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Gender Difference in Suicide, Household Production and Unemployment

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This paper aims to explain why men's suicide rate is generally higher than women's and why the former tends to fluctuate with unemployment. Adopting Hamermesh and Soss's suicide model (1974), with a two-period household production model, I argue that (1) the gender gap in suicide rate increases with the unemployment rate, because unemployed men suffer a larger 'human capital loss,' due to the division of labor within their household and (2) men's suicide rate is generally higher than women's because of the shorter expected life of the former. Both international and US support this hypothesis.

JEL Classification: I12, J12, J16, J24

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I. Introduction

The path-breaking work on suicide behavior in Economics literature was carried out by Hamermesh and Soss in 1974, in which they constructed a testable economic theory on suicide (which will be called HS model here after), with three important findings. First, the suicide rate decreases with permanent income. Second, the rate of suicide increases with age. Third, the suicide rate increases with the unemployment rate. Several empirical studies (Hamermesh 1974, Hamermesh and Soss 1974, Stack 1987, Yang and Lester 1990, Yang and Lester 1995, Yang and Stack 1992, Chuang and Huang 1997) have been done to test these predictions. Although the findings in the above studies are consistent with the HS model, the gender difference in the suicide rate is not. The gender difference in the suicide rate can be defined as men's suicide rate minus women's suicide rate[1], or men's and women's suicide rate ratio. According to Cantor (2000), the suicide rate of men is consistently higher than that of women. Why is men's suicide rate generally higher than women's, when men's income is generally higher? A study carried out by Stack in 1987 also found that the effect of unemployment on the suicide rate is higher for men than women. The HS model cannot explain either of these. I attempt to explain the positive gender gap on the suicide rate[2] across developed countries, within the context of household production and derive propositions on the effect of unemployment on the gender gap.

I incorporate the HS model and the division of labor within the household and argue that men suffer more by unemployment because of their specialization under the marriage contract. This article is organized as follow: Section II explores the theoretical model. In section III, I will discuss the empirical evidence. The article ends with a conclusion in Section IV

II. The Theoretical Model

According to HS model, the ith individual commits suicide if

$$L_i(a, Y_p) + b_i = 0 \tag{1}$$

$L_i(a, Y_p)$ is the present value of the ith individual's expected life-time utility at age *a*. Y_p is his/her permanent income. Obviously, *L* decreases with *a* but increases with *Yp*. b_i is a non-negative number representing the his/her taste for living. Let *S(a)* be the suicide rate of all the people at age *a*. Equation (1) implies that:

$$S(a) = f\lfloor L(a, Y_p) \rfloor \tag{2}$$

Since $\frac{\partial S}{\partial L} < 0$, $\frac{\partial S}{\partial a} = \frac{\partial S}{\partial L}\frac{\partial L}{\partial a} > 0$ and $\frac{\partial S}{\partial YP} = \frac{\partial S}{\partial L}\frac{\partial L}{\partial U}\frac{\partial U}{\partial Y_p} < 0$

The above implies that the suicide rate increases with age but decreases with income. This is the result of an increased present value of the expected life-time utility, as a result of an increase in permanent income. In order to explain the positive gender gap in suicide rate, we need to extend the HS model.

According to his book, 'A Theory of the Consumption Function' (Friedman 1957)

Friedman defined 'permanent income' as the yield on wealth, i.e.$Y_P = rW$, where W represents wealth. As Y_P is a function of W, we can write the suicide rate as a function of W:

$$S(a) = f\left[L(a, W)\right]$$

Differentiate it with respect to W, we obtain

$$\frac{\partial S}{\partial W} = \frac{\partial S}{\partial L}\frac{\partial L}{\partial W} < 0 \qquad (3)$$

If the wealth of a person is positively related to his/her expected life time, the shorter expected life span of the male, than that of the female, implies

Proposition 1

The gender difference in the suicide rate is positive, given the shorter expected life of men.

In order to explain the relationships between the fluctuations of the unemployment rate and the gender difference, we need to extend the model further. Consider a person with two periods in his/her life, let Z_j be the only utility generating composite commodity in period j. I assume Z_j is a public good in household. Its production problem is discussed in the next section. In this study, I specify the wealth in our model as:

$$W = Z$$

Z is the discounted value of Z_j of the individual's remaining life time[3].

The marriage market in period 1

Suppose the expected present value of the commodity produced by a couple at the beginning of period 1 is

$$Z^{mf} = Z^{m} = Z^{f}$$

Z^{m} stands for the commodity share of the husband and Z^{f} stands for the commodity share of the wife. Becker (1993) shows us that a man and a woman get married if and only if:

$$Z^{f} = Z^{mf} \geq Z^{s} \text{ and } Z^{m} = Z^{mf} \geq Z^{s}$$

Z^{s} is the expected present value of the commodity a single person can consume (assuming that both sexes consume the same amount of Z if they are single). For simplicity, I assume that individuals are homogenous and all marriages are monogamous. I also assume that there is an excess supply of men, $N_{m} > N_{f}$ [4]. Under these assumptions, people can be separated into three categories: married men, single men and married women. We know that the equilibrium offers to women and married men are both equal to Z_{mf}. The excess supply of men reinforces the gender gap in the suicide rate[5], because all the women in this model are in a two people household and therefore enjoy a larger output.

The discounted consumption of the single composite commodity in the different periods can be written as

$$Z = \sum_{j=1}^{2} \frac{Z_j(x_j, t_{hj}; H_{wj}, H_{hj})}{(1+r)^{j-1}}$$

where Z_j is the composite commodity, x_j the purchased good input, t_{hj} time spent on household production, H_w and H_{hj} the human capital stocks for market work and household work respectively at the beginning of period j. I also assume that *Z* is a public good within a household. In other words, every body in the same household can enjoy *Z* without reducing the other members' consumption of it. Human capital stocks are zero in period one, while the human capital stocks in period two are given by

$$H_{i2} = Q_{i1}$$

$i = w, h$, Q_{i1} is the amount of human capital i produced in period 1, which is subject to the following production function:

$$Q_{i1} = Q_i(t_{Qi1})$$

In period two, the proportion *u* of the participated workers, under each kind of marital status, are unemployed. *u* is 'drawn' from a normally distributed random variable, with the mean u^* being the constant expected natural rate of unemployment. The wage rate in period 2 depends on the human capital stock for market work in that period:

$$w_2 = \alpha \ H_{w2}$$

α is an exogenous parameter representing the return of the human capital. The effective household working time, $t_h^{'}$, depends on the human capital stock for household work:

$$t_h^{'} = t_h \psi(H_h)$$

The total amount of time in a period is *t*. The allocation of the time in period 1 and 2 are

$$t_{h1} + t_{Qw1} + t_{Qh1} + t_{w1} = t$$

$$t_{h2} + t_{w2} = t$$

I assume that the external capital market is imperfect, so that people can finance their expenditure in period 1 only by endowments they may be given, E. Beside the assumptions I specified above, the household production also depends on their marital status, determined in the marriage market.

The optimization problem in period 2

The optimization problem of each spouse/household is solved by backward induction. At this moment, I take the following optimized solutions from period one as given.

$$H^*_{wm2} > H^*_{ws2} > H^*_{wf2} = 0 \qquad H^*_{hf2} > H^*_{hs2} > H^*_{hm2}$$

$$t_{wf2} = 0, \qquad t_{hf2} = t \qquad t_{wm2} > t_{ws2} > 0 \quad 0 < t_{hm2} < t_{hs2}$$

In order to analyze the effect of unemployment on people under different marital status, the optimization problems of the *employed* people in period 2, under different marital status, are discussed first. Then the optimization problems for those *unemployed,* under different marital status, are presented and their reductions in welfare with unemployment are compared.

An employed single man

At period 2, the utility maximization problem of an employed single person household is:

$$\max_{x_{s2},t_{hs2}} Z^{s2}\left(x_{s2},t_{hs2};H^*_{ws2},H^*_{hs2}\right)$$

subject to

$$p_2x_{s2}=\alpha\ H^*_{ws2}\left(t-t_{hs2}\right)+\left(E-p_1x^*_{s1}\right)\left(1+r\right)$$

The second term on the right hand side is the endowment, less the expenditure in period one, plus the corresponding interest. The *s* subscript denotes singles while the * superscript denotes optimal solutions in period 1. x_{s2} and t_{hs2} represent purchased goods and time spent on household production respectively in period 2.

The solution can be written as a function of p_2,α,H^*_{ws2} and H^*_{hs2}

$$Z^{s2*}=Z^{s2*}\left(p_2,\alpha\ ,H^*_{ws2},H^*_{hs2}\right) \qquad (4)$$

An employed married man

I assume that any spouse can walk out of a marriage contract freely, a married man can choose between two options: (1) remain married or (2) divorce. The married man chooses the option which brings him the highest consumption.

If the man and the woman choose to remain married, the optimization problem for the household would be

$$\max_{x_{m2},x_{f2},t_{hm2},t_{hf2}} Z^{mf2}\left(x_{m2},x_{f2},t_{hm2},t_{hf2};H^*_{wm2},H^*_{hm2},H^*_{wf2},H^*_{hf2}\right)$$

subject to

$$\alpha H^*_{wm2}\left(t-t_{hm2}\right)+\left[\left(E-p_1x^*_{m1}\right)\left(1+r\right)+\left(E-p_2x^*_{f1}\right)\left(1+r\right)\right]=p_2x_{m2}+p_2x_{f2}$$

The m and f subscripts denote the man and the woman respectively. The solutions to the above system is denoted as

$$Z^{mf2*}=Z^{mf2*}\left(x^*_{m2},x^*_{f2},t^*_{hm2},t^*_{hf2};H^*_{wm2},H^*_{hm2}H^*_{wf2},H^*_{hf2}\right) \tag{5}$$

Comparative advantage ensures that the division of labor within a two people household must produce more than the sum of the output of two separate single person households.

$$Z^{mf2}>2Z^{s2*} \tag{6}$$

If the man chooses to divorce and becomes single, his optimization problem would be

$$\max_{x_{dm2},t_{hdm2}} Z^{dm2}\left(x_{dm2},t_{hdm2};H^*_{wm2},H^*_{hm2}\right)$$

subject to

$$\alpha\ H_{wm2}\left(t-t_{hdm2}\right)+\left(E-p_1x^*_{m1}\right)\left(1+r\right)=p_2x_{dm2}$$

The d subscript represents 'divorced'. The solution to the above system can be written as

$$Z^{dm2*} = Z^{dm2*}\left(x^{*}_{dm2}, t^{*}_{hdm2}; H^{*}_{wm2}, H^{*}_{hm2}\right) < Z^{mf2} \tag{7}$$

(7) tells us that an employed married man would choose to remain married.

A married woman with an employed husband

As the married man, the married woman chooses one of the three options at the beginning of period 2. The three options are: (1) remain married (2) divorce and get married again to an initially single man (3) divorce and become single. As the total household product *Z* is a public good in the household, the consumption of the married woman would be Z^{mf2*} (see equation 8). If she chooses to divorce and get married again to an employed single, her optimization problem would be

$$\max_{x_{s2}, x_{f2}, t_{hs2}, t_{hf2}} Z^{rmf2}\left(x_{s2}, x_{f2}, t_{hs2}, t_{hf2}; H^{*}_{ws2}, H^{*}_{wf2}, H^{*}_{hs2}, H^{*}_{hf2}\right)$$

subject to

$$\alpha\, H^{*}_{ws2}\left(t - t^{zs2}_{hs2}\right) + \left(E - p_1 x^{*}_{s1}\right)(1+r) + \left(E - p_1 x^{*}_{f1}\right)(1+r) = p_2 x_{s2} + p_2 x_{f2}$$

The solution to the above system is denoted as

$$Z^{rmf2*}\left(H^{*}_{ws2}, H^{*}_{wf2}, H^{*}_{hs2}, H^{*}_{hf2}\right) < Z^{mf2*}\left(H^{*}_{wm2}, H^{*}_{wf2}, H^{*}_{hm2}, H^{*}_{hf2}\right) \tag{8}$$

If she chooses to divorce and becomes single, her optimization problem would be exactly the same as that of a divorced man discussed before with the subscript *m* becomes *f* in the woman's case. Therefore, we obtain the following result:

$$Z^{df2*} = Z^{df2*}\left(x^{*}_{df2}, t^{*}_{hdf2}; H^{*}_{wf2}, H^{*}_{hf2}\right) < Z^{mf2*} \tag{9}$$

(8) and (9) tell us that a married woman would choose to remain married. In

short, both the married man and woman would choose to remain married if the husband is employed in period 2.

A married woman with an unemployed husband

As we have already mentioned above, an initially married woman may choose from three options: (1) remain married (2) divorce and become single (3) divorce and get married again to an initially single employed man. We first consider the case where the woman chooses to remain married to the unemployed man. A person being unemployed can be represented by a fall in α to zero, this is equivalent to regard H_{wm2} as zero. If we write the household consumption as a function of the human capital, the consumption of the household that the husband is unemployed can be given by

$$Z^{mfu2}\left(H^{0}_{wm2}, H^{*}_{hm2}, H^{*}_{wf2}, H^{*}_{hf2}\right) < Z^{mf2*}\left(H^{*}_{wm2}, H^{*}_{hm2}, H^{*}_{wf2}, H^{*}_{hf2}\right) \qquad (10)$$

Note that H^{0}_{wm2} represents $H_{wm2} = 0$.

If the woman chooses to get married again to an employed single instead, the optimal consumption is given by equation (8). If the woman chooses to divorce and become single, the optimal consumption is given by equation (9). If the spouses have different comparative advantage, the division of labor ensures a gain in total output. Therefore, we can write that

$$Z^{df2} + Z^{s2} < Z^{rmf2*} \qquad (11)$$

(11) rules out the option of becoming single. As I mentioned before,

$$H^{0}_{wm2} < H^{*}_{ws2} \qquad H^{*}_{hm2} < H^{*}_{hs2}$$

If x is non-inferior, the higher output of a two people household implies that

$$x_{m1} \geq x_{s1}$$

Therefore, we can conclude that

$$Z^{mfu2}\left(H^{0}_{wm2}, H^{*}_{hm2}, H^{*}_{wf2}, H^{*}_{hf2}\right) < Z^{rmf2*}\left(H^{*}_{ws2}, H^{*}_{hs2}, H^{*}_{wf2}, H^{*}_{hf2}\right) \tag{12}$$

(11) and (12) tell us that the married woman, with an unemployed husband, would choose to *divorce* and then get married to an employed single[6].

An unemployed married man

Since his wife would choose to divorce, the unemployed married man would become single. His consumption when unemployed can be written as

$$Z^{dmu2}\left(H^{0}_{wm2}, H^{*}_{hm2}\right) < Z^{dm2}\left(H^{*}_{wm2}, H^{*}_{hm2}\right) \tag{13}$$

Combining (7) and (13), we can conclude that

$$Z^{dmu2} < Z^{dm2*} < Z^{mf2} \tag{14}$$

An unemployed single

Similarly, the unemployed single person household's output can be written as

$$Z^{su2}\left(H^{0}_{ws2}, H^{*}_{hs2}\right) < Z^{s2*}\left(H^{*}_{ws2}, H^{*}_{hs2}\right) \tag{15}$$

The optimization problem in period 1

Now we step back to discuss the optimization problem in period 1 and see why the results mentioned, before the discussion about period 2, are optimization results.

A single

In period one, a single man faces the following problem:

$$\max_{x_{s1},t_{hs1},t_{Qws1},t_{Qhs1}} :$$

$$Z_1(x_{s1},t_{hs1})+\frac{\{(1-u^*)\{AZ^{rmf2}[H_{ws2}(t_{Qws1}),H_{hs2}(t_{Qhs1})]+(1-A)Z^{s2}[H_{ws2}(t_{Qws1}),H_{hs2}(t_{Qhs1})]\}+u^*Z^{su2}[H^0_{ws2},H^*_{hs2}(t_{Qhs1})]\}}{1+r}$$

subject to

$$p_1x_{s1}+\frac{p_2\{(1-u^*)[Ax^{rmf*}_{s2}+(1-A)x^*_{s2}]+u^*x^{su*}_{s2}\}}{(1+r)}=(1-u^*)\frac{\alpha H_{ws2}[A(t-t^{rmf*}_{hs2})+(1-A)(t-t^*_{hs2})]}{(1+r)}+E$$

and

$$p_1x_{s1}\le E$$

r is the interest rate. As mentioned before, a consequence of unemployment is that men who are single in period 1 may be able to marry divorced women at the beginning of period 2, if they remain employed in period 2. $A=\left(\frac{u^*N_f}{(1-u^*)(N_m-N_f)}\right)$ is the probability that an employed initially single person can marry a woman in period 2. x^{rmf*}_{s2} and t^{rmf*}_{hs2} are a single man's optimal purchase and time spent on household production in period 2 if he becomes married in period 2. x^*_{s2} and t^*_{hs2} are a single man's optimal purchase and time spent on household production in period 2 if he is employed but remains single in period 2. x^{su*}_{s2} is his optimal purchase in period 2 if he is unemployed. An interior solution implies that a single person invests in both kinds of human capital. We can write the indirect utility/commodity function at period 1 as

$$Z^{s*} = Z^{s*}\left(p_j, p_{Qwj}, p_{Qhj}, \alpha\right)$$

Married household

In period 1, given the possibility of the husband being unemployed, the solution of the household production can be represented as a non-cooperative Nash-bargaining solution.

The non-cooperative production problem

The optimization problem of the married man is

$$\max_{x_{m1}, t_{hm1}, t_{Qwm1}, t_{Qhm1}} : Z^{mf1}\left(x_{m1}, t_{hm1}\right) + \frac{\left[\left(1-u^*\right)Z^{mf2}\left(H_{Qwm2}\left(t_{Qwm1}\right), H_{Qhm2}\left(t_{Qhm1}\right)\right) + u^* Z^{dmu2}\left(H^0_{Qwm2}, H_{Qhm2}\left(t_{Qhm1}\right)\right)\right]}{1+r}$$

subject to

$$p_1 x_{m1} + \frac{p_2\left[\left(1-u^*\right)x^{mf*}_{m2} + u^* x^{dmu*}_{m2}\right]}{1+r} = \frac{\left(1-u^*\right)\alpha H_{wm2}\left(t - t^{mf*}_{hm2}\right)}{1+r} + E + \frac{\left(1-u^*\right)\left(E - x^*_{f1}\right)}{1+r}$$

and

$$p_1 x_{m1} \le E$$

The second term in the last objective function is the discounted expected value of the consumption of the man in period two. In the first budget constraint, x^{mf*}_{m2} and t^{mf*}_{hm2} are the man's optimal purchase and time spent on household production if he remains married in period 2. x^{dmu*}_{m2} is his optimal purchase in period 2 if he becomes unemployed. On the other hand, the married woman's optimization problem would be

$$\max_{x_{f1},t_{hf1},t_{Qwf1},t_{Qhf1}} : Z^{mf1}\left(x_{f1},t_{hf1}\right)+\frac{\left[\left(1-u^{*}\right)Z^{mf2}\left(H_{Qwf2}\left(t_{Qwf1}\right),H_{Qhf2}\left(t_{Qhf1}\right)\right)+u^{*}Z^{rmf2}\left(H_{Qwf2}\left(t_{Qwf1}\right),H_{Qhf2}\left(t_{Qhf1}\right)\right)\right]}{1+r}$$

subject to

$$p_1x_{f1}+\frac{p_2\left[\left(1-u^{*}\right)x_{f2}^{mf*}+u^{*}x_{f2}^{rmf*}\right]}{1+r}=\frac{\left(1-u^{*}\right)\alpha H_{wf2}\left(t-t_{hf2}^{mf*}\right)}{1+r}+E+\frac{\left(1-u^{*}\right)\left(E-x_{m1}^{*}\right)+u^{*}\left(E-x_{s1}^{*}\right)}{1+r}$$

and

$$p_1x_{f1}\leq E$$

In the first budget constraint, x_{f2}^{mf*} and t_{hf2}^{mf*} are the woman's optimal purchase and time spent on household production if her husband is employed in period 2. x_{f2}^{rmf*} is her optimal purchase in period 2 if her husband is unemployed. By solving the above systems simultaneously, we obtain the non-cooperative Nash bargaining solution:

$$Z^{mf*}=Z^{mf*}\left(p_j,\alpha,r\right) \tag{16}$$

If the probability of being unemployment is very low, this solution should be very close to the cooperative maximization problem discussed below.

The cooperative maximization problem

Following Becker (Becker 1993), I define the comparative advantage of a member as 'the relation between the ratio of his/her marginal products in the market and household sectors and the ratios of other members'. Optimization implies that the marginal product of the alternative time use is equal. Divide the marginal products in the market and household sectors of the woman by those of the man, we have

$$\frac{\frac{\partial Z^{mf2}}{\partial t_{wf2}}}{\frac{\partial Z^{mf2}}{\partial t_{wm2}}} = \frac{H_{wf2}}{H_{wm2}} = \frac{\frac{\partial Z^{mf2}}{\partial t_{hf2}}}{\frac{\partial Z^{mf2}}{\partial t_{wf2}}} = \frac{\psi(H_{hf2})}{\psi(H_{hm2})} \tag{17}$$

As $\alpha, p_{x2}, \frac{\partial Z^{mf2}}{\partial x_2}$ and $\frac{\partial Z^{mf2}}{\partial t_{h2}}$ are the same for the husband and the wife, which can be seen in equation (17), the two stocks of human capital determine the comparative advantage. Suppose the woman has a comparative advantage in the household sector. (17) becomes

$$\frac{\frac{\partial Z^{mf2}}{\partial t_{wf2}}}{\frac{\partial Z^{mf2}}{\partial t_{wm2}}} = \frac{H_{wf2}}{H_{wm2}} < \frac{\frac{\partial Z^{mf2}}{\partial t_{hf2}}}{\frac{\partial Z^{mf2}}{\partial t_{wf2}}} = \frac{\omega\psi(H_{hf2})}{\psi(H_{hm2})} \tag{18}$$

Note that $\omega > 1$. If the human capital stocks for the two spouses were the same, the woman has a comparative advantage in the household sector and the man has a comparative advantage in the market sector. Therefore, the woman would specialize mainly in the household sector and the man would specialize mainly in the market sector[7]. In this case, the man spends time on both sectors. A spouse has a strong incentive to invest in the corresponding human capital for the sector that he/she specializes in[8], this implies that the married man would invest more in the human capital of the market sector, than a single man, but less in the human capital of the household sector. The possibility of being unemployed (and divorced) in the second period makes the man's incentive to invest in the household human capital stronger than if u is zero. On the other hand, the woman would invest solely in the human capital of the household sector[9].

Comparing the effect of unemployment on the three types of people

In order to predict the effect of unemployment on the suicide rate of the three types of people, we need to compare the consumption level of them in period 2. The difference between the consumption of an initially married man and a single man under different employment status is represented by

$$\phi = \left(Z^{s2*} - Z^{mf2}\right) - \left(Z^{su2} - Z^{dmu2}\right)$$

(6) tells us that the first bracketed term is negative. We also know that $H^0_{wm2} = H^0_{ws2} = 0$, $H^*_{hs2} > H^*_{hm2}$ and $x_{m1} \geq x_{s1}$. Therefore, we can write the second bracketed term as

$$Z^{su2}\left(H^0_{ws2}, H^*_{hs2}\right) - Z^{dmu2}\left(H^0_{wm2}, H^*_{hm2}\right) > 0$$

As a result, ϕ is negative, which means that married men suffer more from unemployment than single men. On the other hand, the difference between the consumption of the initially married men with those of married women under different employment status is

$$\delta = \left(Z^{mf2*} - Z^{mf2*}\right) - \left(Z^{rmf2*} - Z^{dmu2}\right)$$

The first bracketed term is zero. Comparative advantages ensure that the division of labor within a two people household must produce more than the sum of the output of two households, where both people are single:

$$Z^{rmf2} > Z^{s2*} + Z^{df2*} \tag{19}$$

Given the unique optimum combination of human capitals for singles and non-inferior *x*, we have

$$Z^{s2*}\left(H_{ws2}^{*}, H_{hs2}^{*}, x_{s1}^{*}\right) > Z^{dmu2*}\left(H_{wm2}^{0}, H_{hm2}^{*}, x_{m1}^{*}\right) \tag{20}$$

(19) and (20) tell us that $\delta < 0$. This means that married men suffer more than married women from unemployment. We get the following empirical implications:

<u>Proposition 2</u>

Gender difference of the suicide rate increases with the unemployment rate.

The intuition behind proposition 2 is that when a married man is unemployed, his 'human capital loss' is higher than that of his wife because of the division of labor within married household.

<u>Proposition 3</u>

Gender difference of the suicide rate is positively correlated to the divorce rate

III. Empirical Evidence

In this section, I test the propositions from my theoretical model by using both US and international data.

International Evidence

The data set

The time series data of the total suicide rate, by gender, for 14 developed countries, from 1992 to 2000, was used for the first empirical test. The length of the time series and the countries being selected is determined by the availability of data. The 14 developed countries are Australia, Canada, Finland, France, Germany, Hong Kong, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom and United States of America. The aggregate unemployment rate, rather than unemployment rate by gender, is used for two reasons. First, there is evidence that the discouraged worker effect dominates the added worker effect, and the former is larger for women than men (Filer, Hamermesh and Rees 1996). Therefore, the smaller fluctuation of women's unemployment rate may be a result of 'under-reporting' the real picture. Second, only men participated in the labor market in the theoretical model, therefore there is no reason to use the women's unemployment rate data. Table 1 shows the gender difference in the suicide rate for 14 developed countries, from 1992 to 2000. For all the observations, the gender difference is positive, which is consistent with proposition 1.

The estimation method and results

The data set is panel data, both the random effect GLS model with AR(1) disturbances and the fixed effect model with AR(1) disturbances, are used. The estimates of the coefficients are shown in table 2. Both gender difference and gender ratio are used as dependent variables. Columns a and b show the results with gender difference as dependent variables. Columns c and d show the results with gender ratio as dependent variables. The two models provide us with very similar results. The estimation results are consistent with proposition 2, showing that the gender difference in the suicide rate increases with the unemployment rate. All the estimated coefficients are significant at 10% level, except the estimated coefficient of u^2 in column d. As my model predicted, the estimated coefficients of unemployment are positive. A one percentage point increase in unemployment rate increases the gender difference in suicide rate by around 0.8 percentage point.

United States Evidence

The data set

The US time series data is used to test the propositions in the second empirical studies. The time series data for the suicide rate is given in 10-year age groups (from 25-65 years old) and by gender, from 1950 to 2000, except 1952, 1961 and 1965 due to availability. The teenage group (15-24 years old) is excluded because the presented model focuses on the married household[10]. Due to the reasons mentioned previously, the aggregate unemployment rate is used, instead of the unemployment rate by gender.

The estimation method and results

In order to test proposition 2 and 3, three econometric models are constructed. Pooled least squared estimation is used, with the estimates of the coefficients of model A, B and C being shown in table 3. For model A, all the estimated coefficients are significant and the results are consistent with my predictions. A one percent point increase in unemployment rate increases the gender difference in suicide rate by around 1.67 percentage point. The positive coefficient of unemployment in models A and B suggests that proposition 4 is also supported by the US evidence. For both models B and C, the estimated coefficients of the male divorce rate are positive and significant and consistent with proposition 3. The less significant estimated coefficient of unemployment in model B, than that in model A, is probably a result of the high positive correlation (0.6817) between unemployment and the male divorce rate. There is also a negative time trend. This is probably a result of the increasing female labor market participation, which make the effect of unemployment on both genders converge.

IV. Conclusion

The theoretical model presented in this paper is an attempt to explain the gender difference in suicide rate. By adopting the HS model with a two-period household production model, I argue that the higher unemployment rate enlarges the gender difference in the suicide rate. Although it is supported by both international and US evidence, further empirical tests by micro data are needed.

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Table 1a: The gender difference in suicide rate in some developed countries or region

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Australia	15.2	14.2	16.3	13.9	16.6	16.7	17.1	16.2	14.6
Canada	15.2	15.6	15.2	16.1	15.4	14.5	14.4	15.8	13.2
Finland	35.8	33.7	31.8	31.6	28	30.7	28.2	28.3	23.7
France	19.3	20.1	20.8	19.6	18.4	18.3	17.9	16.7	18.4
Germany	14	13.8	14.5	14.5	13.6	14	14.2	12.9	13.3
HK	3.7	3.1	2.1	5.1	6.7	3	7.6	6.9	6
Japan	10.6	11.2	12.2	12.1	12.8	14.1	21.8	22.4	21.8
Holland	6.8	6.6	7.9	6.6	6.8	6.8	6.4	6.7	6.5
New Zealand	17.5	14.7	17.4	17.6	17.5	17.5	16.8	13.7	15.6
Norway	13.5	14.6	10.8	12.9	12.3	11.2	11.5	12.7	12.7
Spain	7.6	8.1	9	8.8	8.5	8.9	9.2	8.4	9.1
Sweden	12.3	12.7	12.5	12.3	11.5	11.9	12.3	11.7	11
UK	9	8.6	8.6	8.5	7.8	7.8	8.4	8.5	8.1
US	15	15.3	15.3	15.4	14.9	14.3	14.2	13.5	13.1

Table 1b: The male-female ratio of suicide rate in some developed countries or region

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Australia	3.87	4.16	4.47	3.73	4.32	3.78	4.05	4.18	3.81
Canada	3.76	3.89	3.87	3.98	3.70	3.84	3.82	3.87	3.54
Finland	4.14	4.01	3.69	3.68	3.62	3.87	3.82	3.98	3.17
France	2.77	2.75	2.94	2.81	2.77	2.81	2.95	2.78	2.94
Germany	2.41	2.55	2.69	2.67	2.64	2.73	2.95	2.77	2.90
HK	1.35	1.36	1.19	1.55	1.75	1.38	1.83	1.70	1.59
Japan	1.91	2.01	2.12	2.07	2.11	2.18	2.48	2.59	2.63
Holland	1.96	1.96	2.23	2.02	2.00	2.01	1.98	2.06	2.05
New Zealand	4.24	3.83	4.11	3.84	3.97	3.78	3.43	3.04	4.71
Norway	2.75	3.25	2.57	3.08	3.16	2.70	2.72	2.87	3.19
Spain	3.24	3.13	3.43	3.38	2.98	3.12	3.42	3.10	3.28
Sweden	2.28	2.34	2.40	2.34	2.35	2.55	2.58	2.46	2.51
UK	3.50	3.46	3.61	3.66	3.36	3.44	3.55	3.58	3.53
US	4.26	4.33	4.40	4.50	4.39	4.25	4.23	4.29	4.28

Source of data: WHO Statistical Information System

Table 2 Estimated coefficients of international data

	GD=m-f		GDR=m/f	
	(a)	(b)	(c)	(d)
Methods / Variables	Random effect model	Fixed effect model	Random effect model	Fixed effect model
Constant	8.486*** (1.907)	8.662*** (0.614)	2.64*** (0.223)	2.738*** (0.1633)
Unemployment rate	0.959*** (0.265)	0.884*** (0.299)	0.077*** (0.029)	0.06* (0.032)
Unemployment rate squared	-0.029*** (0.011)	-0.024** (0.01)	-0.002* (0.001)	-0.002 (0.001)
R^2 (within)	0.1507	0.0945	0.0597	0.0437
R^2 (between)	0.2431	0.1958	0.229	0.1621
R^2 (overall)	0.2246	0.1926	0.2003	0.1462
Observations	126	112	126	112

Note—numbers in the parentheses are standard error

*** significant at 1% level ** significant at 5% level * significant at 10% level

Table 3 Estimated coefficients of US evidence

	Model A		Model B		Model C	
	GD=m-f	GDR=m/f	GD=m-f	GDR=m/f	GD=m-f	GDR=m/f
Constant	26347.26*** (5297.121)	9665.46*** (744.2)	137006.3*** (27579.64)	26242.75*** (6017.98)	98057.26*** (22737.95)	19103.17*** (3877.75)
age	0.323*** (0.026)	0.0161*** (0.003)	0.995*** (0.147)	0.139*** (0.023)	1.077*** (0.141)	0.154*** (0.023)
unemployment rate	1.665*** (0.216)	0.256*** (0.027)	0.478* (0.241)	0.088 (0.06)		
male divorce rate			0.97*** (0.159)	0.158*** (0.027)	1.098*** (0.146)	0.182*** (0.024)
time	-26.639*** (5.363)	-9.799*** (0.753)	-138.322*** (27.851)	-26.539*** (6.082)	-98.957*** (22.952)	-19.323*** (3.919)
time squared	0.0067*** (0.0014)	0.0025*** (0.0002)	0.0349*** (0.007)	0.0067*** (0.0015)	0.25*** (0.006)	0.0049*** (0.001)
R^2	0.4792	0.6092	0.6518	0.7471	0.6267	0.7352
Observations	192	192	44	44	44	44

Note—numbers in the parentheses are robust standard error

*** significant at 1% level ** significant at 5% level * significant at 10% level

Footnotes

1. In this paper, this definition is used mainly.
2. My study focuses on analyzing the completed suicide rate. I assume that people who commit suicide must kill themselves successfully. In other words, completed suicide and attempted suicide are considered as two different phenomenons. For a model of the dynamic of suicide attempted and completion of teenagers, see Cutler, Glaeser and Norberg (2000).
3. Note that all the Zs in this paper, except those with time period indicators, are the total discounted value of the commodity in the remaining life time.
4. The last assumption is not unrealistic, although the total number of women is more than that of men, in all the developed countries. This result is generally reversed if we consider only people aged below 50 (United Nations Population Division 2004).
5. See proposition 1.
6. In this paper, for simplicity, without alternating the empirical implications, I assume that the number of employed men is larger than that of women. If this is not the case, some women would be forced to choose to remain married to their unemployed husband and not all couples with unemployed husband would divorce.
7. Theorem 2.1 in Becker (1993) applies here.
8. Becker's theorem 2.2 (1993) applies here.
9. Although the optimization problem in period 1 is non-cooperative, it should approximately follow the results from a cooperative game if the expected unemployment is small.
10. The result does not change much even if the 15-24 years old age group is included in the data set.