecting everyday activities	0.134	0.153	negative
ii) affecting communication and socialisation	0.053	0.061	negative
iii) affecting other aspects of life	0.085	0.097	negative

N=1659

Table 2. Naïve general model

Variable	Parameter estimate	|T|	P > |T|
Intercept	0.65	14.81	0.00
No Qualifications (population > 15)	0.03	2.70	0.01
Female proportion of population over 15	-0.22	3.55	0.00
Proportion of males married	0.20	5.50	0.00
Proportion of females married	0.10	2.63	0.01
Porportion of population aged 0-4	0.49	0.63	0.53
Proportion of population aged 5-14	-0.07	1.70	0.09
Proportion of over 15 population aged over 65	-0.50	12.83	0.00
Proportion of over 15 population doing unpaid work	0.11	3.29	0.00
Proportion of total population who are Maori	-0.05	6.67	0.00
Proportion of population with disability	-0.15	3.30	0.00
Proportion of population with everday health problems	-0.01	0.52	0.61
Proportion of population with communication problems	0.20	7.60	0.00
Proportion of population with other health problems	-0.14	6.30	0.00

R^2=0.457; F =106.37 (p=0.0001); N=1659

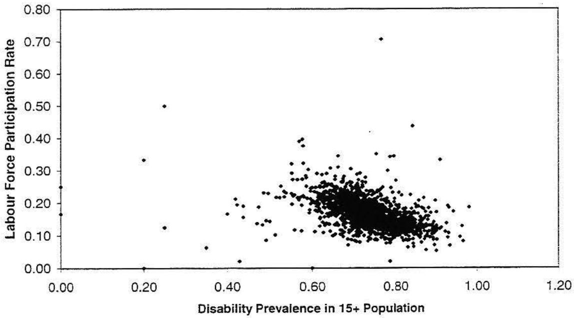
number 4, for example, can be rounded to either 3 (with probability 2/3) or 6 (with probability 1/3 so the expectation equals the correct number). If all four people in the area unit are working, and labour force participation is rounded to 6, but population to 3, the labour force participation rate is erroneously calculated as 200%. The impact of this is minor, as only 18 of the census area units have populations less than 20.

We will concentrate on the limitation of health on everyday activities (for brevity this is referred to as "everyday health problems") and disability questions as the measures of health because they provide the broadest measure of ill-health in the community. The variables are all qualitative, so that the census area unit averages resolve to the proportion of the population with the given characteristic.

Bivariate relationships

Firstly, we examine the bivariate relationship between the two measures of ill health and the labour force participation rate. The correlations between the labour force participation rate, and disability and everyday health problems indicators are -0.41 and -0.35 respectively. The two measures of health are highly correlated (0.94), so multicollinearity is likely to be a problem in the regression

Figure 1. Influence of disability on labour supply



equations. Examining the scatter plot the strong negative relationship between ill-health and disability, and labour force participation is clear (Figure 1).

Single equation models

We now move onto examining the influence of everyday health problems and disability prevalence on the labour force participation rate, in the context of a regression model. As health questions were only introduced to the census in 1996 it is not possible to examine the change in the impact of health over time (c.f. Poot and Siegers, 1992). The dependent variable is the labour force participation rate (c.f Dooley, 1982). As stated previously, although the individual data are available the cost was prohibitive for this study, and data averaged at a census area unit level are used.

The problems of using grouped data instead of the unit records are relatively well known, but it is useful to review them. Within group variation is obscured, and the parameter estimates are less efficient due to the loss of information. Some of these problems can be overcome when the data is available grouped on different variables, but this possibility is not explored further here (Fukushige and Hatanaka ,1991). Conversely, goodness-of-fit measures are inflated. This presents a trap for researchers who select models on this basis. The R2 statistic, both adjusted and unadjusted, is particularly affected by grouping the data. Kakwani (1993) proposes a goodness-of-fit measure which adjusts for the differences in group sizes, and varies substantially more than R2 statistics, thus discriminating better between competing models.

Differing group sizes also lead to a structural heteroskedasticity, which is traditionally corrected by weighting observations by the square root of group size. Dickens (1990) suggests that when the individual error terms within groups are not independent then the traditional weighting method will introduce more heteroskedasticity. Specifically he argues that "to assume these errors are indepenent ....[w]hen grouping is done by characteristics such as geographic location... is untenable" (p.329). Location decisions are behavioural, and will be related to the independent and dependent variables in question. The problem of assuming independence is compounded by large differences in group size, though this particular problem is not present in the current study. Implementing the estimation scheme proposed by Dickens' requires an iterative procedure, not available in any standard econometric software. It is however, an aspect of the research that needs to be followed up.

Table 2 shows the results of a naïve general regression model. All health related variables are included. Interestingly, the effect of two of the ill-health variables is significantly positive, while disability prevalence and health problems with 'other activities' exert a significantly negative effect on the labour force participation rate. Although no correction has been made for heteroskedasticity a graphical inspection showed no apparent relationship between the size of the fitted value and the residuals. This is somewhat confirmed by rerunning the same analysis with White's correction for heteroskedasticity. The estimates of the standard errors are remarkably similar. Indeed for all variables they are the same to at least two decimal places.

We now re-estimate the general model, and implement the standard correction for heteroskedasticity of weighting every observation by the square root of group size (in this case the census area unit population). The results for this model are presented in Table 3. Parameter estimates and standard errors differ somewhat from the naïve model presented in Table 2. It is interesting that the only health variables which are statistically significant are the communication and 'other' health problems variables. Moreover the impact of everyday health problems is tiny - the coefficient estimate is 0. Because socialisation and communication are everyday activities the answers to the separate question on communications are likely to be encompassed by the more general everyday health problems question. Interestingly,

Table 3. General model estimated by weighted least squares

Variable	Parameter estimate	|T|	P > |T|
Intercept	0.94	20.15	0.00
No Qualifications (population > 15)	0.01	0.50	0.58
Female proportion of population over 15	-0.64	10.34	0.00
Proportion of males married	0.16	4.08	0.00
Proportion of females married	-0.01	0.17	0.87
Porportion of population aged 0-4	0.11	1.58	0.12
Proportion of population aged 5-14	-0.01	0.21	0.84
Proportion of over 15 population aged over 65	-0.43	13.31	0.00
Proportion of over 15 population doing unpaid work	0.15	4.69	0.00
Proportion of total population who are Maori	-0.07	10.47	0.00
Proportion of population with disability	-0.08	1.70	0.09
Proportion of population with everday health problems	-0.00	0.30	0.77
Proportion of population with communication problems	0.19	4.53	0.00
Proportion of population with other health problems	-0.13	3.07	0.00

R^2=0.523; F =138.77 (p=0.0001); n=1659

the proportion of school children in the population, and the proportion of women over 15 who are married do not have a significant influence on the labour force participation rate. A larger elderly population is associated with lower labour force participation. Although the Human Rights Act makes it possible for people to keep working past 65, labour force exit is substantial for this group.

Dickens (1990) proposes a test to determine whether there is a group error component, because group membership is non-random. The test involves regressing the squared residuals from the weighted regressions on a constant and the group sizes. If there is no group error component then the probability limit of the coefficient on the group size variable will be zero. For the model estimated in Table 3 the t-statistic for the coefficient of group size was 6.9. This is clear evidence of a group error component.

The results from estimation of the general model presented in Tables 2 and 3 suggested that some variables did not have a significant influence on labour supply. It is also of interest to investigate the change in parameter estimates when only one of the health variables is included. In Table 4 the variable for the proportion of the population aged 5-14 is excluded, and the only health variable is the disability rate. The estimation method is again weighted least squares. Dickens' test again showed strong evidence of a group error component.

This equation is re-estimated with the health variable now being replaced by the everyday problems indicator (see Table 5). Estimated coefficients for the non-health variables are very robust with respect to the specification of the health variables. An F-test that the coefficient vectors are equal was rejected. But this is due to the large sample size, and the practical importance of the difference in the coefficients is minimal (on the general problem see McCloskey 1985; McCloskey and Ziliak, 1996). However, while the coefficient on everyday health problems is of the correct sign, it fails to reach statistical significance. There is little to differentiate the models on standard goodness-of-fit tests.

It is of interest to see how the estimates change if both health variables are included. There is likely to be substantial multicollinearity between the two health variables - the simple correlation coefficient was 0.94. Results from this

Table 4. Parsimonious model estimated by weighted least squares: health variable is disability prevalence

Variable	Parameter estimate	|T|	P > |T|
Intercept	0.94	20.75	0.00
No Qualifications (population > 15)	0.01	0.53	0.59
Female proportion of population over15	-0.64	10.38	0.00
Proportion of males married	0.21	5.56	0.00
Proportion of females married	-0.06	1.57	0.12
Porportion of population aged 0-4	0.12	1.94	0.05
Proportion of over 15 population aged over 65	-0.44	13.35	0.00
Proportion of over 15 population doing unpaid work	0.16	5.51	0.00
Proportion of total population who are Maori	-0.07	10.39	0.00
Proportion of population with disability	-0.11	2.33	0.02

R^2=0.508; F =188.99 (p=0.0001); n=1659

Table 5. Parsimonious model estimated by weighted least squares: health variable is everyday health problems prevalence

Variable	Parameter estimate	ITI	P > ITI
Intercept	0.90	20.87	0.00
No Qualifications (population > 15)	0.00	0.02	0.98
Female proportion of population over 15	-0.59	9.69	0.00
Proportion of males married	0.14	3.52	0.00
Proportion of females married	0.02	0.65	0.51
Porportion of population aged 0-4	0.11	1.85	0.06
Proportion of over 15 population aged over 65	-0.45	14.35	0.00
Proportion of over 15 population doing unpaid work	0.16	5.53	0.00
Proportion of total population who are Maori	-0.08	10.90	0.00
Proportion of population with everday health problems	-0.02	5.57	0.00

R^2=0.52; F =194.76 (p=0.0001); n=1659

regression are shown in Table 6. Again, the coefficient estimates for the non-health variables are robust to the change in specification of the health variables, giving greater confidence in the results. The health variables are of opposite sign, and only the everyday health problems variable achieves statistical significance at standard levels. At the sample means the elasticity of the labour force participation rate with respect to disability is 0.02, so that a 10% increase in the prevalence of self-reported disability will be associated with a 0.2% increase in the labour force participation rate. Similarly, the elasticity at the sample means of the everyday health problems prevalence is -0.004. A 10% rise in the proportion of the population reporting that health affects everyday activities will be associated a reduction in the labour force participation rate of 0.04% When the disability and everyday health problems were included individually the elasticities were -0.02 and -0.004 respectively.

The substantial change in the parameter estimates for the health variables when they are included in the same equation suggests that multicollinearity is indeed a problem. It is likely that the questions asked in the 1996 census do not pick up all the dimensions of health, because in many respects they overlap. People reporting activity limitations due to a long-term health problem or disability, are a subset of those who have a health problem or disability. Similarly, the "everyday activities" question encompasses aspects of the other two sub-questions.

One way to explore this is to use principal components analysis, to create mutually uncorrelated linear combinations of the original variables, and hopefully achieve some reduction in the dimensionality of the data. A potential problem with the approach is that the variables created can be at worst meaningless and often difficult to interpret (Greene, 1997). However, the use of the technique is not without precedent (eg. Grossman and Benham, 1974).

The data is essentially one-dimensional, with the first principal component accounting for nearly 75% of the variation in the data, and two principal components encompassing over 99% of the variation (see Table 7). However, the eigenvectors show that a substantial amount of information about the questions remains in the last three components. By excluding the third and fourth principal components more than half the variation in everyday health problems and health limitations on other activities will remain unexplained. It seems likely that it will not be possible to construct a 'better' health variable from the data available. Including the first principal component in a regression as the health variable left the estimates of other coefficients

Table 6. Model incorporating both health variables

Variable	Parameter estimate	ITI	P > ITI
Intercept	0.92	20.57	0.00
No Qualifications (population > 15)	0.01	0.81	0.42
Female proportion of population over 15	-0.60	9.78	0.00
Proportion of males married	0.14	3.60	0.00
Proportion of females married	0.01	0.22	0.82
Porportion of population aged 0-4	0.09	1.55	0.12
Proportion of over 15 population aged over 65	-0.44	13.32	0.00
Proportion of over 15 population doing unpaid work	0.16	5.37	0.00
Proportion of total population who are Maori	-0.07	10.52	0.00
Proportion of population with everday health problems	-0.02	5.39	0.00
Proportion of population with disability	0.09	1.84	0.07

R^2=0.516; F =175.88 (p=0.0001)

Table 7. Principal components of the health variables

Principal component	Eigenvalue	Proportion
First	2.98	0.745
Second	0.99	0.249
Third	0.02	0.004
Fourth	0.01	0.001

basically unchanged. However, the health variable itself had a minor and statistically insignificant impact on the labour force participation rate.

Conclusion

The models presented in Table 4 through 6 offer weak and contradictory messages. The effect of ill health and disability on labour force participation rates ranges from weakly negative through to weakly positive. Grossman's theoretical work showed that the impact of health on labour supply was indeterminate. This prediction is grounded in two responses. Firstly, if health lowers productivity and potential wages this alters the budget constraint faced by people in ill health, and it is well known that the labour supply effect of a change in wages is the result of offsetting income and substitution effects. Secondly, and more directly leisure becomes less pleasurable if one is in pain, and getting paid to be in work may be more attractive. This can be interpreted as a change in the shape of the indifference curves between leisure and labour.

Theory, then, cannot buttress any of the models by suggesting that it is the more plausible result. The answer to the question posed 'what is the effect of health on labour supply' will be supplied by a range of studies pointing to the same result. This is the case in the United States, where it has been consistently found that health is an important determinant of early labour force exit. The results presented here suggest that ill health has a weakly negative effect on labour force participation, and this qualitative conclusion is robust to the specification of the variable measuring health. The robustness of the coefficient estimates for the other variables to changes in the specification of the health variable give further confidence in the results. It indicates that health does have an independent effect on labour force participation rates, though it was not possible to make a precise estimate of the size of the effect. Depending on the specification, the elasticity of labour force participation rates with respect to health ranged from -0.02 to 0.02. In aggregrate, then, the effect of ill-health on labour supply appears to be minimal.

Future research

Further research into the impact of health on labour supply in New Zealand is desirable and needed. The availability of good data sets for pursuing the question creates the possibility as well.

Firstly, the use of grouped data is problematic, and Dickens (1990) showed that the estimates can be improved by allowing for the fact that group sizes can vary substantially, and the individual observations are unlikely to be independent. Implementing Dickens' suggested correction with the data set used in this study is a feasible and quickly achievable project. But individual level data exists, and should be utilised.

The measurement of health is an issue which requires quite a lot of work. Dummy variables for the presence or absence of a health condition or disability fall a long way short of ideal. Severity, as well as prevalence, needs to be taken account of. The 1996/97 Household Health Survey used the SF-36 health status instrument, and the scores from this could be used to estimate the effects of marginal changes in health status. Additionally, the SF-36 is explicitly designed to encompass the different dimensions of health. Despite the limitations of the health variables in the 1996 census there is better income information available in this data set, than in either the 1992/93 or 1996/97 Household Health Surveys.

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Table 8. Eigenvectors of the principal components

	Principal Component			
Eigenvectors	**1st**	**2nd**	**3rd**	**4th**
Population with disability	0.039	0.999	0.002	0.002
Health affects everyday activities	0.577	-0.020	-0.436	-0.690
Health affects other activities	0.578	-0.023	-0.378	0.723
Health affects communication and socialisation	0.576	-0.024	0.817	-0.033

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