Mothers' Involuntary Job Loss and Children's Academic Achievement

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Abstract Using matched mother-child data from the National Longitudinal Survey of Youth, I examine the impact of mothers' involuntary job loss on children's academic achievement. Single mothers' job displacement affects children's math and reading test scores negatively and statistically significantly in the short run. Displacement of married mothers has no impact on their children's test scores. The decline in income and a worsening of child's behavioral problems are two channels through which single mothers' job loss impacts test scores.

Keywords Job displacement · Academic achievement · NLSY79

JEL Classification J62 · J65 · I20

Introduction

In families where women are income earners, the job loss of women is expected to affect the well-being of the family. Between 2007 and 2009, 6.9 million workers were displaced from their jobs in the U.S. and two-fifths of these displaced workers were women (Bureau of Labor Statistics, 2011).[1] In this study, I use the National Longitudinal Survey of Youth 1979 (NLSY79) and National Longitudinal Survey of Youth 1979 Child/Young Adult Survey (NLSY79-CS) to investigate the effect of mothers' job displacement on children's academic achievement during the period 1988–2002. Job displacement is defined as an involuntary job loss due to plant closure. The educational

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[1] http://www.bls.gov/cps/wlf-databook-2011.pdf

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achievement of the child is measured by math and reading recognition scores from the Peabody Individual Achievement Tests (PIATs).

The negative impact of job displacement on income, consumption, health, and family structure has been well documented in the literature. For example, Kletzer and Fairlie (2003), Jacobson et al. (1993), Stevens (1995), and Ruhm (1991a, b) show that following job displacement, the earnings of workers decline by 10 to 25 %. Furthermore, Browning and Crossley (2008) find that layoffs reduce family consumption by 4 to 10 %. Ruhm (1991a, b) concludes that displaced workers experience longer unemployment spells.

Involuntary job loss not only affects income, but also affects family dynamics and health of the individual. Sullivan and von Wachter (2009) find that the mortality rate of employees who were displaced is higher compared to the workers who were not displaced. Although their study covers a small sample of workers from Pennsylvania, this result is significant in terms of the impact of job displacement on parents' health. Using two data sets, Americans' Changing Lives Study and Wisconsin Longitudinal Study, Burgard et al. (2007) find that involuntary job loss causes poorer physical health and it increases depressive symptoms. Following a job loss, the individual may experience marriage problems, often leading to separation or divorce (Charles and Stephens 2004).

These negative effects of involuntary job loss may spread to children. The potential channels through which these effects reach and affect children can be classified under two main mechanisms: income and depression/stress. The decrease in family income due to displacement limits the financial resources available for children. Particular channels through which this effect works includes less spending on education, health, food, and social activities. Shea (2000), using the Panel Study of Income Dynamics and job loss as an exogenous shock to income, finds that parental income has a negligible effect on child's future labor market earnings and years of schooling. However, Oreopoulos et al. (2008) find that individuals whose father experienced job loss when they were children have lower annual earnings compared to children whose father did not experience job loss. Coelli (2011) investigates the impact of job loss on children's educational outcomes by using the Canadian Survey of Labour and Income Dynamics and concludes that parental job loss decreases the probability of attending university and increases the probability of dropping out of high school. Dahl and Lochner (2012) investigate the effect of family income on child's test scores by using the NLSY79, and find that a $1,000 increase in family income leads to 2.1 and 3.6 % of a standard deviation increase in math and reading test scores, respectively.

There are several potential reasons for a psychological disturbance following a job loss. For example, McLoyd (1989) defines the economic loss caused by job loss as a stressor and "crisis-provoking event" for which parents were not prepared. In addition, parents may be stressed because being jobless may be associated with loss of social status and shame, or because they may be stressed during the process of looking for a new job. As a result, a parent's attitude towards children may change. For example, parents may pay less attention to a child's needs, or they may be abusive. The child may be disturbed by the new emotional and psychological environment at home. A child's concentration at school and motivation for school and education related activities may decrease and the child's expectations about the future may be impacted. On the other hand, there may be a positive effect of the mother being at home. Following a job

separation, the mother may have additional time to spend with her children. The mother may be able to supervise children better, help with school work, cook healthy foods at home, and increase interaction with her children. If the increase in time spent together is also quality time, then there may be a positive impact of job displacement on child development. Since the mother is usually the primary care giver of children in most cases, the extra time may increase children's educational outcome.

Studies focusing on the impact of parental job displacement on child's educational outcome generally find a negative effect. For example, Stevens and Schaller (2011) use the Survey of Income and Program Participation and conclude that the job loss of parents increases the probability of grade repetition by 15 %. Kalil and Ziol-Guest (2008) investigate the relationship between parental employment experiences and their children's grade repetition and school suspension/expulsion. They find that the probability of grade repetition is two times higher and the probability of expulsion/suspension is two and a half times higher for children whose fathers experienced involuntary job loss, compared to children whose fathers did not lose their job. Rege et al. (2011), using data from Norway, find that parental job loss has a negative effect on child's school performance, which is measured by grade point averages (GPA) of graduating secondary school students.

The current paper provides three contributions to the existing literature. First, there are not many studies focusing on the impact of mother's job loss on child outcomes. Rege et al. (2011), and Kalil and Ziol-Guest (2008) are the only studies, to the best of my knowledge, which investigate the impact of mother's job loss separately from the father's job loss. Kalil and Ziol-Guest (2008) find that the employment patterns of the mother do not affect academic progress. However, for a family in which both the mother and father work, economic welfare and family well-being may well be altered by not only the father's but also by the mother's job loss. Moreover, they focus on job separations which take place due to slack business and work conditions, being unable to find a job, labor dispute, illness or disability, and other reasons. The exogeneity of these reasons is open to debate. Rege et al. (2011) find a positive but statistically insignificant effect of mother's displacement on the child's 10th grade GPA. Thus, the question whether mother's job displacement plays a role in academic achievement of children requires further investigation.

Second, this study utilizes the exact timing of the displacement incidence of the mother and educational outcome of the child. NLSY provides a detailed work history of mothers,[2] which enables me to observe the date of the displacement. The administration date of the PIAT tests is the child's interview date. Thus, I can measure three intervals with precision: first, the time interval between tests taken by children, second, the time interval between the displacement event and the test dates and third, the duration of unemployment following job displacement. In a particular survey year the child takes the test at the interview date. In order to observe the link between mother's job displacement and the child's test score, I can distinguish whether the test was taken

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[2] The data does not provide information on father's work history.

before or after the displacement incidence. Thus, using the detailed event dates in NLSY, I can accurately link the date of displacement to the date of the test.[3]

Third, in this study I employ a mother-child matched data set provided by the NLSY79 and NLSY79-CS.[4] The matched data set provides detailed demographic characteristics of the mother and the child, work history of the mother, and the child's achievement test scores. Starting 1986, children who are 5 years and older are administered PIATs. There are three PIAT assessments: math, reading recognition and reading comprehension. In this study, I will focus on PIAT in mathematics (PIAT-M) and in reading recognition (PIAT-R). Since the NLSY79-CS is a biennial survey, for children ages 5 to 14, it is possible to observe the achievement score of the same child for up to 5 periods.[5]

Using a matched mother-child sample from NLSY79, I find evidence that mother's job displacement affects child's reading and math scores negatively. The results are different for single and married mother samples. I find that job displacement of a *single* mother generates lower reading and math scores. This impact is due to displacement that occurred 1 year prior to the test date and lasted up to 12 months. I do not find evidence that a married mother's job displacement affects test scores. Controlling for child fixed-effects reduces the estimated impacts but statistical significance is retained for reading score. In addition, the falsification test supports the assumption that mother's job displacement due to plant closure is exogenous. Finally, the results from the strategy introduced by Oster (2015) suggest that the results might be causal.

The rest of the paper proceeds as follows: Second section describes the empirical specification, Third section introduces the data and descriptive statistics, Fourth section presents the results and Fifth section concludes.

Empirical Specification

Equation (1) depicts a child's academic success (school performance) as a function of her/his own attributes and the family characteristics.

$$A = f_1(X, PI, Z) \tag{1}$$

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[3] Stevens and Schaller (2011) utilize the job loss which occurred in the year of grade repetition and one or more years prior to the grade repetition to investigate the impact of parental job loss. However, it might be the case that a parent lost her/his job at either the very beginning or end of the school year. The impact of the former is expected to be different than the latter. If the length of time between displacement and the test is not controlled for, the same weight will be attributed to the displacement that occurred in a closer date to test date and to the displacement that occurred in a distant time. Similarly, in Kalil and Ziol-Guest (2008), the timing of the displacement is set to be within a 24 month window, but the actual length of the time between involuntary job loss and education outcome is not considered. Another study investigating the link between parental unemployment and test scores is Levine (2011). He finds that father's or mother's unemployment does have much effect on children's test scores. However, he does not separate unemployment by reasons.

[4] To the best of my knowledge, the only study using the same data set to investigate the association between job displacement and child outcomes is Wightman (2009). Although the NLSY79 does not provide detailed work history for the fathers (spouses), he focuses on either parent's job loss by considering fathers (spouses) who were not working in the previous year as displaced due to "any reason" This set up of involuntary job loss is problematic because job loss due to illness, being fired, seasonal jobs, etc. are not exogenous shocks.

[5] If a child takes the test when s/he is 5 years old for the first time, s/he can take the test again at the ages 7, 9, 11 and 13. When s/he is 15, s/he is not administered the test. Note that the child might not necessarily take the test in consecutive survey years.

where A is the academic achievement of the child, X is a vector of child characteristics and PI is the parental investment which is a function of characteristics of parents, children, and family income. Z stands for the mother characteristics. Equation (2) represents parental investment as a function of family income, Y, the quality and quantity of time spent with children, QT, the characteristics of the child and the mother, X and Z respectively, and a family shock, D.

$$PI = f_2(X, Y, \, QT, \, \mathbf{Z}, \, D) \qquad (2)$$

D stands for the involuntary job loss of the mother. Job displacement might affect parental investment directly as depicted in Eq. (2), but also indirectly through channels such as reduction in income, change in the quality and quantity of time spent with children and other unobserved channels. For example, uncertainty about the future, change in the family structure (e.g. divorce and separation) and the child's perception about education following a job displacement might decrease the investment in children.

Family income consists of mother income (MI) and non-mother income (NMI). Mother's income includes components such as income from her wages, salary, and tips, military income, income from farm and business and unemployment compensation. The other family income includes spouse or partner's income from wages and salary, his income from military, income from farm and business, unemployment compensation, income of other family members, welfare payments, child support and alimony, and income from sources other than family members. Thus, family income is Y = MI + NMI, where $MI = f(D, \mathbf{Z})$. Mother's job displacement is expected to reduce mother's income. These arguments indicate that family income, Y, can be represented as:

$$Y = f_3 \, (\text{NMI, D, } \mathbf{Z}) \qquad (3)$$

The quality and the quantity of time the mother spends with children, QT, is a function of family income, displacement, and mother characteristics. Since family income consists of both mother and non-mother income I can write quality and quantity of time as:

$$QT = f_4(D, \, NMI, \, \mathbf{Z}) \qquad (4)$$

Substituting (Eqs. 3 and 4 into Eq. 2, and Eq. 2 into Eq. 1 yields a reduced form where $A = f_1(X, \, NMI, D, \mathbf{Z})$. The estimation equation therefore is:

$$A_{ijt} = \alpha + D_{ijt}\Omega' + \mathbf{X_{ijt}}\beta' + NMI_{ijt}\delta' + \mathbf{Z_{ijt}}\psi' + \lambda_t + \mathbf{e_{ijt}} \qquad (5)$$

where A_{ijt} stands for academic achievement of child i of mother j at time t, where t is the child's test date. [6] D_{ijt} represents the mother's job displacement. X_{ijt} is a vector of child characteristics which includes gender, race, birth order, age indicators, number of siblings, and the type of school the child attends. Z_{ijt} is a vector of mother

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[6] If the child's interview date is missing, the mother's interview date is employed as child's interview date.

characteristics. This vector includes education status of the mother, mother's age at birth of child i, whether the household resides in an urban area, and marital status of mother. There is no information on the father's work history in the NLSY79. Thus, I cannot control for father's work status.

Estimation of Eq. (5) will provide an unbiased estimate of the displacement coefficient under the assumption that involuntary job loss is independent of mother and child characteristics. This may be a strong assumption. In the literature, both layoffs and plant closures are utilized as exogenous reasons of job loss (for example Kletzer and Fairlie 2003; Ruhm 1991a, b; Charles and Stephens 2004; etc). Involuntary job loss due to being laid off, however, might be correlated with the characteristics of the mother. For instance, a mother with relatively low productivity is more likely to be laid off instead of a mother with relatively high productivity. If the mother's productivity is not related to the child's test score, then layoffs can be used in the analysis. However, if mothers who are more productive at work are also more productive at home regarding home production, the productivity differences will have an impact on the test scores. Thus, I focus on displacements related to plant closures as indicators of involuntary job loss. [7] Equation (5) includes year dummies in order to control for unobserved year effects, λ_t.

Data

To analyze the impact of mother's job displacement on child's educational outcome a child-mother matched data set is required. The National Longitudinal Survey of Youth 1979 (NLSY79), and the National Longitudinal Survey of Youth 1979 Child/Young Adult Survey (NLSY79-CS) provide such a matching for mothers and their children. NLSY79 includes 12,686 individuals, 6,403 males and 6,283 females, who were initially interviewed in 1979 and were aged 14–21 as of December 1978. The NLSY79 was conducted annually from 1979 to 1994, and biennially thereafter. The NLSY79-CS includes the children who were born to female respondents of NLSY79. NLSY79-CS survey started at 1986 and has been conducted biennially thereafter.

The NLSY79 provides information on earnings, marriage, demographic and many other characteristics of the mother. The NLSY79-CS provides information on child characteristics as well as several assessment measures such as academic achievement, temperament, motor and social development, and behavioral problems.

Test Scores: Peabody Individual Achievement Tests

Beginning in 1986, children who were aged five and above were administered the Peabody Individual Achievement Tests (PIAT) in mathematics (PIAT-M), in reading recognition (PIAT-R), and in reading comprehension (PIAT-C). [8] Children receive a

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[7] Some studies include being fired or discharged as a reason of an involuntary job loss. For example Stevens and Schaller (2011) and Wightman (2009) employ being fired a reason of involuntary job loss. Following Kletzer and Fairlie (2003) I exclude being fired/discharged from the analyses due to the same concerns I exclude layoffs.

[8] After 1994, the test is given to children aged 5–14 only. Thus, the sample consists of children of this age range.

PIAT-C only if they get a certain score on PIAT-R. Thus, I focus only on the PIAT-M and PIAT-R.[9] The NLSY79 guides define PIAT-M as a measure of child's mathematical attainment as it is taught in mainstream education.[10] It includes 84 questions which can be solved mentally. According to PIAT manual the mathematics test is designed to measure the ability of applying mathematical knowledge to solve practical problems (Dunn and Markwardt 1970). Thus, it is not only measuring the knowledge of mathematics, but also the ability to use this knowledge. PIAT-R is defined as an oral reading test and measures word recognition and pronunciation ability, which are essential components of reading achievement.[11] It is also noted that reading ability is a sign of a "cultured person," which might be accepted as an asset in the process of human capital accumulation. These measures are accepted as highly reliable and valid assessments of a child's academic achievement and are utilized by many researchers as a measure of achievement (Todd and Wolpin 2007; Dahl and Lochner 2012).

In this study, the standardized PIAT scores are utilized. PIAT scores have a mean of 100 and standard deviation of 15. Since the NLSY79-CS is a biennial survey, for children aged 5–14 it is possible to observe the achievement score of the same child for up to 5 periods.

Mother's Job Displacement

One of the advantages of the NLSY79 is to have access to detailed work history of respondents. In each survey year, the respondents provide the start-end dates, and the reason for leaving each job for up to five jobs.[12] Thus, from the work history it is possible to identify the exact date of a job loss.[13] I define mother's job displacement as job loss due to plant closure. The job displacement is measured by D_{ijt}, and t represents the date the PIAT was administered. D_{ijt} takes the value of one if the child's mother is displaced any time within the 24-month period prior to the child's test date. For each child, I create a 24-month window which has the test day as the starting point. For example, if the child takes the test on 12th of March, 2000, the window in which the mother might experience job displacement begins at 3/12/1998 and ends at 3/12/2000. If the child's mother j is displaced within this period, $D_{ij,2000}$ takes the value of one. Because the children take the test on different dates, I restrict mothers of the control group to those who have three continuous years of work experience. Following the example given above, children in the control group have mothers who have been working continuously for 3 years (or 36 months) for 2000, 1999 and 1998 survey years. Thus, $D_{ij,2000}$ takes the value of zero for these mothers.

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[9] Although PIAT-C is not discussed in this study, the PIAT-C estimation results are very similar to the PIAT-R.
[10] http://www.nlsinfo.org/childya/nlsdocs/guide/assessments/PIATMath.htm
[11] http://www.nlsinfo.org/childya/nlsdocs/guide/assessments/PIATReading.htm
[12] The work history is constructed by following NLSY79 updated Appendix 9 which explains linking the jobs through survey years. After 1998, the mother's work history is known up to 11–12 jobs. However, the reason why respondent left the job is not available for the jobs listed after the fifth. Thus, this information is not utilized in the study.
[13] There is no information on fathers work history. Thus, I cannot control for the father's employment status.

Descriptive Statistics

Table 1 reports descriptive statistics for the estimation sample by mother's marital status and the definitions of the variables are given in appendix Table 8. The PIAT is given to children who are at least 5 years old, and beginning in 1994, the test is no longer given to children older than 14. Thus, the final estimation sample consists of children who are between the ages of 5 and 14. I exclude children who are not living with their mothers since the focus of the study is the interaction between mother and the child. Children who are in the age interval 5–14 but who do not have a test score are excluded from the sample. In addition, since some of the child characteristics are not available for 1986 survey, this survey year is excluded from the analyses. Finally, children whose mothers are not in the labor force and do not satisfy displaced or non-displaced sample criteria are excluded. The final sample consists of 3,111 children between the ages of 5 and 14, living with the mother at the time of interview and have a test score.[14]

The average PIAT-R for the all mothers sample is 106. PIAT-R is 102 for children whose mother experienced a job displacement, and it is 106 for children whose mother was continuously working during the reference period. The entire sample average of PIAT-M is 102 and the average for the displaced mothers sample is 99. The average for the PIAT-M score is lower compared to reading test. Both reading and math test scores are lower for the single mother sample compared to the married mother sample and test scores are higher for non-displaced mothers in both samples. Five percent of the children in the all mothers sample have mothers who have experienced displacement during the period 1988–2002. For the single mother sample, 7 % of the children have a displaced mother which is higher compared to married mother sample.

On average, in both single and married mother samples, 44 % of children who have a displaced mother are first born. Thirty three percent of children in single mother sample and 61 % of children in married mother sample are white. The number of siblings is similar for both samples, and the percentage of children with a displaced mother in public school for the single mother sample is higher. The behavioral problems index (BPI) is higher for single mother sample compared to married mother sample. The children with a displaced mother in the single mother sample are more antisocial, depressed, hyperactive and dependent compared to children in married mother sample.

Family income is expressed in real dollars (2000 prices) and is a monthly measure. Average family income is lower for single mother sample and mother income is the same for the single and the married mother samples. Other family income, non-mother income,[15] is lower for single mothers, which is expected since there is no husband to support the mother. Other income might be obtained from welfare payments, child support and other sources such as other family members. For the married mother sample, non-mother income is greater than mother income. In both samples, the displaced mothers have lower earnings and lower family income. On average, 78 %

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[14] There are 1,785 mothers and 199 of them experience an involuntary job loss before the child takes the test. On average, children have two test scores.

[15] The other family income includes income earned by husband, income of other family members, welfare payments, child support and income from sources other than family members.

Table 1 Descriptive statistics

Variables	Mean (STD)								
	All mothers			Single mother sample			Married mother sample		
	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced
PIAT achievement tests									
PIAT-Reading	106.00	101.90	106.24	102.99	99.42	103.24	107.28	103.67	107.47
	(14.29)	(14.03)	(14.27)	(14.54)	(14.18)	(14.54)	(14.00)	(13.68)	(13.98)
PIAT-Math	102.46	98.97	102.66	99.33	95.55	99.58	103.79	101.42	103.93
	(13.36)	(13.41)	(13.34)	(12.92)	(12.11)	(12.91)	(13.33)	(13.79)	(13.31)
Displacement									
Job displacement		0.05			0.07			0.04	
		(0.22)			(0.25)			(0.20)	
Unemployment spell		4.14			4.49			3.87	
		(5.58)			(5.96)			(5.29)	
Child characteristics									
First born	0.44	0.42	0.44	0.42	0.45	0.41	0.44	0.39	0.45
	(0.50)	(0.49)	(0.50)	(0.49)	(0.50)	(0.49)	(0.50)	(0.49)	(0.50)
White	0.53	0.45	0.53	0.33	0.38	0.33	0.61	0.49	0.61
	(0.50)	(0.50)	(0.50)	(0.47)	(0.49)	(0.47)	(0.49)	(0.50)	(0.49)
Female	0.50	0.57	0.50	0.50	0.59	0.50	0.50	0.55	0.50
	(0.50)	(0.50)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)
Number of siblings	1.47	1.72	1.46	1.44	1.61	1.42	1.48	1.80	1.47
	(0.98)	(1.26)	(0.96)	(1.06)	(1.33)	(1.04)	(0.95)	(1.20)	(0.93)
Public school	0.64	0.63	0.64	0.66	0.70	0.66	0.63	0.58	0.63

Table 1 (continued)

Variables	All mothers			Single mother sample			Married mother sample		
	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced
	Mean (STD)								
Behavioral problems [1]	(0.48)	(0.48)	(0.48	(0.47)	(0.46)	(0.48)	(0.48)	(0.49)	(0.48)
BPI (Total Std. Score)	103.22	105.24	103.04	105.43	109.34	105.10	102.35	102.56	102.25
	(14.22)	(15.40)	(14.11)	(14.94)	(15.32)	(14.87)	(13.83)	(14.91)	(13.73)
Anti-social	104.18	105.40	104.03	107.07	109.32	106.84	103.03	102.84	102.95
	(13.40)	(14.42)	(13.29)	(14.06)	(14.07)	(13.99)	(12.96)	(14.12)	(12.84)
Anxiety/Depression	101.39	103.60	101.25	102.74	106.70	102.47	100.85	101.58	100.77
	(12.96)	(13.02)	(12.94)	(13.34)	(13.35)	(13.31)	(12.76)	(12.44)	(12.77)
Headstrong	101.23	101.74	101.15	101.74	103.54	101.59	101.03	100.55	100.98
	(12.89)	(13.30)	(12.85)	(13.02)	(13.21)	(12.98)	(12.83)	(13.28)	(12.79)
Hyperactive	102.49	103.60	102.37	103.76	106.68	103.48	101.98	101.58	101.94
	(13.58)	(14.66)	(13.50)	(14.15)	(16.13)	(13.96)	(13.31)	(13.30)	(13.30)
Dependent	104.06	107.20	103.84	106.48	109.39	106.26	103.11	105.76	102.91
	(13.12)	(13.95)	(13.04)	(13.50)	(13.75)	(13.46)	(12.85)	(13.96)	(12.76)
Peer conflict	103.00	103.84	102.92	103.97	106.52	103.77	102.62	102.08	102.59
	(11.57)	(12.55)	(11.47)	(12.29)	(14.14)	(12.11)	(11.26)	(11.10)	(11.20)
Mother characteristics									
Family income[2]	4,895	3,514	4,978	3,061	2,448	3,114	5,673	4,273	5,743
	(2,646)	(1,982)	(2,657)	(1,928)	(1,403)	(1,955)	(2,523)	(1,988)	(2,525)
Mother income[2]	2,349	1,509	2,400	2,240	1,482	2,301	2,395	1,529	2,441

Table 1 (continued)

Variables	All mothers			Single mother sample			Married mother sample		
	Mean (STD)								
	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced	Entire sample	Displaced	Non-displaced
	(1,358)	(997)	(1,361)	(1,281)	(967)	(1,286)	(1,387)	(1,020)	(1,388)
Non-mother income[2]	2,546	2,005	2,578	821	965	813	3,278	2,744	3,303
	(2,077)	(1,623)	(2,095)	(1,253)	(1,110)	(1,267)	(1,918)	(1,525)	(1,930)
Urban	0.75	0.73	0.75	0.80	0.71	0.81	0.73	0.75	0.73
	(0.43)	(0.45)	(0.43)	(0.40)	(0.46)	(0.40)	(0.45)	(0.44)	(0.44)
High school or less	0.50	0.73	0.49	0.59	0.78	0.58	0.46	0.69	0.45
	(0.50)	(0.45)	(0.50)	(0.49)	(0.42)	(0.49)	(0.50)	(0.46)	(0.50)
Age at birth	26.07	24.62	26.14	25.14	24.14	25.22	26.46	24.95	26.52
	(4.45)	(4.47)	(4.44)	(4.65)	(4.72)	(4.63)	(4.31)	(4.27)	(4.30)
Single	0.30	0.42	0.29	–	–	–	–	–	–
	(0.46)	(0.49)	(0.45)	–	–	–	–	–	–

The sample consists of children who are between the ages of 5 and 14, living with the mother at the time of interview and have a test score. In addition, children whose mother does not satisfy displaced and non-displaced sample criteria are excluded. (1) Sample consists of children who are between the ages of 5 and 12. (2) Real income with base year 2000

of children with a displaced mother in the single mother sample have a mother who has no more than a high school education and this percentage is lower for married mother sample. In other words, mothers in the married mothers sample are more educated.

Results

Mother's Job Displacement and Child's Test Scores

The baseline estimation results from Eq. (5) are presented in Table 2. Columns 1 and 2 show that the displacement coefficient is small, negative and statistically significant for both math and reading test scores. This result suggests that there is evidence that mother's job displacement has a negative impact on child's test scores. To be specific, the reading score is about 17 % and math test is 10 % of a standard deviation lower for children of displaced mothers compared to children of non-displaced mothers. Table 2 indicates that child and family characteristics are important determinants of the child's achievement. The results are consistent with the previous studies examining the child's education performance. [16] On average, children with more siblings have relatively lower math and reading scores than children with fewer siblings. This might be due to the sharing of parental resources. As the number of siblings increases, the child has to share financial and time resources that a parent can devote to their children. If the child is the first born, the test scores are higher. The first child spends some time alone with parents as the receiver of all resources. Thus, it is possible for a firstborn to accumulate higher human capital compared to her/his siblings (See Bahrman and Taubman 1986; Black et al. 2005). Females have higher test scores compared to males in reading. White children have higher test scores compared to non-white children and children in the public schools have lower test scores compared to the children who are in private, religious, and other types of schools.

If the mother has a high school education or less, the test scores for her children are lower compared to the mothers who have higher education levels. This might be due to the better supervision abilities of an educated mother or her attitudes towards education. For example, Leibowitz (1974) states that the quality of time spent with children increases with the parents' education level. Mother's age at birth is an important determinant of child's achievement. Similar to the education level of the mother, age at birth may affect the supervision abilities. In addition, it is likely that children born at later ages will be planned. Thus, it is more likely that the woman would spend more resources on the child. The higher the mother's age at birth, the higher are the child's reading and math scores as compared to mothers who had the child at early ages. Living in an urban area and being a single mother do not have significant effects on child's test scores. The non-mother income has positive impact on both test scores. [17]

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[16] See Haveman and Wolfe (1995) for a review of determinants of child's educational attainments.

[17] Excluding non-mother income does not change the results presented in Table 2. The coefficients of job displacement increase to −1.47 and −2.46 for math and reading scores respectively. Thus, evidence suggests that non-mother income is not affected by the job displacement of the mother.

Table 2 The impact of mother's job displacement on PIAT Scores 1988–2002 - All mothers sample

Dependent variables: PIAT scores	PIAT-Math (1)	PIAT-Reading (2)
Job displacement within 24-month window	−1.537*	−2.549***
	(0.838)	(0.889)
Characteristics of child		
Number of siblings	−0.775**	−0.930**
	(0.315)	(0.366)
First born	0.958**	2.441***
	(0.477)	(0.536)
White	5.988***	3.412***
	(0.565)	(0.615)
Female	−0.340	2.879***
	(0.434)	(0.477)
Public school	−1.590***	−2.296***
	(0.565)	(0.586)
Characteristics of mother		
High school or less	−2.919***	−2.833***
	(0.541)	(0.613)
Urban	0.414	0.492
	(0.515)	(0.575)
Age at birth	0.249**	0.268**
	(0.114)	(0.135)
Single	−0.675	−0.616
	(0.649)	(0.786)
Non-mother income	0.684***	0.880***
	(0.224)	(0.248)
Year and age effects	Yes	Yes
Observations	6,055	6,055

Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

The Length of Unemployment Spell Followed by the Job Displacement

A job displacement that occurs at different times prior to the child's test date might have different impacts. Thus, it is important to control for the timing of the displacement. For example, a mother's displacement that happened 3 months prior to the test date and a displacement that occurred 12 months prior to the test date might have different impacts on test scores. Furthermore, it is important to consider the length of the time the mother has spent jobless following her job displacement. To address these issues, I divided the 24-month period prior to child's test date into two 12-month fixed displacement windows, $k = \{(0 - 12), (13 - 24)\}$.[18] Three job displacement dummies are created to show the timing of the job displacement and the length of the unemployment spell

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[18] The mean of the time interval between the mother's job displacement and the child's test date is 12 months.

following the job displacement. If the mother was displaced 1 year prior to the test date and experienced an unemployment spell of up to 12 months, the first job displacement dummy takes the value of one, $D_{jt}{}^{k=(0-12)} = 1$. In other words, this job displacement dummy consists of children whose mother experienced a period of unemployment due to job displacement up to 12 months prior to the test date. The second dummy takes the value of one if the mother was displaced 2 years prior to the test date and stayed unemployed for at least 13 months, $D_{jt}{}^{k=(13-24)} = 1$. The third one takes the value of one if the mother was displaced 2 years prior to the test date and experienced an unemployment spell of up to 12 months. In this latter case, the mother's joblessness period occurred and ended at least 13 months prior to the test date. Thus, the first job displacement dummy shows the impact of a short run job displacement while the second and the third dummies show the impact of a long run job displacement. The control group includes children whose mothers were working continuously for 3 years—including the year the child took the test.

The results are presented in Table 3. The impact of displacement on test scores is negative for math (column 1) and reading scores (column 2) in any window. However, the job displacement coefficients are not statistically significant for math test and statistically significant for reading score only in the short run. This negative impact of the mother's job loss may be due to a decrease in quality and quantity of time spent with children or decrease in income. Following the displacement, the family might suffer sudden decreases in income. This loss might reduce the immediate financial resources as well as resources which might be available in the following year for the children. However, at the same time, the family might adjust the income by working more to compensate for mother's job loss. This adjustment in the family resources may be the reason that mother's job displacement has no impact on test scores in the long run.

Table 3 The impact of mother's job displacement followed by different unemployment spells on child's PIAT scores 1988–2002 - All mothers sample

Dependent variables: PIAT scores	PIAT- Math	PIAT-Reading	Children with displaced mothers %
	(1)	(2)	
Displacement 0–12 month before test date	−1.471	−2.792**	2.44
(Unemployment=0–12 months)	(1.158)	(1.205)	
Displacement 13–24 month before test date	−1.950	−1.533	1.49
(Unemployment=0–12 months)	(1.349)	(1.470)	
Displacement 13–24 month before test date	−0.449	−2.987	0.51
(Unemployment=13–24 months)	(3.116)	(3.205)	
Child and Mother Characteristics	Yes	Yes	
Year and age effects	Yes	Yes	
Observations	6,055	6,055	

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Child characteristics are whether child is first born, white, female, number of siblings and whether child attends to public school and mother characteristics are whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and non-mother income. (3) Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

I re-do the analysis to see if the impact of the mother's job displacement on her child's test scores changes by mother's marital status. In the case of single mothers there is no husband to compensate for the income loss due to a job loss and there is no emotional support after a job loss. Thus, the impact of a job displacement on the family might be different compared to a married mother's job displacement. Table 4 shows the impact of job displacement on child's test scores for single and married mother samples. The results in panel A suggest that for the single mother sample, math and reading test scores are lower for children of displaced mothers (Panel A1). When I control for the unemployment spell following a job displacement, results show that a job displacement which was followed by an up to 12 months unemployment spell in the first window has a negative impact on both math and reading scores and coefficients are statistically significant for both test scores in the single mother sample (Panel A2). In other words, job displacement affects reading and math test scores negatively in the short run. In addition, the reading score is lower if the unemployment following a job displacement lasted more than a year. For the married mother sample, the job displacement has a negative impact on both scores (Panel B1). Coefficients are statistically insignificant and are lower compared to single mother sample coefficients. A married and displaced mother might be spending more time with children and helping them out with school-work with less stress since they might have emotional and financial support of the husband, leading to a less stressful environment at home.

Causality

The negative association between mother's job displacement and children's test scores that is documented in the previous section is consistent with the hypothesis that involuntary job displacement of the mother affects the child's test scores negatively. In this study, as in the literature, I assume that plant closure is an exogenous event and that mother's characteristics are independent of her job displacement. However, this correlation might be due to unobserved mother and child characteristics such as ability or productivity. For instance, less productive or less educated mothers might have self-selected themselves into failing plants. In this section, I utilize three strategies to investigate whether the correlations documented in the previous section are causal. First, I check exogeneity of mother's job displacement by employing a job displacement that occurred after the child took the test. Second, I estimate Eq. (5) by adding child fixed effects into the specification. Last, I employ the strategy discussed in Oster (2015), selection on unobservable variables, as a robustness check.

Exogeneity of Mother's Job Displacement

The descriptive statistics show that displaced mothers are less educated and they give birth at younger ages. This could invalidate the exogeneity assumption of plant closures. In order to test the exogeneity of job loss due to plant closures, I estimate job displacement which occurred within a 24-month period *after* the interview date (future job loss) on mother characteristics which are

Table 4 The impact of the mother's job displacement on PIAT scores by mother's marital status 1988–2002

Dependent variables: PIAT scores	PIAT-Math	PIAT-Reading	Children with displaced mothers %
Panel A: Single mothers ($N = 1,799$)			
Panel A1: 24-Month Window			
Job Displacement within 24-Month Window	−3.106***	−3.474**	
	(1.113)	(1.460)	
Panel A2: Different Windows			
Displacement 0–12 month before test date	−2.891**	−4.221**	3.61
(Unemployment=0–12 months)	(1.391)	(1.793)	
Displacement 13–24 month before test date	−2.624	−0.368	2.17
(Unemployment=0–12 months)	(1.845)	(2.443)	
Displacement 13–24 month before test date	−5.352	−7.300*	0.89
(Unemployment=13–24 months)	(3.556)	(4.358)	
Panel B: Married mothers ($N = 4,256$)			
Panel B1: 24-month window			
Job displacement within 24-month window	−0.088	−1.676	
	(1.173)	(1.128)	
Panel B2: Different windows			
Displacement 0–12 month before test date	−0.102	−1.547	1.95
(Unemployment=0–12 months)	(1.739)	(1.622)	
Displacement 13–24 month before test date	−0.906	−1.971	1.20
(Unemployment=0–12 months)	(1.901)	(1.813)	
Displacement 13–24 month before test date	5.791	2.264	0.35
(Unemployment=13–24 months)	(4.388)	(4.057)	
Child and mother characteristics	Yes	Yes	
Year and age effects	Yes	Yes	

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Child characteristics are whether child is first born, white, female, number of siblings and whether child attends to public school and mother characteristics are whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and non-mother income. (3) Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

measured at the interview date. I employ future job displacement and interview date characteristics to investigate whether pre-displacement characteristics influence the displacement event as shown in Eq. (6).

$$D_{j,t+1} = \alpha + \boldsymbol{Z_{jt}}\psi' + \boldsymbol{Y_{jt}}\delta' + \lambda_t + \boldsymbol{e_{jt}} \qquad (6)$$

The existence of an association would mean that the assumption of exogeneity is not valid. Appendix Table 9 presents the results of all, single and married mother samples that are obtained by estimating Eq. (6). Although displaced mothers have different levels of education and age at birth compared to non-displaced mothers, impact of both variables are small and statistically insignificant as the rest of the control variables. Thus, the evidence shows that, for both single and married mother samples, mother characteristics do not explain job displacement of the mother. The evidence from this exogeneity tests shows that, for both single and married other samples, the job displacement of the mother due to plant closure may be an exogenous event.

Fixed Effects

It is possible that unobserved ability of the mother, which might be affecting job displacement probability, is correlated with the ability of the child. In such a case, unobserved child characteristics will be associated with mother's job displacement. The results from Eq. 5 with child fixed effects are shown in appendix Table 10. Similar to previous results, coefficients of job displacement for reading and math test scores are negative, but only the coefficient for the reading score is statistically significant in the single mother sample (see Panel A). If the mother becomes displaced, the child's reading score decreases by 13 % of a standard deviation. Panel B column (4) shows that the impact of the job displacement on reading score seems to be working in the short run. The coefficient of displacement for the math score is positive (Panel A, column 5) and the coefficient of reading score is negative (Panel A, column 6) for the married mothers sample. However, coefficients are statistically insignificant.

Selection on Observables

The third strategy is from Oster (2015) which can be used to check the robustness of results. Adding observable controls and analyzing the movements in the coefficient of the variable of interest is one alternative way to check the robustness of results to omitted variable bias. However, Oster (2015) argues that coefficient movements are not sufficient to calculate this bias. R-squared movements should also be considered. Although I control for observable factors, the estimates might still be biased due to unobserved child and mother characteristics.

To calculate the identified set,[19] which would yield results as if the job displacement was randomized, first an equation only with the variable of interest- job displacement of the mother- is estimated. The restricted coefficient and R-squared values are obtained from this estimation. Then, a second regression equation which includes all controls is estimated and unrestricted coefficient and R-squared values are obtained. Using these values and making an assumption on R-squared, which would be obtained if all unobservable variables were measured and included into the equation, and on the degree of proportionality, which measures the relative importance of unobservable variables, an identified set can be calculated. This set provides a range for the level of stability in non-randomized data if the treatment was assigned exogenously. When

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[19] See Appendix 1 for explanation of the strategy.

the inclusion of control variables move the coefficient of interest towards zero, exclusion of zero implies that the results are robust.

The results from this strategy are presented in appendix Table 11. The table shows identified sets for $\tilde{\delta} = 1$, which means that observable variables are at least as important as the unobservable variables, and for two different bounds on R_{max}: 1.5 $\tilde{R}$ and 2.2 $\tilde{R}$. Inclusion of control variables affects the magnitude of the mother's job displacement moving it the coefficients towards zero (columns 1 to 6) and all identified sets exclude zero regardless of the R_{max} boundary. For the single mother sample, the set is far from including zero. However, the identified set for PIAT-Math for married mothers include zero with 2.2 $\tilde{R}$ boundary on maximum R-squared. As Oster (2015) discusses, the 2.2 $\tilde{R}$ cutoff might be too aggressive and a smaller R_{max} might be more appropriate to use. In that case, 1.5 $\tilde{R}$ cutoff can be used to analyze the robustness. However, for the married mother sample even this cutoff seems to be too aggressive. From this table, it can be concluded that the relationship is causal at least for single mother sample. These two strategies, adding child fixed effects and selection on observables suggest that results reported in the previous section are causal.

Discussion of Possible Channels

Given that there is evidence that mother's job displacement affects children's test scores, in this part, I investigate the possible channels through which job displacement might affect test scores. I focus on two possible channels: income and child's behavioral problems.

Impact of Mother's Job Displacement on Income

As mentioned before, one of the effects of job displacement is the reduction in income. Table 5 shows the impact of mother's job displacement on family income (from Eq. 3) and on its components. Panel A presents the results for single mother families. The mother income is 48 % and family income is 20 % lower for displaced mothers compared to mothers who were not displaced (Panel A1). Non-mother income is 31 % higher for displaced mothers and the coefficient is statistically significant. This evidence suggests that there is a support coming from other family members or other sources for single mothers. It might be due to possible welfare payments, food stamps, etc. an unemployed single mother can obtain. In addition, for single mothers, motivation to find a new job to compensate for income loss, which cannot be compensated by a husband, might be stronger compared to married mothers.

Panel B shows the impact of job displacement on income for the married mother sample. In married mother sample, displacement lowers mother income by approximately 45 % (Panel B1). The impact of the job displacement in the long run is greater than the unemployment in the short run. It might be the case that married mothers give up looking for a job since there might be compensation for some of the mother income loss. It is possible that after the mother is displaced, other family members might choose to work more to compensate for income loss. However, I cannot find evidence supporting it. The family income is 20 % lower for displaced mothers in both samples. It decreases less than the decrease in mother income for both samples suggesting that

Table 5 The effect of the mother's job displacement on income by mother's marital status 1988–2002

Dependent variables: income components	Monthly log mother income	Monthly log non-mother income	Monthly log family income
Panel A: Single mothers ($N=1,230$)			
Panel A1: 24-month window			
Job displacement within 24-month window	−0.480***	0.309*	−0.200***
	(0.092)	(0.161)	(0.064)
Panel A2: Different windows			
Displacement 0–12 month before test date	−0.619***	0.485**	−0.220**
(Unemployment=0–12 months)	(0.142)	(0.226)	(0.096)
Displacement 13–24 month before test date	−0.398***	0.176	−0.264**
(Unemployment=0–12 months)	(0.152)	(0.225)	(0.111)
Displacement 13–24 month before test date	−0.258	0.711**	0.043
(Unemployment=13–24 months)	(0.168)	(0.347)	(0.117)
Panel B: Married mothers ($N=2,777$)			
Panel B1: 24-month window			
Job displacement within 24-month window	−0.452***	−0.054	−0.195***
	(0.086)	(0.075)	(0.044)
Panel B2: Different windows			
Displacement 0–12 month before test date	−0.343***	−0.053	−0.203***
(Unemployment=0–12 months)	(0.091)	(0.089)	(0.063)
Displacement 13–24 month before test date	−0.316***	−0.076	−0.201***
(Unemployment=0–12 months)	(0.095)	(0.133)	(0.072)
Displacement 13–24 month before test date	−0.761	−0.499	−0.303
(Unemployment=13–24 months)	(0.496)	(0.486)	(0.224)
Mother characteristics, Year effects	Yes	Yes	Yes

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Mother Characteristics are mother's age, age square, race of the mother, whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and number of children. (3) Robust standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

there is some support coming from other family members, husband or the government, although I cannot find evidence supporting this claim for the married mother sample. The negative impact of job displacement on income which is reported here is consistent with the previous studies.

Impact of Mother's Job Displacement on Child's Behavioral Problems

Another possible channel is behavioral problems of children. Behavioral Problems Index (BPI) is based on 28 questions which were asked to mothers in each survey year. These questions are designed to measure the frequency, range and type of childhood behavioral problems for children age four and over in the past 3 months (NLSY Child Handbook, Baker et al. 1993) For each question, mothers are asked to choose whether

the statement is often true (1), sometimes true (2) and not true (3). If the response is often or sometimes true the record takes the value of one and zero otherwise. Then these mother-reported responses are summed to create an overall BPI score. A higher BPI score represents a higher level of behavioral problems. There are six behavioral subscales created from these questions. These are antisocial, anxious/depressed, headstrong, hyperactive, immature dependency and peer conflict subscales. [20] The BPI overall score and each subscales are standardized measures with mean of 100 and standard deviation of 15. Similarly, the higher scores represent higher behavioral problems for each subscale.

Table 6 shows the results of the analysis of the link between job displacement and child's behavioral problems by estimating Eq. (4) for the single mother sample only. Since the standard score is available only for the children of age 5 to 12, children aged 13 and 14 are not in the sample. The results at Panel A suggest that the overall BPI score is approximately 28 % of a standard deviation higher for children of displaced mothers compared to children of mothers who were not displaced. It might be due to change in home environment, increase in stress and depression of mother or depreciation in the quality of time the mother spends with children. There might be no other family member to support the mother emotionally, thus the stress might be spreading to children. As a result, children of single displaced mothers might be absorbing the stress and emotional problems of the mother and reflecting these problems at home and school. The child may become more antisocial, treat other kids at school badly to release the stress overload, try to hurt others to get attention, etc. The child might get fearful about the future, feel unhappy because of the problems at home, have sudden changes in the mood and have difficulties concentrating on school work. S/he might become more dependent to the mother trying to get her attention, become more disobedient and nervous at home.

When I examine the impact of mother's job displacement on the six subscales of behavioral problems measuring different aspects of behavioral problems, results suggest that children of displaced mothers are more antisocial, feel depressed, more hyperactive and more dependent compared to children of non-displaced mothers. To be specific, anti-social score is 18 %, anxiety/depression score is 26 %, hyperactive score is 20 % and dependent score is 18 % of a standard deviation higher for the children of displaced mothers compared to children of mothers who were not displaced. The coefficient of the short run job displacement is positive for all subscales, but statistically insignificant in all cases. The coefficients of the long run job displacement are also positive in all cases, representing a greater behavioral problem, and coefficients are statistically significant for all subscales (Panel B). The evidence suggests the longer the unemployment spell is, the greater the negative impact of mother's job displacement on behavioral problems. There is no evidence that mother's job displacement impacts child's behavioral problems for the married mother sample. [21]

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[20] Questions related to each subscale are presented in Appendix Table 12.
[21] The results are available from the author if requested.

Table 6 The impact of the mother's job displacement on child's behavioral problems by mother's marital status 1988–2002 children aged 5 to 12

Dependent variables: Behavioral problems

Single mothers ($N=1,191$)

	BPI total Std. score	Anti-social	Anxiety/ Depression	Headstrong	Hyperactive	Dependent	Peer conflict
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: 24-Month Window							
Job displacement within 24-month window	4.139**	2.726*	3.886**	2.052	2.960*	2.770*	2.588
	(1.776)	(1.594)	(1.634)	(1.558)	(1.759)	(1.650)	(1.731)
Panel B: Different windows							
Displacement 0–12 month before test date	4.068	3.183	3.347	1.624	2.780	3.434	3.400
(Unemployment=0–12 months)	(2.582)	(2.050)	(2.434)	(2.306)	(2.455)	(2.130)	(2.407)
Displacement 13–24 month before test date	5.186**	5.532*	5.365**	4.294*	0.350	1.024	2.025
(Unemployment=0–12 months)	(2.605)	(2.981)	(2.595)	(2.304)	(2.450)	(3.177)	(2.771)
Displacement 13–24 month before test date	7.401	2.901	6.629***	1.644	8.675*	8.078**	2.888
(Unemployment=13–24 months)	(4.575)	(4.459)	(2.196)	(3.748)	(4.725)	(3.970)	(4.912)
Child and mother characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and age effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Child characteristics are whether child is first born, white, female, number of siblings and whether child attends to public school and mother characteristics are whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and non-mother income. (3) Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

Are Income and Child's Behavioral Problems Channels Explaining the Impact of Job Displacement on Test Scores?

Previous sections have shown that mother's job displacement has a negative impact on family income and also on the child's behavioral problems. To investigate whether income and behavioral problems are channels through which job displacement affects child's test scores I include mother income and overall BPI score one at a time to the Eq. (5).

If income is a channel through which mother's job displacement affects child's test scores, adding mother income into Eq. (5) should alter the

Table 7 The impact of the mother's job displacement on PIAT scores by mother's marital status 1988–2002 - The role of income and child's behavioral problems

Dependent variables: PIAT scores	PIAT-Math (1)	PIAT-Reading (2)	PIAT-Math (3)	PIAT-Reading (4)	PIAT-Math (5)	PIAT-Reading (6)
Single mothers						
Panel A: 24-month window						
Job displacement within 24-month window	−3.116***	−3.469**	−2.337**	−2.883*	−2.248	−1.906
	(1.113)	(1.459)	(1.167)	(1.555)	(1.414)	(1.715)
Panel B: Different windows						
Displacement 0–12 month before test date	−2.902**	−4.219**	−1.819	−3.422*	−1.742	−1.235
(Unemployment=0–12 months)	(1.390)	(1.792)	(1.506)	(1.932)	(1.715)	(2.181)
Displacement 13–24 month before test date	−2.638	−0.359	−2.124	0.018	−0.370	0.160
(Unemployment=0–12 months)	(1.845)	(2.442)	(1.860)	(2.454)	(2.593)	(2.498)
Displacement 13–24 month before test date	−5.362	−7.293*	−4.908	−6.959	−7.522*	−6.214
(Unemployment=13–24 months)	(3.554)	(4.358)	(3.533)	(4.422)	(3.840)	(4.532)
Observations	1,801	1,801	1,801	1,801	1,191	1,191
Mother income	No	No	**Yes**	**Yes**	**Yes**	**Yes**
BPI total score	No	No	No	No	**Yes**	**Yes**
Child and mother characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Year and age effects	Yes	Yes	Yes	Yes	Yes	Yes

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Child characteristics are whether child is first born, white, female, number of siblings and whether child attends to public school and mother characteristics are whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and non-mother income. (3) Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

coefficient of job displacement. In the Table 7, the first two columns do not control for mother income or overall BPI score. Panel A, columns (3) and (4) show that after controlling for the mother income, the magnitude of the impact of job displacement decreases for both test scores, suggesting that mother's income is a channel through which mother's job displacement affects the child's test scores. The result is the same for short run and long run job displacements. The coefficient of the short run job displacement, a job displacement which is followed by up to 12 months unemployment spell, decreases for both scores and becomes statistically insignificant for math score (Panel B). These results support the evidence that income is a channel through which mother's job displacement affects test scores. This channel seems to be working in the short run since the coefficient of the long run job displacement slightly changes for both test scores after controlling for the mother income. Single mother's income and also family income decreases due to the job

displacement. Hence, the effect of job displacement on mother income might be spreading to children outcomes.

Columns (5) and (6) present the results obtained from estimating Eq. (5) after controlling for *both* mother income and overall BPI score. The coefficient of job displacement decreases for both math and reading scores and becomes statistically insignificant for both scores (Panel A). Specifically, the magnitude of the impact of job displacement decreases from 21 to 15 % of a standard deviation for math score and it decreases from 23 to 13 % of a standard deviation for the reading score after controlling for both mother income and overall BPI score. The results suggest that income and behavioral problems are channels explaining the link between the mother's job displacement and test scores. Since the sample size changes after controlling for BPI score, it is not possible to discuss which channel dominates the other. In other words, it is not clear whether the income effect is greater or lower compared to behavioral problems effect.

Conclusion

Using matched mother-child sample from the NLSY, I find evidence that the mother's job displacement has a negative impact on the child's reading test scores. After controlling for the length of the unemployment spell followed by job displacement, I find that the impact is stronger in the short run. However, coefficients of the job displacement are not statistically significant for the math test. The reading score is almost 17 % lower for children of displaced mothers compared to children of mothers who were working continuously. The impact of job displacement on test scores is different for single and married mother samples. There is a negative impact of job displacement on child's both test scores for single mothers. After controlling for the length of unemployment spell followed by a job displacement, I find that there is a negative impact on math and reading scores in the short run for the single mother sample. The math score is 19 % and reading score is 28 % of a standard deviation lower for children of displaced mothers compared to children whose mothers were not displaced. There is no evidence that job displacement affects child's test scores for married mothers. Controlling for child fixed-effects, I find that estimated impact of displacement decreases for both test scores. The displacement coefficient is negative for both scores but only significant for the reading score. Falsification test suggest that plant closure may be an exogenous event and results from the Oster (2015)'s strategy show that results are causal.

I also examined whether income and child's behavioral problems are channels through which the job displacement might affect test scores. Job displacement of the mother has a negative effect on both family income and mother income and the child's behavioral problems for the single mother sample. To be able to investigate whether mother income and child's behavioral problems are channels which link mother's job displacement and child's test scores, mother income and overall BPI scores are added to the estimation equation for single mother sample. After adding mother income, coefficients of job displacement

decrease for both test scores. Coefficients of short run and long run job displacements also decrease for both test scores and become statistically insignificant in the short run. After controlling for mother income and the overall BPI score, coefficients of job displacement decrease and become statistically insignificant for both test scores. The results suggest that mother income and child's behavioral problems are channels through which mother's job displacement affects math and reading test scores.

It can be concluded that child's test scores are affected by the mother's involuntary job loss. The negative impact of mother's job displacement on test scores seems to be working through income and child's behavioral problems channels. Contrary to Kalil and Ziol-Guest (2008) and Rege et al. (2011), I find evidence that mother's job displacement has an impact on child's educational achievement which is measured by PIAT math and reading scores.

Appendix 1

Summary of the Strategy Introduced by Oster 2015:

$A = \omega D + X_1 + X_2$ where A is the test outcome, child's test score, D is mother's job displacement, X_1 is the set of observables and X_2 is the set of unobservable variables. Oster (2015) defines the proportional selection assumption as $\frac{cov(D,X_2)}{var(X_2)} = \delta$ $\frac{cov(D,X_1)}{var(X_1)}$ where δ is the degree of proportionality. When the model has an error term included, there are two components for δ. The first component, $\tilde{\delta}$, is the proportional selection between X_1, observable variables, and the unobservable variables related to D. It captures how much of D is explained by observables and how much is explained by unobservable variables. The second component is, R_{max}, the full regression R-Squared in which D, X_1 and X_2 are controlled for. Once we have values for R_{max} and $\tilde{\delta}$, an identified set for the treatment effect can be calculated. The identified set is: $\tilde{\delta} \in [0,1]$ and $R_{max} \in [\tilde{R}, \min\{\mu\tilde{R}, 1\}]$ where $\tilde{R}$ is the R-squared from estimating equation with observable variables (D and X_1) and μ is a parameter taking different values. The question is what values to set for $\tilde{\delta}$ and R_{max}. Note that the cutoff value for R_{max} varies with the value of μ. By utilizing nature of randomized data, Oster (2015) defines a bounding value for R_{max} with which a result can be considered as robust. This value is obtained by $\mu = 2.2$. in a second robustness standard, she checks whether the bounds of the identified set falls within $+/-2.8$ standard errors of the controlled estimate. The cut-off value generated by the randomized data is determined by $\mu = 1.5$

The steps in the procedure are as follows.

1. Estimate A on D, obtain baseline coefficient on D and R-squared
2. Estimate A on D and X_1, obtain controlled effect coefficient on D and R-square
3. Assume $\tilde{\delta} = 1$, which means observable variables are at least as important as the unobservable variables and calculate identified set with $\mu = 1.5$ and $\mu = 2.2$.
4. Analyze if the set excludes zero.

Appendix 2

Table 8 Definitions of the variables

Variables	Definition
PIAT achievement tests	
PIAT-Reading	= Standard Score for Reading Recognition
PIAT-Math	= Standard Score for Math
Displacement	
Job displacement	=1 if the mother is displaced due to plant closure within (0–24) months window prior to the child's test date, 0 otherwise
Unemployment spell	= Unemployment Spell followed by a job displacement (months)
Child characteristics	
First born	=1 if the child is the first born, 0 otherwise
White	= 1 if White, 0 otherwise
Female	= 1 if Child is Female, 0 otherwise
Number of siblings	= The number of siblings of the child
Public school	= 1 if Public School, 0 otherwise
Behavioral problems	
BPI (Total Std. Score)	= Standard Score for Overall Behavioral Problems
Anti-social	= Standard Score for Anti-social Subscale
Anxiety/Depression	= Standard Score for Anxiety/Depression Subscale
Headstrong	= Standard Score for Headstrong Subscale
Hyperactive	= Standard Score for Hyperactive Subscale
Dependent	= Standard Score for Dependent Subscale
Peer conflict	= Standard Score for Peer Conflict Subscale
Family/Mother characteristics	
Family income[1]	= Real Monthly family income ($) (base year 2000)
Mother income[1]	= Real Monthly Mother Income ($) (base year 2000)
Non-mother income[1]	= Real Monthly Income of all Other Family Members ($) (base year 2000)
Urban	= 1 if Mother is living in Urban Area, 0 otherwise
High school or less	= 1 if Mother is high school graduate or less, 0 otherwise
Age at birth	= Mothers age when she gave birth to child
Single	= 1 if the mother is single, 0 otherwise

Table 9 Exogeneity test

Dependent variable: Job displacement within 24-month period *after* interview date

	All mother sample	Single mother sample	Married mother sample
Age	−0.003	−0.003	−0.003
	(0.004)	(0.003)	(0.006)
Age square	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Mother income	−0.003	−0.011	−0.001
	(0.003)	(0.010)	(0.001)
Non-mother income	0.001	0.002	0.000
	(0.001)	(0.001)	(0.000)
High school or less	0.001	−0.003	0.003
	(0.001)	(0.003)	(0.002)
Urban	0.001	−0.002	0.002
	(0.002)	(0.007)	(0.001)
Age at birth	0.000	0.000	−0.000
	(0.000)	(0.001)	(0.000)
White	0.001	0.002	0.001
	(0.002)	(0.003)	(0.002)
Single	0.004	–	–
	(0.004)	–	–
Number of children	0.001	0.006	−0.001
	(0.002)	(0.006)	(0.001)
Observations	2,947	831	2,116
Year effects	Yes	Yes	Yes

(1) The coefficients are the effect of the Mother's Characteristics. (2) Robust standard errors are in parentheses.
* 10 %, ** 5 %, ***1 %

Table 10 The impact of the mother's job displacement on PIAT scores fixed effects estimates

Dependent variables: PIAT scores	All mother sample		Single mother sample		Married mother sample	
	PIAT-Math	PIAT-Reading	PIAT-Math	PIAT-Reading	PIAT-Math	PIAT-Reading
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: 24-month window						
Job displacement within 24-month window	0.948	−0.800	−0.083	−1.917*	1.342	−0.523
	(0.637)	(0.620)	(0.952)	(1.014)	(0.873)	(0.781)
Panel B: Different windows						
Displacement 0–12 month before test date	1.101	−1.725*	−0.729	−3.809***	1.627	−0.476
(Unemployment=0–12 months)	(0.983)	(0.960)	(1.086)	(1.467)	(1.411)	(1.193)
Displacement 13–24 month before test date	1.506	0.414	1.275	1.342	1.613	−1.162
(Unemployment=0–12 months)	(1.051)	(0.977)	(1.745)	(1.394)	(1.484)	(1.332)
Displacement 0–12 month before test date	−0.305	−0.255	−1.909	−4.979	0.771	2.337
(Unemployment=0–12 months)	(1.797)	(1.964)	(3.585)	(3.024)	(2.029)	(1.693)
Observations	4,834	4,834	1,344	1,344	3,490	3,490
Child and mother characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Year and age effects	Yes	Yes	Yes	Yes	Yes	Yes

(1) The coefficients are the effect of the Mother's Job Displacement. (2) Child characteristics are whether child is first born, white, female, number of siblings and whether child attends to public school and mother characteristics are whether the mother has high school education or lower, whether mother resides in an urban area, mother's age at first birth and non-mother income. (3) Robust, mother-clustered standard errors are in parentheses. * 10 %, ** 5 %, ***1 %

Table 11 Coefficients of 'Mother's Job Displacement' in the baseline and controlled estimation equations and identified sets - The treatment variable: mother's job displacement

	Entire sample		Single mothers		Married mothers	
	PIAT-Math	PIAT-Reading	PIAT-Math	PIAT-Reading	PIAT-Math	PIAT-Reading
	1	2	3	4	5	6
Baseline effect	−2.926	−3.855	−3.740	−3.709	−1.645	−3.293
	(0.753)	(0.807)	(1.170)	(1.317)	(0.968)	(1.017)
	{0.019}	{0.012}	{0.014}	{0.012}	{0.020}	{0.012}
Controlled effect	−1.537	−2.549	−3.105	−3.473	−0.087	−1.676
	(0.754)	(0.813)	(1.174)	(1.334)	(0.981)	(1.038)
	{0.131}	{0.114}	{0.101}	{0.086}	{0.126}	{0.110}
Identified set						
$\tilde{\delta}=1,\ \mu=1.5$	[−1.537, −0.721]	[−2.549, −1.821]	[−3.105, −2.738]	[−3.473, −3.335]	[−0.087, 0.845]	[−1.676, −0.764]
$\tilde{\delta}=1,\ \mu=2.2$	[−1.537, 0.420]	[−2.549, −0.802]	[−3.105, −2.223]	[−3.473, −3.140]	[−0.087, 2.150]	[−1.676, 0.512]

* The coefficients reported are the effects of mother's job displacement. The baseline regressions include year, age and sex dummies only. Standard errors are in the parentheses. R-Squared is reported in the braces

Table 12 BPI subscale questions

BPI subscales	
Antisocial	**Hyperactive**
Child Cheats and tells lies	Child has difficulty concentrating/paying attention
Child bullies or is cruel/mean to others	Child is easily confused/in a fog
Child does not feel sorry after misbehaving	Child is impulsive- acts without thinking
Child breaks thing deliberately	Child has trouble with obsession etc.
Child is disobedient at school	Child is restless, overly active etc.
Child has trouble getting along with teachers	
Anxiety/Depression	**Dependent**
Child has sudden changes in mood/feelings	Child clings to adults
Child feels/complains no one loves him/her	Child cries too much
Child is too fearful or anxious	Child demands a lot of attention
Child feels worthless or inferior	Child is too dependent on others
Child is unhappy, sad or depressed	
Headstrong	**Peer Conflict**
Child is rather high strung, tense, nervous	Child has trouble getting along with others
Child argues too much	Child is not liked by other children
Child is disobedient at home	Child is withdrawn, not involved with others
Child is stubborn, sullen, or irritable	
Child has strong temper, loses it easily	

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