The Longitudinal Effects of Disability Types on Income and Employment

Bob Millard

Stony Brook University

2023 Stata Conference
Introduction: Economic Consequences of Disability

Disability is primary income risk: impairs ability to perform tasks in work and daily life

▶ affects financial independence, individual welfare, social costs of insuring

▶ in Canada, 33% lower employment income, 2x as much from transfers (Wall 2017)
Introduction: Economic Consequences of Disability

Disability is primary income risk: impairs ability to perform tasks in work and daily life

- affects financial independence, individual welfare, social costs of insuring
  - in Canada, 33% lower employment income, 2x as much from transfers (Wall 2017)

- substantial variation in the effects of disability
  - varying personal income telling of changing economic circumstances
  - policy relevance: how to best allocate resources to those with gaps in insurance
Disability is primary income risk: impairs ability to perform tasks in work and daily life

- affects financial independence, individual welfare, social costs of insuring
  - in Canada, 33% lower employment income, 2x as much from transfers (Wall 2017)

- substantial variation in the effects of disability
  - varying personal income telling of changing economic circumstances
  - policy relevance: how to best allocate resources to those with gaps in insurance

Key source of variation: distinguishing disability by types of activities limited

- conditions can vastly differ in the tasks that are limited at work.
  - relates disability to human capital and subsequent productivity
  - e.g., mobility limitation affects productivity of an economist less than a brick layer
Introduction: Economic Consequences of Disability

Disability is primary income risk: impairs ability to perform tasks in work and daily life

▶ affects financial independence, individual welfare, social costs of insuring

▶ in Canada, 33% lower employment income, 2x as much from transfers (Wall 2017)

▶ substantial variation in the effects of disability

▶ varying personal income telling of changing economic circumstances

▶ policy relevance: how to best allocate resources to those with gaps in insurance

Key source of variation: distinguishing disability by types of activities limited

▶ conditions can vastly differ in the tasks that are limited at work.

▶ relates disability to human capital and subsequent productivity

▶ e.g., mobility limitation affects productivity of an economist less than a brick layer

▶ disabilities are dynamic in nature
Research Agenda and Approach

Analyze heterogeneity in longitudinal effects of disability types on the level and composition of personal income

▶ mutually exclusive disability types based on limitations to daily activities
Research Agenda and Approach

Analyze heterogeneity in longitudinal effects of disability types on the level and composition of personal income

▶ mutually exclusive disability types based on limitations to daily activities
▶ personal income comprised of market income and government transfers
Research Agenda and Approach

Analyze heterogeneity in longitudinal effects of disability types on the level and composition of personal income

- mutually exclusive disability types based on limitations to daily activities
- personal income comprised of market income and government transfers
  - market income: effect of disability on earnings capacity and behavior
  - government transfers: extent of public insurance available for this shock
  - additional consumption smoothing: tax system, family income
Research Agenda and Approach

Analyze heterogeneity in longitudinal effects of disability types on the level and composition of personal income

▶ mutually exclusive disability types based on limitations to daily activities
▶ personal income comprised of market income and government transfers
  ▶ market income: effect of disability on earnings capacity and behavior
  ▶ government transfers: extent of public insurance available for this shock
  ▶ additional consumption smoothing: tax system, family income

Interaction-weighted estimator of (Sun and Abraham 2020)

▶ dynamic design: point estimate for each of the ten years after onset
▶ implemented with eventstudyinteract
Contributions

1. Longitudinal effects of health shocks
   - Analyze type based heterogeneity in unified framework using rich administrative data

2. Income shocks and partial insurance
   - Specificity of source of shocks motivated by taks-based human capital model

3. Empirical approach using recent estimator
   - Robust to bias in two-way fixed effects estimation with heterogeneous treatment effects and variation in timing
Data: The Longitudinal and International Study of Adults (LISA)

Biennial panel survey of Canadian households aged 15 and older (2012-2018)

- rich measures of disability and demographics: education, family composition, sex

Linked income tax filings: T1 Family Files

- annual panel of disaggregated incomes and transfers (1982-2017)

- market income: wages, salaries, and commissions, labor market participation, other employment income

- government transfers: disability (relevant) transfers, transfers for families

- pre- and post-tax total income, total non-taxable income, total family income
Data: The Longitudinal and International Study of Adults (LISA)

Biennial panel survey of Canadian households aged 15 and older (2012-2018)

- rich measures of disability and demographics: education, family composition, sex

Linked income tax filings: T1 Family Files

- annual panel of disaggregated incomes and transfers (1982-2017)
  - market income: wages, salaries, and commissions, labor market participation, other employment income
  - government transfers: disability (relevant) transfers, transfers for families
  - pre- and post-tax total income, total non-taxable income, total family income
Biennial panel survey of Canadian households aged 15 and older (2012-2018)

▶ rich measures of disability and demographics: education, family composition, sex

Linked income tax filings: T1 Family Files

▶ annual panel of disaggregated incomes and transfers (1982-2017)
  ▶ market income: wages, salaries, and commissions, labor market participation, other employment income
  ▶ government transfers: disability (relevant) transfers, transfers for families
  ▶ pre- and post-tax total income, total non-taxable income, total family income

Sample: ever- and never-disabled in the age range 22-61, living in Canadian provinces, whose onset occurred in age range 23-56
Disability Screening Questions (*Grondin 2016*)

Self-reported frequency of limitation

- “*How often does [this difficulty ...] limit your daily activities?*”
Disability Screening Questions (*Grondin 2016*)

Self-reported frequency of limitation

- “*How often does [this difficulty ...] limit your daily activities?*”

Mutually exclusive type of activity limitation

- **aggregate physical:**
  - kinetic ability (mobility, flexibility, dexterity)
  - exclusively pain

- **mental-cognitive:**
  - cognitive functioning: learning, memory, attention
  - exclusively mental-health: anxiety, depression, emotional, psychological
Disability Screening Questions (*Grondin 2016*)

Self-reported frequency of limitation

▶ “How often does [this difficulty ...] limit your daily activities?”

Mutually exclusive type of activity limitation

▶ **aggregate physical:**
  ▶ kinetic ability (mobility, flexibility, dexterity)
  ▶ exclusively pain

▶ **mental-cognitive:**
  ▶ cognitive functioning: learning, memory, attention
  ▶ exclusively mental-health: anxiety, depression, emotional, psychological

Age of disability onset

▶ “at what age did you first start having difficulty or activity limitation?”
Empirical Framework: Interaction-Weighted estimator

Define cohort-average treatment on the treated, for onset of disability type $g$

$$\text{CATT}_{e,l}^g = E[Y_{i,e+l}^g - Y_{i,e+l}^\infty | E_i = e]$$

- $E_i$ is the year, t, of disability onset
Empirical Framework: Interaction-Weighted estimator

Define cohort-average treatment on the treated, for onset of disability type $g$

$$\text{CATT}_{e,l}^{g} = E[Y_{i,e+l}^{g} - Y_{i,e+l}^{\infty} | E_i = e]$$

- $E_i$ is the year, $t$, of disability onset
- $Y_{i,e+l}^{g}$ is outcome $l$ periods relative to treatment, if $i$ first treated in year $e$
Empirical Framework: Interaction-Weighted estimator

Define cohort-average treatment on the treated, for onset of disability type $g$

\[ CATT_{e,l}^g = E[Y_{i,e+l}^g - Y_{i,e+l}^\infty | E_i = e] \]

- $E_i$ is the year, $t$, of disability onset
- $Y_{i,e+l}^g$ is outcome $l$ periods relative to treatment, if $i$ first treated in year $e$
- $Y_{i,e+l}^\infty$ is outcome $l$ periods relative to treatment, if $i$ wasn’t treated in year $e$
Empirical Framework: Interaction-Weighted estimator

Define cohort-average treatment on the treated, for onset of disability type $g$

$$CATT_{e,l}^g = E[Y_{i,e+l}^g - Y_{i,e+l}^\infty \mid E_i = e]$$

- $E_i$ is the year, $t$, of disability onset
- $Y_{i,e+l}^g$ is outcome $l$ periods relative to treatment, if $i$ first treated in year $e$
- $Y_{i,e+l}^\infty$ is outcome $l$ periods relative to treatment, if $i$ wasn’t treated in year $e$

Treatment effect of for disability type $g$: weighted average of $CATT_{e,l}$

$$v_{l}^g = \sum_e CATT_{e,l}^g \cdot Pr\{E_i = e \mid E_i \in [-l, T - l]\}$$

- weights are shares of cohorts experiencing at least $l$ periods relative to onset
- separating CATT’s removes any “illegal comparisons”
Empirical Framework: Interaction-Weighted estimator

Step 1: estimate cohort average treatment effects using \texttt{reghdfe} (Correia 2016)

\[ Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_{e} \sum_{l} \delta_{l,e}^{g} A_{l,it}^{g} A_{e,i}^{g} + \epsilon_{it} \]
Empirical Framework: Interaction-Weighted estimator

Step 1: estimate cohort average treatment effects using \texttt{reghdfe} (Correia 2016)

\[
Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_e \sum_l \delta^g_{l,e} A^g_{l,it} A^g_{e,i} + \epsilon_{it}
\]

- $A^g_{l,it} = 1$ if $l \in \{-5, ..., 10\}$ years relative to onset, $A^g_{e,i} = 1$ if treatment cohort $e$
- $\delta^g_{l,e}$ are cohort specific average treatment on the treated

- $\hat{\delta}^g_{l,e}$ are cohort specific average treatment on the treated
Empirical Framework: Interaction-Weighted estimator

Step 1: estimate cohort average treatment effects using \texttt{reghdfe} (Correia 2016)

\[
Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_e \sum_l \delta_{l,e} A_{l, it} A_{e, i} + \epsilon_{it}
\]

- \(A_{l, it} = 1\) if \(l \in \{-5, ..., 10\}\) years relative to onset, \(A_{e, i} = 1\) if treatment cohort \(e\)

- \(\delta_{l, e}\) are cohort specific average treatment on the treated

- \(\alpha_i\) and \(\gamma_t\) control for individual-fixed and time-fixed unobserved heterogeneity

- \(X_{it}\) controls for differences between treatment and control

- \(\epsilon_{it}\) serially correlated error
Empirical Framework: Interaction-Weighted estimator

Step 1: estimate cohort average treatment effects using `reghdfe` (Correia 2016)

\[ Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_e \sum_l \delta_{l,e}^g A_{l, it}^g A_{e, i}^g + \epsilon_{it} \]

- \( A_{l, it}^g = 1 \) if \( l \in \{-5, \ldots, 10\} \) years relative to onset, \( A_{e, i}^g = 1 \) if treatment cohort \( e \)
  - \( \delta_{l,e}^g \) are cohort specific average treatment on the treated
- \( \alpha_i \) and \( \gamma_t \) control for individual-fixed and time-fixed unobserved heterogeneity
- \( X_{it} \) controls for differences between treatment and control
- \( \epsilon_{it} \) serially correlated error

Step 2: weights are shares of cohorts with at least \( l \) periods relative to treatment

\[ \hat{Pr}\{E_i = e|E_i \in [-l, T - l]\} \]
Empirical Framework: Interaction-Weighted estimator

Step 1: estimate cohort average treatment effects using `reghdfe` (Correia 2016)

\[ Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_{e} \sum_{l} \delta^g_{l,e} A^g_{l,it} A^g_{e,i} + \epsilon_{it} \]

- \( A^g_{l,it} = 1 \) if \( l \in \{-5, \ldots, 10\} \) years relative to onset, \( A^g_{e,i} = 1 \) if treatment cohort \( e \)
- \( \delta^g_{l,e} \) are cohort specific average treatment on the treated
- \( \alpha_i \) and \( \gamma_t \) control for individual-fixed and time-fixed unobserved heterogeneity
- \( X_{it} \) controls for differences between treatment and control
- \( \epsilon_{it} \) serially correlated error

Step 2: weights are shares of cohorts with at least \( l \) periods relative to treatment

\[ \hat{P}r\{E_i = e|E_i \in [-l, T - l]\} \]

Step 3: take weighted (step 2) sum of \( \delta_{e,l} \)'s (step 1)

\[ \hat{\nu}^g_i = \sum_{e} \hat{\delta}_{e,l} \hat{P}r\{E_i = e|E_i \in [-l, T - l]\} \]
Identifying assumptions

Causal inference relies on never-disabled being counterfactual for no disability onset

1. conditional parallel trends in pre-onset outcomes
   ▶ quadratic age and time trend interacted with education, family composition, sex
   ▶ additional linearity assumption in step 1

2. no anticipation in effects
   ▶ can shift treatment window to accommodate leading effects
   ▶ limitation: anticipation, progression of disability, or measurement error?

3. IW estimator robust to treatment heterogeneity by cohort

Under 1-3, $\hat{v}_g^l$ recovers an average effect of onset of disability type $g$, $l$ periods relative to onset.
Empirical Results 1: Components of Market Income
Empirical Results 1: Components of Market Income

Figure: Aggregate Physical

Wages, Salaries, and Commissions

Thousands of $
Empirical Results 1: Components of Market Income

Figure: Mental-Cognitive

![Graph showing wages, salaries, and commissions over years since onset.]
Empirical Results 1: Components of Market Income

Figure: Aggregate Physical

Labor Market Participation

Wages, Salaries, and Commissions for Workers

Self- and Other Employment Income
Empirical Results: Market Income

Figure: Mental-Cognitive
Empirical Results 1: Components of Market Income

Figure: Kinetic Ability

- Wages, Salaries, and Commissions
- Labor Market Participation
- Wages, Salaries, and Commissions for Workers
Empirical Results 1: Components of Market Income

Figure: Exclusively Pain

Wages, Salaries, and Commissions

Labor Market Participation

Wages, Salaries, and Commissions for Workers
Empirical Results 1: Components of Market Income

Figure: Exclusively Mental Health
Empirical Results

Figure: Cognitive Functioning

- Wages, Salaries, and Commissions
- Labor Market Participation
- Wages, Salaries, and Commissions for Workers
Empirical Results 2: Government Transfers
Empirical Results 2: Government Transfers

Figure: Aggregate Physical

- Total Government Transfers
- Family Transfers
- Disability Relevant Transfers
Empirical Results: Government Transfers

Figure: Mental-Cognitive
Empirical Results 2: Government Transfers

Figure: Kinetic Ability
Empirical Results 2: Government Transfers

Figure: Exclusively Pain

Total Government Transfers

Family Transfers

Disability Relevant Transfers
Empirical Results 2: Government Transfers

Figure: Exclusively Mental Health

- Total Government Transfers
- Family Transfers
- Disability Relevant Transfers
Empirical Results 2: Government Transfers

Figure: Cognitive Functioning

- Total Government Transfers
- Family Transfers
- Disability Relevant Transfers
Empirical Results 3: Smoothing Mechanisms

Figure: Before Tax Total Income
Empirical Results 3: Smoothing Mechanisms

Figure: After Tax Total Income
Empirical Results 3: Smoothing Mechanisms

Figure: Total Non-taxable income
Empirical Results 3: Smoothing Mechanisms

Figure: Family Total Income
Empirical Results 3: Smoothing Mechanisms

Figure: Before Tax Total Income

![Graph showing before tax total income over time for kinetic ability and exclusively pain categories.](image-url)
Empirical Results 3: Smoothing Mechanisms

Figure: After Tax Total Income

Kinetic Ability

Exclusively Pain
Empirical Results 3: Smoothing Mechanisms

Figure: Total Nontaxable Income
Empirical Results 3: Smoothing Mechanisms

Figure: Total Family Income
Empirical Results 3: Smoothing Mechanisms

Figure: Before Tax Total Income

[Graph showing before tax total income for Exclusively Mental Health and Cognitive Functioning over years since onset, with confidence intervals.]
Empirical Results 3: Smoothing Mechanisms

Figure: After Tax Total Income

- Exclusively Mental Health
- Cognitive Functioning
Empirical Results 3: Smoothing Mechanisms

**Figure:** Total Nontaxable Income

- Exclusively Mental Health
- Cognitive Functioning
Empirical Results 3: Smoothing Mechanisms

Figure: Total Family Income

Robert Millard
The Longitudinal Effects of Disability Types on Income and Employment
Conclusion

Market Income:
▶ level effects of mental-cognitive > physical
  ▶ earnings loss driven by extensive margin for physical, combination for mental-cognitive
▶ within physical: effects driven by limitations to kinetic ability
▶ within cognitive: large magnitude for both

Government Transfers:
▶ similar in total government transfers between physical and mental-cognitive
  ▶ entirely from disability relevant transfers for physical, only long run for mental-cognitive
  ▶ within physical: the rise in transfers driven by kinetic ability
  ▶ within cognitive: insurance gaps for mental health

Other smoothing mechanisms
▶ non-taxable income main insurance for aggregate physical, effect of mental-cognitive buffered by tax system
THANK YOU!!
Conceptual framework: task-specific human capital

Workers

- $s_t : k$ dimension skill portfolio vector
  - $s^j_t \in \mathbb{R}$ represents proficiency in productive skills of type $j$
- $d_t : k$ dimension extent of disability vector
  - $d^j_t \in [0, 1]$ - extent of limitation for skills of type $j$

Occupations

- $x_t : k$-dimensions bundle of skill requirements
  - $x^j_t \in \mathbb{R}$ represents complexity/intensity of use of skills in production
  - derived from set of task requirements of an occupation
Conceptual framework: wage determination function

Workers hourly wage equals their marginal value product:

\[ w_t = \pi(x_t)q(x_t, s_t)\exp(\eta_t). \]

- \( \pi(x_t) \): is market pricing of output produced by tasks, \( x_t \)
- \( q(x_t, s_t) \): productivity of worker with skill \( s_t \) at job with task complexity \( x_t \)
  - \( \ln q(x_t, s_t) = \theta'(x_t)s_t \), where \( \theta'(x_t) \) is k-dim vector of implicit skill prices
- \( \eta_t \): I.I.D productivity shocks

Skills matter for productivity as along as you can use them

- define \( h_t = s_t \cdot x_t \) to be a workers "effective skills"

Disability induced mismatch

\[ \Delta w = (q(s_t, x_t) - q(h_t, x_t))\pi(x_t)\exp(\eta_t) = \theta'(x_t)(s_t - h_t)\pi(x_t)\exp(\eta_t) \]
Conceptual framework: dynamic effects of disability

To illustrate, consider simple skill accumulation process

\[ s_{t+1} = Ds_t + A_1 x_t + A_2 d_t + \epsilon_{t+1} \]

▶ **D**: diagonal elements are depreciation
▶ **A_1**: "learning by doing,"
  ▶ diagonal : higher intensity of task \( x_t^i \), higher accumulation of these skills
  ▶ off-diagonal : complementarities between tasks and other skills (e.g., healthy body results in health mind)
▶ **A_2**: impact of disability on next period skills
  ▶ diagonal : direct effect limitation in one dimension
  ▶ off-diagonal : limitation in some dimensions, may influence skill accumulation in another

Repeatedly substitute previous periods skills

\[ s_{t+1} = D^{t-n} s_{t-n} + \sum_{j=0}^{n} D^j A_1 x_{t-j} + \sum_{j=0}^{n} D^j A_2 d_j + \sum_{j=0}^{n} D^j \epsilon_{t-n+1} \]
Empirical Framework: Treatment effect of interest

We observe the following post-treatment

\[ Y_{i,t} = Y_{i,t}^E = Y_{i,t}^\infty + \sum_{0 \leq e \leq T} (Y_{i,t}^e - Y_{i,t}^\infty) \mathbb{I}\{E_i = e\} \]

- \(e\) is treatment cohort, \(\mathbb{I}\{E_i = e\}\) is indicator for \(i\) in treatment cohort \(e\)
- \(Y_{i,e+l}\) is outcome \(l\) periods relative to treatment, if \(i\) first treated in period \(e\)
- \(Y_{i,e+l}^\infty\) is outcome \(l\) periods relative to treatment, if \(i\) wasn’t treated in period \(e\)

Define cohort-average treatment on the treated, \(k\) periods relative to treatment

\[ CATT_{e,l} = E(Y_{i,e+l} - Y_{i,e+l}^\infty|E_i = e) \]

- average treatment effect \(l\) periods from first treatment for cohort first treated at \(e\)
- note: timing in terms of \(l\), instead of \(t\).
Intuition of contamination

Workhorse estimator for dynamic treatment effects: Two-way fixed effects

\[ Y_{i,t} = \alpha_i + \lambda_t + \sum_l \delta_l A_{l,i,t} + \epsilon_{it} \]  

- \( A_{l,i,t} \) an indicator for \( k \) periods relative to \( i \)'s initial treatment
- \( \delta_k \) are dynamic treatment effects of interest

Sun and Abraham (2020) show \( \delta_k \) is a weighted sum of \( CATT_{e,l} \) as well as \( CATT_{e,l'} \) from other relative periods (and even excluded periods)

- **why?** with staggered treatment timing, earlier treatment cohorts compared to later treatment cohorts

- **issue?** If weights \( w_{e,k'} \) are non-zero, then effects from other relative periods may contaminate interpretation of \( \delta_k \)

- **solution?** Separately estimate all \( CATT_{e,l} \)'s, then take a specific weighted average to recover treatment effect of interest
Self-reported disability and concerns

Subjectivity in extent of health

- any positive limitations to a specified activity, and abstracts from the degree of impairment

State dependent reporting: justification bias

- **physical**: narrow the scope of justification bias to be anchored to the activities in question
  
  “How often are you limited walking on a flat surface for 20 minutes”

- **cognitive**: base the existence of a limiting condition to the diagnosis of a medical professional
  
  “Has a doctor or medical professional ever said you have a learning disability”

- **mental-health**: frame limitations related to mental health with specific examples of diagnoses
  
  “Do you have an emotional or psychological condition ... such as anxiety, depression, bipolar disorder, etc..”

Back