

Does unemployment leave persistent scars on earnings? Evidence from the Swedish twin registry

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Abstract

Does unemployment leave persistent scars on earnings? The European debt crisis has pushed unemployment rates to extraordinary levels in various parts of Europe. This raises important questions about the long term consequences of the crises. Previous research conducted in the USA, Great Britain and Sweden has provided strong evidence for lasting scars inflicted on unemployed workers wages. This paper estimates the long term impact of unemployment on earnings using high quality data on 17,184 twins. A control for twin pair specific heterogeneity is introduced by exploiting the twin dimension through the fixed effects estimator. An additional year of unemployment was found to decrease annual earnings by approximately 5%. These results are consistent with those obtained in previous studies conducted in the USA, Great Britain and Sweden.

1. Introduction

The European debt crisis has pushed unemployment rates to extraordinary levels in various parts of Europe. This raises important questions about the long term consequences of the crisis. There is considerable evidence that the human costs of job displacement are severe and persistent. Mai Dao and Prakash Loungani (2010) found evidence of lasting scars inflicted on earnings, deterioration of health prospects and other detrimental factors. In addition, results from Arulampalam et al. (2000) indicated that workers who have been exposed to job displacement are more likely to experience unemployment in the future. Moreover, Eliason, Lundborg and Vikström (2010) found evidence that unemployment duration severely deteriorates health prospects. However, some studies have suggested that the consequences of unemployment are overestimated. Eriksson and Rooth (2011) used data from a field experiment to examine if past or contemporary unemployment affected the probability of being invited to a job interview. They found no evidence that recruiters used unemployment history to sort workers. They did however find some evidence that recruiters used contemporary unemployment as a sorting criterion. Moreover, quantifying the human costs associated with unemployment is an important part of assessing the appropriate policy response. High costs would justify aggressive policies such as weakening labor laws and implementing expansionary fiscal and monetary policy.

The existing body of literature would thus suggest a variety of human costs associated with unemployment. This paper will however limit the analysis to the long term impact of unemployment on earnings. This is referred to as scarring within the labor economics literature. The purpose of this paper is thus to answer the question: *“What is the long term penalty on earnings associated with an additional year of unemployment?”*

I will attempt to answer this question with data from the Swedish twin registry. This is the world’s largest twin registry and it contains information on about 170,000 twins. The data used in this paper is extracted from a survey conducted in 1973 where twin pairs from the cohort born in 1926-1958 were asked to respond to questions about their unemployment history. Each respondent has been linked to the national income registry. The available sample is fairly large with observations on 17,184 individuals and 8,592 twin pairs. The data set used in this paper has several advantages over those used in previous research. Unemployment insurance and sickness benefits were not defined as taxable incomes in Sweden until 1974. Unemployed workers will thus have an income equal to zero the year that the survey was conducted. The researcher can therefore restrict the sample to workers who were employed in 1973. This is a major advantage over data sets used in previous research conducted in the USA and Great Britain (see for

example Mary Gregory and Robert Jukes 2001 and Jacobson et al 1993). Contrasting employed workers earnings in 1973 against their unemployment history provides a useful framework for identifying the scarring parameter. The data set is however associated with a severe drawback worth mentioning. The amount of time that has elapsed between 1973 and when the most recent unemployment spell ended is unknown. The definition of “long term penalty on earnings” is therefore somewhat ambiguous.

Estimating wage equation with non-experimental data is generally problematic. One would expect ability to have a strong association with earnings and years of unemployment. High ability individuals earn higher wages and are less likely to spend substantial periods of time in unemployment. Ability is however imperfectly observed and thus difficult to control for in a regression analysis. Estimating the scarring parameter with a control strategy is therefore problematic. I will however attempt to control for ability by exploiting the twin dimension through the fixed effects estimator. This provides a significant advantage over previous research about scarring effects in a Swedish context (see for example Marcus Eliasson and Donald Storrie 2006).

This paper is organized as follows: The next section provides a theoretical treatment of scarring effects. The third section reviews some results from previous research. The data is described forth section and the fifth section presents the empirical framework where the research design is discussed in detail. The sixth section presents the empirical findings and the final section provides a concluding discussion.

2. Theoretical framework

There are primarily three different areas of economic theory that gives predictions about the long term impact of unemployment on earnings: human capital, search and imperfect information. Each framework emphasis different aspects of the unemployment experience. Their predictions are therefore neither clear cut nor mutually consistent.

Human capital theory indicates that an unemployment spell diminishes skills through various channels. Scarring would occur if the reduction in productivity is persistent. Moreover, job termination obviously leads to the erosion of firm specific skills. Through on the job training, workers accumulate a skillset well suited for their current position. Some of these skills are likely

to be non-transferable which would suggest that job displacement causes an initial drop in productivity. The wage reduction following reemployment should however disappear over time as workers accumulate new on the job training. Moreover, unemployment duration precludes the accumulation of work experience. The well documented increase in earning associated with tenure (see for example Masanori and John Raisian 1985) can arguably be attributed to the growth in skills that comes with experience. A sufficiently long unemployment spell could thus preclude enough accumulation of tenure so as to impose a persistent deterioration of labor market outcomes. Moreover, it is often argued that unemployment depreciates general non-transferable skills. These arguments have been examined extensively. Clark (1996) found evidence that unemployment has somewhat worse implications for psychological well-being than a divorce. Moreover, Goldsmith et al (1996) showed that unemployment causes severe deterioration of self-esteem. Other results from studies such as Fagan and Freeman (1997) indicated that unemployment often causes social dislocation and thus increases the probability of engaging in criminal behavior. These effects are likely to deteriorate general non-transferable skills and thus impose a persistent penalty on earnings.

The search framework states that the productivity of any given worker is strongly influenced by the quality of their current job match. Jovanovic (1979) formalized the search framework in a theoretical model of job matching. The basic idea is that each worker has a very different set of skills that translates well into certain settings and poorly into others. The quality of a given match is unknown at the time of hiring so both high and low productivity matches occur. The quality is however gradually revealed as time progress and low productivity job matches tend to be terminated. This allows the worker to search for a new job that makes better use of his skills. If the search results in a better match, the worker will become more productive and thus earn a higher wage. Moreover, those who choose to stay with their employer tend to do so because they have already found a high productivity job match. According to Jovanovics model, the hazard of terminating a job contract should therefore initially be fairly large but decreasing with tenure. This pattern of hazard rates has been confirmed empirically by Randolph (1983). Improved matching could thus offset some or perhaps even all of the negative consequences of unemployment.

The imperfect information framework emphasizes that employers have limited information about workers at the time of hiring. They therefore seek signals reveling information about workers productivity. An unemployment spell would be such a signal and a negative one. High ability workers are less likely to be exposed to job displacement. An unemployment spell would thus suggest that the worker has a fairly weak set of skills. The employer might therefore be unwilling

to pay anything but a low wage due to low expectations of how the worker will contribute to the firm. This would suggest that an unemployment spell causes an initial reduction in earnings following reemployment. These effects have been shown to exist under fairly general conditions, see for example Vishwanath (1989) for a formal treatment. However, the wage reduction due to negative signaling should disappear over time if the unemployment spell did not cause the deterioration of skills emphasized by the human capital framework. This would suggest that scarring does not occur. The human capital and search frameworks do unlike imperfect information suggest that job displacement has long term effects on earnings. Their predictions are however inconsistent with each other. The former states that an unemployment spell imposes long term penalties on earnings while the latter suggest that the opposite might occur.

The life-cycle theory of human capital provides a useful foundation for a unified analysis of each framework. The theory states that a workers wage is a function of productivity which depends on the stock of human capital, the quality of a given job match and the capital-labor ratio. The stock of human capital is divided into firm specific, job specific and general. I will limit the analysis to the quality of a given job match (λ) and the entire stock of human capital (k) since these are the relevant variables when analyzing the search and human capital frameworks in a scarring context. Thus, assume that the productivity any given worker is a function of k and λ . Moreover, assume that λ is a strictly increasing linear function of time spent in unemployment. This is a fair assumption since one would expect the probability of finding a high productivity job match to increase as the worker spends more time searching for a good match. By contrast, assume that k is a strictly decreasing linear function of time spent in unemployment. This is consistent with the human capital propositions about the long term impact of unemployment on productivity. Moreover, assume that any given worker is currently employed but has previously spent t years in unemployment. Finally, assume that the unemployment spell ended sufficiently far ago so that any wage reduction due to negative signaling has been eliminated. The earnings function is thus given by:

$$w = f(\lambda(t), k(t)) \tag{1}$$

We can then use the chain rule to find:

$$\frac{dw}{dt} = \frac{\partial w}{\partial k} * \frac{dk}{dt} + \frac{\partial w}{\partial \lambda} * \frac{d\lambda}{dt} \tag{2}$$

Let $\frac{\partial w}{\partial k} * \frac{dk}{dt} = \alpha$ and $\frac{dk}{dt} + \frac{\partial w}{\partial \lambda} = \gamma$. Since unemployment duration depreciates human capital and thus lowers earnings, $\alpha < 0$. Moreover, since a good match increases productivity and thus yield a

higher wage, $\gamma > 0$. The long term impact of unemployment on earnings is thus given by:

$$\alpha + \gamma = \phi \tag{3}$$

scarring occur if and only if $\phi < 0$. Note that if the long term impact of unemployment on earnings is entirely explained by the imperfect information framework, $\phi = 0$ since that would imply that $\alpha = \gamma = 0$. Moreover, if $\alpha = \gamma = \theta$ for some arbitrary constant θ , the depreciation of human capital is precisely balanced by improved matching and no scarring occurs. The empirical section outlines the econometric framework used to identify the ϕ parameter.

3. Previous research

Mary Gregory and Robert Jukes (2001) estimated two types of scarring effects in a British context: The reduction in earnings associated with unemployment incidence and unemployment duration. I will limit the discussion to the effects of unemployment duration since that is the topic of this paper. The effect was estimated using the NESPD-JUVOS dataset. It links the New Earnings Survey Panel (NESPD), longitudinal data on individual earnings, with the joint Unemployment and Vacancies Operating System (JUVOS) dataset, which contains observations on individual unemployment experiences. The available sample is large varying from a low of 66,000 observations in 1994 to almost 77,000 observations in 1998. However, there is a major drawback associated with the NESPD-JUVOS dataset. It has been shown that only about half of those ceasing to claim unemployment benefits in the JUVOS dataset actually found employment. Many switched to other sources of income such as sickness or disability benefits while remaining in economic inactivity. Thus, the description of workers transitioning from unemployment into the labor force is fairly blurry. The fixed effects estimator was implemented to control for time invariant individual heterogeneity. However, even though a fairly large vector of controls was included, (occupation, region of workplace etc), potentially important variables such as differences in job characteristics, demographics and so forth, had to be excluded. Biased parameter estimates will emerge if the excluded variables are associated with the included regressors. Unemployment duration was found to have a permanent impact on earnings. The evidence suggested that an additional year of unemployment permanently decreased earnings with 10%.

Marcus Eliasson and Donald Storrie (2006) examined the long term impact of unemployment on various types of labor market outcomes in a Swedish context. I will restrict the discussion to the

impact of unemployment on earnings. The effect was estimated using panel data on workers being pushed into unemployment following an establishment closure. This creates a quasi-experimental setting since all workers are discharged regardless of underlying characteristics such as experience, ability and so forth. Propensity score matching was implemented to estimate the causal effect of unemployment on earnings. The basic idea behind this method is that the researcher observes the variables determining who gets pushed into treatment. By balancing the covariates, one can create an artificial treatment and control group. Even though the research design has several important strengths, it is associated with some major drawbacks worth mentioning. The closure of an establishment takes place over a substantial period of time. Workers are thus aware of a fore coming closure and some choose to stay and some choose to exit at an earlier stage. The exit decision is probably influenced by the opportunity cost of staying. High ability workers with a variety of career opportunities are likely to exit at an earlier stage than low ability workers with dim outlooks on the labor market. Unemployment due to establishment closure might therefore be assigned non-randomly. This creates a potential selection problem. Moreover, propensity score matching is always associated with the risk of “selection on unobservable”. The researcher might simply not observe all variables determining who gets pushed into treatment. This would render the artificial treatment and control group invalid and the treatment effect poorly estimated. Unemployment was found to have a significant long term impact on earnings. Being pushed into unemployment was estimated to decrease annual earnings by 6,717 Swedish kronor 12 years after the event.

Jacobson et al (1993) examined the magnitude and temporal pattern of displaced workers earnings losses in an American context. I will limit the discussion to the long term pattern since that is the topic of this paper. The effect was estimated using panel data on displaced workers in Pennsylvania during the early and mid 1980's. The dataset is however associated with a major disadvantage. There is no information that allows the researcher to differentiate between workers whose income drop to zero due to unemployment as opposed to dropping out of the Pennsylvanian labor force. Blurry information about workers unemployment history is obviously an undesirable feature of a dataset used to estimate the long term impact of unemployment on earnings. A fairly sophisticated control strategy was implemented to deal with several potential sources of bias. A detailed discussion about the estimation technique is beyond the scope of this text. However, a quick review about the statistical properties of the model is appropriate. The fixed effects estimator was implemented to deal with time invariant individual heterogeneity. Unbiased parameter estimates do however require some untestable assumptions to hold. Thus, care should be taken when interpreting the results. Job displacement was found to impose long-term losses averaging 25% per year.

The three papers discussed above reach similar conclusions despite using alternative estimation techniques and different samples. This would suggest that scarring occur but that the exact quantitative implications are unknown. Moreover, the potential sources of bias are clearly different in each paper and independent of one another. The authors still reach similar conclusions which would suggest that the disadvantages do not cause significant bias. Moreover, a major threat to Marcus Eliasson and Donald Storries research design (the Swedish study) is failure to account for time invariant individual heterogeneity. This is by contrast an important strength associated with the twin design used in this paper. Since both studies were conducted in a Swedish context, contrasting Marcus Eliasson and Donald Storries estimates with the results produced in this paper should be of particular interest.

4. The data

The data used in this paper originates from the Swedish twin registry. It is the world's largest twin registry, containing information about approximately 170,000 twins. In 1972-1973, a mail out questioner was sent to same sexed twins from the cohort born in 1926-1958. The twins were asked to respond to questions concerning issues ranging from their diet to their labor market experiences. Information about their unemployment history was collected by first asking them if they are or had ever been unemployed. The twins were required to provide a yes or no answer to this question. Those who said yes were then asked to provide information about the number of years they had spent in unemployment. The method used to collect data on unemployment history causes some concern since one would expect self-reported information to be associated with a significant amount of measurement error. The other important variable used throughout the empirical part of this paper is "years of schooling". This variable was constructed through a combination of self-reported educational information and register based data. One would therefore expect this variable to be measured with error as well. I will go through the implications of measurement error in great detail when interpreting the results.

The twin registry received answers from 36,000 individuals including 14,000 twin pairs. Each respondent has been linked to the national income registry. This allows the researcher to trace various sources of income to each respondent. I will limit the analysis to income from labor market participation since this is the relevant source of income when analyzing scarring effects. The survey conducted in 1973 does however fail to include information about the respondent's current employment situation. The purpose of this paper is to examine how unemployed workers

perform when they make the transition back into the labor market. Workers who are unemployed in 1973 are thus irrelevant. However, unemployment benefits were not defined as a taxable income in Sweden until 1974. Since the survey was conducted in 1973 unemployed workers will have a taxable income equal to zero that year. By removing these observations the sample is restricted to employed workers. Moreover, subsets of the respondents are very young and thus irrelevant for a study about scarring effects. Since the survey was conducted in 1973 and included respondents born in 1958, some of them will be 15 years of age at the time. They will obviously not add anything to research about the long term impact of unemployment on earnings. However, the estimation technique used in this paper will eliminate the problem. The fixed effects estimator uses within twin pair variation to estimate the parameters. Information about very young twin pair where none has ever experienced unemployment will therefore not be used to identify the scarring parameter. Moreover, observations on twin pairs where relevant information about one twin is missing will have to be deleted since this renders the within twin pair variation undefined. Two types of observations will thus be deleted from the sample. The first type consists of twin pairs where one or both were unemployed in 1973. The second consists of twin pairs where information about educational background or unemployment history is missing on either twin. The available sample is reduced to 17,184 observations and 8,592 twin pairs. This includes 6,898 monozygotic twins and 9,940 same sexed dizygotic twins. Note that the sample contains 346 individuals who have not been identified as either monozygotic or same sexed dizygotic twins. The method used to distinguish monozygotic from same sex dizygotic twins has been proven to have 98% or higher accuracy (Lichtenstein et al., 2002). Moreover, the data set does not contain any information about the amount of time that has elapsed between 1973 and when the most recent unemployment spell ended. The purpose of this paper is to answer the question: *“What is the long term penalty on earnings associated with an additional year of unemployment?”* Since there is no information about when the respondents made the transition back into the labor market, the definition of “long term penalty” is somewhat ambiguous.

Descriptive statistics of the available sample is provided in table 1 on the next page. The average respondent is 31 years of age, has 10 years of schooling and an annual income of 163,644 Swedish kronor. The gender distribution is fairly balanced with 57% males and 43% of females. A rather small fraction (9%) of the sample have ever experienced unemployment. The earnings variable is measured in the price level of 2007 and is defined as income before taxes. The average annual salary is fairly low since the sample contains a set of very young individuals who have just entered the labor market and are unlikely to work full time. Moreover, some additional descriptive statistics of the available sample is provided in table 2 on the next page. The sample has been divided into two separate groups depending on if the respondents have ever experienced

unemployment. The gender distribution is more balanced in the fraction of the sample without any unemployment history. This part of the sample consists of 50% males and 50% females. The part of the sample with unemployment experience consists of 60% males and 40% females. An unexpected feature of the data is that the average amount of schooling is the same in both groups. Moreover, the mean income is actually higher in the group with unemployment experience. This is probably because the group without unemployment experience contains most of the young teenagers without any unemployment experience, few years of schooling and a very low income.

Table 1

Variable	Min	Mean	Max	STD error
Years of schooling	6	10	20	3
Age	15	31	47	8
Income	190	163,644	1,524,647	8
Gender dummy		0.57		
Unemployment dummy		0.09		
Years of Unemployment	0	0.05	25	0.44
Number of observations		17,184		

Notes: The gender and unemployment dummy equals 1 if the respondent is male and has experienced unemployment. The mean of these variables does therefore correspond to the percentage of the sample that is male and has experienced unemployment.

Table 2

Variable	Min	Mean	Max	STD error	Min	Mean	Max	STD error
Years of schooling	6	10	20	3	6	10	20	3
Income	652	112,281	542,440	66,911	190	98,386	1,524,647	98,386
Age	17	30	47	8	15	31	47	8
Gender dummy		0.6				0.5		
Years of unemployment	1	2	25	2				
Number of observations		451				16,733		

Notes: The respondents who has experiences unemployment are collected in the left column. The gender and unemployment dummy equals 1 if the respondent is male and has experienced unemployment. The mean of these variables does therefore correspond to the percentage of the sample that is male and has experienced unemployment.

Some additional descriptive statistics of the monozygotic and the same sexed dizygotic twins is provided below. The two groups appear to have fairly similar features. None of the available variables differs to any significant extent between the two groups.

Table 3

Variable	Min	Mean	Max	STD error	Min	Mean	Max	STD error
Years of schooling	6	11	20	4	6	10	20	3
Income	191	164,135	1,118,580	98,516	202	163,411	1,524,647	98,042
Age	15	31	47	8	16	32	47	8
Gender dummy		0.55				0.57		
Years of unemployment	0	0.044	12	0.39	0	0.048	12	0.39
Unemployment dummy		0.09				0.09		
Number of observations		6,898				9,940		

Notes: The monozygotic twins are collected in the left column. The gender and unemployment dummy equals 1 if the respondent is male and has experienced unemployment. The mean of these variables does therefore correspond to the percentage of the sample that is male and has experienced unemployment.

5. Empirical framework

Estimating the impact of different features on earnings has dominated much of the labor economics literature. The research ranges from questions concerning how union membership, education and unemployment history influences earnings. However, estimating earnings equations with non-experimental data is generally problematic. Workers with different union membership status, unemployment history and education differ in many unobservable ways. Biased parameter estimates will emerge if these differences influence earnings and are associated with the included regressors. This is a well-known problem to researchers who have attempted to estimate the returns to schooling.

Consider the following earnings equation:

$$Y_i = \alpha + \beta X_i + \delta A_i + \gamma S_i + \varepsilon_i \quad (4)$$

Individual i 's wage is assumed to be a function of schooling, S , a vector of covariates, X , and an unobservable level of ability, A . The ability variable contains unobservable features such as motivation, intelligence, social skills and so forth. Since ability is unobservable, the researcher will end up estimating:

$$Y_i = \alpha + \beta X_i + \gamma S_i + \mu_i \quad (5)$$

Where $\mu_i = \delta A_i + \varepsilon_i$. The OLS estimator of the γ parameter will thus have the following probability limit:

$$plim(\gamma_{OLS}) = \gamma + \frac{\delta cov(A, S)}{var(S)} \quad (6)$$

Equation (6) shows that any association between ability and schooling renders the OLS estimator inconsistent. Moreover, ability is typically assumed to be positively correlated with education. This would suggest that the estimator will overestimate the returns to schooling. Since it seems highly unlikely that the researcher would be able to account for everything captured in the ability variable, a control strategy is far from optimal. Moreover, there might not be any good instruments or natural experiments to exploit. This renders the task of estimating the returns to schooling problematic.

The problem of controlling for unobserved ability when estimating the returns to schooling inspired economists to study monozygotic twins. Ashenfelter and Krueger (1994) and later Ashenfelter and Rouse (1998) exploited the twin dimension to estimate the returns to education. They take advantage of the fact that monozygotic twins are genetically identical and have been exposed to the same childhood environment. Features such as intelligence, motivation, social skills and so forth are assumed to be shaped by genetics and social environment. Monozygotic twins are therefore viewed as identical with respect to ability. By relying on within twin pair variation, the researchers hoped to control for ability and thus isolate the impact of schooling on earnings. The research design has however not gone unchallenged. John Bound and Gary Solon (1999) presented strong arguments against it.

The twin design rests on the assumption that within twin pair variation in schooling is random and unrelated to ability. However, John Bound and Gary Solon argued that this is an implausible assumption since twins are shaped by slightly different experiences. Some of these occur before the twins are even born. In some extreme cases of the so called twin transfusion syndrome, identical twins have dramatically different birth weights. This is due to competition for nutrition in the uterus where one twin has flourished at the expense of the other. Moreover, Behrman, Rosenzweig and Taubman (1994) used a sample of identical twins from Minnesota to examine differences in birth weights between monozygotic twins. They found evidence of significant differences in birth weights between identical twins occurring quite frequently. These differences were also found to have a strong correlation with differences in education. Moreover, numerous studies have found evidence of a strong association between birth weight and cognitive ability, see for example Richards et al (2001). Thus, it is probably not be plausible to think of monozygotic twins as identical with respect to ability. Moreover, depending on the extent to which their differences in ability drives the within twin pair variation in education, the estimator might be subject to as just as much inconsistency as in equation (6).

In addition, Gary Solon and John Bound pointed out that the twin design is likely to amplify the problems associated with measurement error. Since twins are very similar, one would expect years of schooling within any given twin pair to have a strong correlation. Within twin pair variation will thus eliminate a substantial part of the “signal” component of the proxy variable for education. There is however no reason to expect a proportional reduction in the noise from measurement error. Twin based estimates will thus be subjected to a significantly larger amount of inconsistency due to measurement error than ordinary cross sectional estimates. Moreover, within twin pair differences in ability will cause upward inconsistency when estimating the returns to schooling. Measurement error will on the other hand cause downward inconsistency. This is obviously a very undesirable feature of the research design since it appears to eliminate any bounding properties of twin based estimates. The twin design can however be saved under reasonable assumptions. Monozygotic twins possess identical sets of genetics and have been exposed to the same childhood environment. One could therefore argue that within twin pair differences in ability are, at least on average, negligible. Moreover, their similarities would also suggest a strong correlation in years of schooling within any given twin pair. This would amplify the impact of measurement error with a significant amount. Under the assumption that any ability bias is dominated by the impact of measurement error, the twin based estimates could be viewed as a lower bound on the returns to schooling.

Consider two individuals who would receive the same wage if they had the same unemployment

history. Then randomly assign an additional year of unemployment to one of them. What is the expected earnings differential? This question: “*What is the long term penalty on earnings associated with an additional year of unemployment?*” is the question this paper will attempt to answer. More formally, the effect to be estimated is given by:

$$E(y_i | x_i = n) - E(y_i | x_i = n - 1) \quad (7)$$

Where y_i is individual i 's wage and x_i is the number of years individual i has spent in unemployment. The effect will be estimated using the twin design. However, as outlined previously, care should be taken when interpreting these results. Consider the following earnings equation:

$$Y_i = \alpha + \beta X_i + \delta A_i + \lambda S_i + \gamma U_i + \varepsilon_i \quad (8)$$

Where Y_i represents individual i 's annual earnings in 1973, U_i corresponds to years of unemployment, A_i an unobservable level of ability, S_i years of schooling and X_i is a vector of covariates containing features such as age and gender. Now consider the earnings equations of two twins:

$$Y_{1i} = \alpha + \beta X_{1i} + \delta A_{1i} + \lambda S_{1i} + \gamma U_{1i} + \varepsilon_{1i} \quad (9)$$

$$Y_{2i} = \alpha + \beta X_{2i} + \delta A_{2i} + \lambda S_{2i} + \gamma U_{2i} + \varepsilon_{2i} \quad (10)$$

Where $A_{1i} = A_{2i}$ and $X_{1i} = X_{2i}$. The within twin pair variation in earnings is thus given by:

$$Y_{2i} - Y_{1i} = \lambda(S_{2i} - S_{1i}) + \gamma(U_{2i} - U_{1i}) + \varepsilon_{2i} - \varepsilon_{1i} \quad (11)$$

The vector of covariates cancels out since the sample consists of same sexed twins that share features such as age and gender. Furthermore, twins are assumed to be identical with respect to ability so this variable will also cancel out. There are however strong reasons to suspect that this assumption is overly optimistic even when the sample is restricted to monozygotic twins. Moreover, in the case of same sexed dizygotic twins who possess different sets of genetics the

reasons for skepticism are even stronger. However, dizygotic twins are arguably similar enough to be relevant for a study that exploits the fixed effects estimator. Previous studies such as Ashenfelter and Zimmerman (1997) used data on brothers and on fathers and sons to control for ability when estimating the returns to schooling. They argue that individuals linked by family affiliation are more likely to have similar levels of innate ability than two arbitrary strangers. Thus, by contrasting the differences in schooling and earnings between brothers and between fathers and sons, they hope to eliminate some ability bias. However, since family environments changes over time and ordinary brothers are of different age, they are exposed to slightly different conditions at different points in their childhood. These differences are likely to drive some of the heterogeneity in ability between brothers. This problem would of course be even more severe when comparing fathers and sons. However, since dizygotic twins are of the same age these differences will disappear when the fixed effects estimator is implemented. Thus, dizygotic twins are arguably superior compared to brothers and fathers and sons in accounting for unobserved ability. However, even though the research design is likely to remove some ability bias, the discussion about the drawbacks associated with the twin design is still important to consider. I will therefore relax the assumption of twins being identical with respect to ability and consider the impact of measurement error when interpreting the results.

6. Results

This section presents the empirical findings of this paper. The Breusch-Pagan test provided strong evidence for heteroscedasticity in every regression I ran so the test statistics were computed using robust standard errors. Moreover, autocorrelation will not be considered since no time dimension was ever present. The estimates were never computed with less than 3,449 observations. I will therefore rely on the asymptotic properties of the test statistics and not make any assumptions about the distribution of the error terms. The twin design is supposed to control for unobserved ability by relying on within twin pair variation. The previous section did however review some strong arguments for why the research design might fail to eliminate ability bias. In addition, the twin design is likely to amplify the problems associated with measurement error. Comparing the OLS and the fixed effects estimates provides a useful framework for testing these arguments empirically. The estimates will have to be computed with the same sample for any comparison to make sense. Observations where information about the relevant covariates is missing on either twin will thus be deleted. The available sample is therefore reduced to 16,608 individuals and 8,304 twin pairs. Estimating equation (11) and (8) produces the results collected

in table 4. Note that the ability variable in equation (8) has been omitted.

Table 4

Variable	OLS	Fixed effects
Years of schooling	9,551*** (304)	4,652*** (345)
Gender	86,617*** (1,224)	
Years of age	4,561*** (93)	
Years of unemployment	-16,389*** (1,556)	-13,132*** (1,777)
Number of observations	16,608	8,304

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The robust standard errors are reported within parenthesis under the estimated coefficients. The gender dummy equal 1 if the respondent is male. Both regressions include a constant.

The OLS estimates are correctly signed and highly significant. An additional year of unemployment was found to decrease annual earnings with 16,389 Swedish kronor. The returns to an additional year of schooling was estimated to 9,551 Swedish kronor a year. The included covariates will however fail to control for unobserved ability. Moreover, ability is typically assumed to correlate positively with years of schooling and negatively with years of unemployment. In addition, measurement error will typically have a marginal impact on ordinary OLS estimates. One would therefore expect unobserved ability to introduce the dominant source of bias. This would suggest that the estimate impact of schooling and unemployment is overestimated. The twin design will however introduce a control for ability and amplify the problems of measurement error. This would suggest that the estimated impact of schooling and unemployment would come out closer to zero. This is exactly what happened. The estimated impact of an additional year of unemployment was reduced to 13,132 Swedish kronor. Moreover, the estimated returns to schooling dropped to 4,652 Swedish kronor. The OLS and the fixed effects estimator do however use different observations to identify the scarring parameter. The first estimator relies on individuals who have experienced unemployment while the latter uses twin pairs who differ with respect to years of unemployment. If the individuals used for identification have different properties this could explain why the estimates come out different. I will however argue that this explanation is unlikely to hold. For point of comparison, I estimated equation (11) separately for the monozygotic and the same sexed dizygotic twins. This produces

the results collected in table 5.

Table 5

Variable	Monozygotic twins	Same sexed dizygotic twins
Differences in years of schooling	1,667** (690)	5,846*** (531)
Differences in years of unemployment	-8,943** (3,804)	-16,312*** (2,680)
Number of observations	3,449	4,970

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The robust standard errors are reported within parenthesis under the estimated coefficients. Both regressions include a constant.

The estimated impact of unemployment and schooling is reduced substantially when one moves from same sexed dizygotic to monozygotic twins. This is exactly what one would expect since monozygotic twins possess identical sets of genetics while same sexed dizygotic twins do not. Twin pairs from the former group are thus likely to be more similar with respect to unobserved ability. The fixed effects estimator should therefore remove more ability bias when the sample is restricted monozygotic twins. In addition, one would expect within twin pair correlation in education and years of unemployment to be stronger for monozygotic compared to same sexed dizygotic twins. This would suggest that the problem of measurement error would be amplified even further when the sample is restricted to monozygotic twins.

The estimated penalty on earnings associated with an additional year of unemployment was reduced from 16,312 to 8,943 Swedish kronor a year when the sample was restricted to monozygotic twins. The mean income in the available sample is 163,644 Swedish kronor a year. The estimate based on dizygotic twins would thus correspond to a 10% penalty on the average workers annual salary. The corresponding number for the estimate based on monozygotic twins is 5%. Moreover, the estimated returns to an additional year of schooling was reduced from 5,846 to 1,667 Swedish kronor a year when the sample was restricted to monozygotic twins. The estimate based on dizygotic twins would thus correspond to a 3% increase in the average workers annual salary. The corresponding number for the estimate based on monozygotic twins is 1%. The estimated returns to schooling produced in this paper are somewhat lower than previous estimates in a Swedish context. Isacson (1999) used data from the same twin registry and estimated the returns schooling to 4.5%. In addition, Edin and Holmlund (1995) used a different data set and estimated the returns to education to over 11%. Moreover, it seems unlikely that the estimates differ because the group of monozygotic and same sexed dizygotic twins consists of individuals with substantially different features. The descriptive statistics provided in table 3 in

the data section would actually suggest that the two groups consist of individuals with very similar features. Furthermore, the pattern that emerges when one move from the OLS to the twin based estimates and then from same sexed dizygotic to monozygotic twins is entirely consistent with the previous discussion about the twin design. The impact of ability bias appears to diminish significantly as the sample is restricted to monozygotic twins. This is probably a combination of a more successful control for ability and amplified effects of measurement. Moreover, in the case of monozygotic twins it is reasonable to assume that any remaining ability bias is dominated by the impact of measurement error. This would suggest that the estimate based on monozygotic twins constitute an upper bound on the scarring parameter.

7. Conclusion

The purpose of this paper is to answer the question “*what is the long term penalty on earnings associated with an additional year of unemployment?*”? An additional year of unemployment was found to decrease annual earnings by approximately 5%. However, care should be taken when interpreting these results. As discussed in the empirical framework section, the assumption that $A_{1i} = A_{2i}$ is probably inaccurate. This would imply that equation (11) does not represent the within twin pair variation in earnings. If $A_{1i} \neq A_{2i}$ some unobservable differences in ability would be captured by the error term. These differences are likely to drive some of the within twin pair variation in years of unemployment and would thus introduce some ability bias. In addition, twin based estimates are likely to amplify the impact of measurement error. I have argued that it is plausible to assume that the impact of measurement error dominates any remaining ability bias when the sample is restricted to monozygotic twins. The pattern that emerges when one move from the OLS to the twin based estimates and then from same sexed dizygotic to monozygotic twins is consistent with such an assumption. It is however by no means a proof. Furthermore, if this assumption holds, the estimate based on the monozygotic twins would constitute an upper bound on the scarring parameter.

Mary Gregory and Robert Jukes (2001) estimated the impact of unemployment on earnings in a British context. They found evidence that an additional year of unemployment permanently decreased earnings with 10%. Moreover, Jacobson et al (1993) estimated the scarring parameter in an American context. They found evidence that job displacement imposed long-term losses averaging 25% per year. The results produced in this paper are thus fairly similar to those from Great Britain but substantially lower than those from the USA. This is encouraging since the

Swedish and the British labor markets are fairly similar. The Swedish and American labor markets are by contrast very different. One would therefore expect greater similarities between British and Swedish evidence. Moreover, Marcus Eliasson and Donald Storrie (2006) estimated the long term impact of unemployment on earnings in a Swedish context. Their results indicated that job displacement leaves long lasting scars on earnings corresponding to 6,717 Swedish kronor a year. This is however measured in the price level of 1999. Assuming an annual inflation rate of 2%, this corresponds to 7,870 Swedish kronor in the price level of 2007 (the income variable used in this paper was measured in the price level of 2007). Previous evidence from the Swedish labor market does therefore point towards scarring effects that are very similar to the twin based estimate. (The most reliable estimates produced in this paper suggested that an additional year of unemployment decrease annual earnings with 8,943 Swedish kronor). This is very encouraging. Moreover, the results produced in this paper add to a very powerful accumulative case for scarring effects. It does therefore seem highly likely that scarring occurs but that the exact quantitative implications are unknown. Additional research could have the potential of further tightening the interval of the scarring parameter.

Furthermore, the results produced in this paper has some interesting theoretical implications worth mentioning. In the second section, I briefly discussed three different areas of economic theory that makes predictions about the long term impact of unemployment on earnings: Human capital, search and imperfect information. As the reader may recall, the long term impact of unemployment on earnings was defined as:

$$\frac{dw}{dt} = \frac{\partial w}{\partial k} * \frac{dk}{dt} + \frac{\partial w}{\partial \lambda} * \frac{d\lambda}{dt} = \alpha + \gamma = \phi \quad (12)$$

Where $\frac{\partial w}{\partial k} * \frac{dk}{dt} = \alpha$ and $\frac{\partial w}{\partial \lambda} * \frac{d\lambda}{dt} = \gamma$. The human capital depreciation associated with unemployment was thus defined as α while the improved job matching was defined as γ . The imperfect information framework states that unemployment only causes an initial wage reduction following reemployment due to negative signaling. This would suggest that unemployment does not have any long term effects on earnings. More formally, this would imply that: $\alpha = \gamma = \phi = 0$. The estimate of the ϕ parameter was however significantly different from zero. The evidence would therefore suggest that unemployment has long term implications for earning and that the imperfect information framework fails to capture some import dynamics of the unemployment experience. Moreover, since the evidence point towards significant deterioration of long term labor market outcomes, it appears as though $|\alpha| > |\gamma|$. This does obviously not prove that unemployment does not increase workers' productivity through improved matching. These effects

do however appeared to be outweighed by the deterioration of skills emphasized by the human capital framework.

The available sample is associated with two potential sources of selection bias. This causes some concerns regarding the external validity of the estimates. The first source of selection bias emerged when the sample was restricted to twin pairs who were employed in 1973.

Unemployment is obviously assigned non-randomly. It is a well-known fact that unskilled labor is more likely to experience unemployment (Oesch 2010). Moreover, several studies have suggested that scarring effects are more severe for high skilled labor, see for example Mary Gregory and Robert Jukes (2001) and Gangl (2006). This source of selection bias would thus suggest that the long term impact of unemployment on earnings may be somewhat overestimated.

Moreover, the external validity of twin based estimates is often called into question. Twins differ from singletons with respect to several different features. If these differences influence how twins react to unemployment it might be inappropriate to generalize these estimates to singletons. It has been pointed out that monozygotic twins influence each other more than ordinary sibling during their childhood (John Bound and Gary Solon 1999). This can arguably be attributed to their psychological need to differentiate themselves from one another. It does however seem highly unlikely that these types of childhood dynamics would cause monozygotic twins to respond differently than singletons when being treated unemployment. Moreover, it is a well-known fact twins have significantly lower birth weights than singletons (O.P Bleker, W. Breur and B.L Huidekoper 2005). This causes some concern since low birth weights have been found to correlate negatively with cognitive development (Barbara J M H Jefferis, Chris Power and Clyde Hertzman 2002). This would suggest that twins on average have somewhat lower levels on innate ability than singletons. One would therefore expect a sample of twins to contain a slightly higher proportion of low skilled labor than a random sample from the Swedish workforce. Moreover, this causes some concern since scarring effects appear to be less severe for low skilled labor. This effect together with the upward inconsistency of the estimator will arguably offset the impact of the previously discussed source of selection bias. The estimate should therefore still be viewed as an upper bound on the scarring parameter.

However, even though some selection bias probably occurred the external validity of these estimates is arguably fairly high. The exclusion of respondents who were unemployed in 1973 will probably not diminish the external validity of these results to any significant extent. Sweden was close to full employment in 1973. This would suggest that the vast majority of those who were excluded because they lacked an income in 1973 were students and not workers unable to find

employment. Low skilled labor is therefore unlikely to be severely underrepresented in the available sample. Moreover, even though twins have lower birth weights than singletons it seems unlikely that their innate level of ability would be so much lower that the external validity of these results would be diminished to any significant extent.

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