

The LEHD Infrastructure Files *and the Creation of the Quarterly Workforce Indicators*

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- What are QWI?
- What is it?
- In this paper

Introduction

What are QWI?

- Since 2003: publication of Quarterly Workforce Indicators

The LEHD Infrastructure Files
Introduction
▸ What are QWI?
▸ What is it?
▸ In this paper
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

What are QWI?

The LEHD Infrastructure Files
Introduction
▢ What are QWI?
▢ What is it?
▢ In this paper
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system

What are QWI?

The LEHD Infrastructure Files
Introduction
▢ What are QWI?
▢ What is it?
▢ In this paper
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system
 - ◆ No additional burden

What are QWI?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system
 - ◆ No additional burden
 - ◆ Extensive use of modern statistics to integrate and improve the data

What are QWI?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system
 - ◆ No additional burden
 - ◆ Extensive use of modern statistics to integrate and improve the data
 - ◆ State-of-the-art confidentiality protection methods

What are QWI?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system
 - ◆ No additional burden
 - ◆ Extensive use of modern statistics to integrate and improve the data
 - ◆ State-of-the-art confidentiality protection methods
 - ◆ Innovative use of wage records to constitute a frame to integrate data

What are QWI?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Since 2003: publication of Quarterly Workforce Indicators
- The first 21st century statistical system
 - ◆ No additional burden
 - ◆ Extensive use of modern statistics to integrate and improve the data
 - ◆ State-of-the-art confidentiality protection methods
 - ◆ Innovative use of wage records to constitute a frame to integrate data
- ◆ The first statistical system to use “jobs” as a frame

What is it?

■ Combines

The LEHD Infrastructure Files

Introduction

➤ What are QWI?

➤ What is it?

➤ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

What is it?

The LEHD Infrastructure Files

Introduction

▸ What are QWI?

▸ What is it?

▸ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

■ Combines

◆ (state) administrative records data on workers (UI Wage records)

What is it?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- ◆ (state) administrative records data on workers (UI Wage records)
- ◆ (state) administrative records data on firms (QCEW aka ES-202)

What is it?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

■ Combines

- ◆ (state) administrative records data on workers (UI Wage records)
- ◆ (state) administrative records data on firms (QCEW aka ES-202)
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What is it?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

■ Combines

- ◆ (state) administrative records data on workers (UI Wage records)
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What is it?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Combines
 - ◆ (state) administrative records data on workers (UI Wage records)
 - ◆ (state) administrative records data on firms (QCEW aka ES-202)
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- careful longitudinal edit of person identifiers and economic firm units

What is it?

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Combines
 - ◆ (state) administrative records data on workers (UI Wage records)
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- careful longitudinal edit of person and firm characteristics

In this paper

- Describe the construction of the LEHD infrastructure

The LEHD Infrastructure Files

Introduction

▸ What are QWI?

▸ What is it?

▸ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

In this paper

- Describe the construction of the LEHD infrastructure
 - ◆ ... in particular the imputation mechanisms used

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

In this paper

- Describe the construction of the LEHD infrastructure
 - ◆ ... in particular the imputation mechanisms used
- Describe the computation of the QWI statistics

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

In this paper

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Describe the construction of the LEHD infrastructure
 - ◆ ... in particular the imputation mechanisms used
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 - ◆ ... in particular the imputation mechanisms used

In this paper

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Describe the construction of the LEHD infrastructure
 - ◆ ... in particular the imputation mechanisms used
- Describe the computation of the QWI statistics
 - ◆ ... in particular the imputation mechanisms used
- Describe the disclosure-proofing mechanism

In this paper

The LEHD Infrastructure Files

Introduction

▢ What are QWI?

▢ What is it?

▢ In this paper

Input Files

Infrastructure Files

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Describe the construction of the LEHD infrastructure
 - ◆ ... in particular the imputation mechanisms used
- Describe the computation of the QWI statistics
 - ◆ ... in particular the imputation mechanisms used
- Describe the disclosure-proofing mechanism
- Describe researcher access to infrastructure files and confidential QWI files

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Input Files

Wage records: UI

- report of an individual's UI-covered earnings by an employing entity

The LEHD Infrastructure Files
Introduction

Input Files

➤ Wage records: UI

➤ Employer reports: ES202

➤ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Wage records: UI

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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Wage records: UI

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- identifies EARNINGS, EMPLOYER, TIME PERIOD

Wage records: UI

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- report of an individual's UI-covered earnings by an employing entity
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Wage records: UI

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- some limited other state-dependent information available
- in particular, for Minnesota, the ESTABLISHMENT is reported

Employer reports: ES202

... or QCEW

The LEHD Infrastructure Files
Introduction

Input Files

➤ Wage records: UI

➤ Employer reports: ES202

➤ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Employer reports: ES202

- collected as part of the Covered Employment and Wages (CEW) (administered by the BLS)

The LEHD Infrastructure Files
Introduction

Input Files

↳ Wage records: UI

↳ Employer reports: ES202

↳ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Employer reports: ES202

The LEHD Infrastructure Files
Introduction

Input Files

↳ Wage records: UI

↳ Employer reports: ES202

↳ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- collected as part of the Covered Employment and Wages (CEW) (administered by the BLS)
- Also used as the inputs to the Business Employment Dynamics (BED)

Employer reports: ES202

The LEHD Infrastructure Files
Introduction

Input Files

↳ Wage records: UI

↳ Employer reports: ES202

↳ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- Also used as the inputs to the Business Employment Dynamics (BED)
- collects from employers covered by state unemployment insurance programs:
 - ◆ employment
 - ◆ payroll
 - ◆ geographic information

Employer reports: ES202

The LEHD Infrastructure Files
Introduction

Input Files

↳ Wage records: UI

↳ Employer reports: ES202

↳ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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 - ◆ employment
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- fundamental unit: 'reporting unit' (\approx establishment)

Employer reports: ES202

The LEHD Infrastructure Files
Introduction

Input Files

↳ Wage records: UI

↳ Employer reports: ES202

↳ Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- collects from employers covered by state unemployment insurance programs:
 - ◆ employment
 - ◆ payroll
 - ◆ geographic information
- fundamental unit: 'reporting unit' (\approx establishment)
- One report per establishment per quarter is filed

Demographics

- Demographics are taken from a number of Census-internal files derived from administrative data:
 - ◆ Person Characteristics File (PCF)
 - ◆ Census Numident

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Demographics

The LEHD Infrastructure Files
Introduction

Input Files

- Wage records: UI
- Employer reports: ES202
- Demographics

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

- Demographics are taken from a number of Census-internal files derived from administrative data:
 - ◆ Person Characteristics File (PCF)
 - ◆ Census Numident
- Where available, more detailed data on individuals is also extracted from surveys and censuses:
 - ◆ CPS
 - ◆ SIPP
 - ◆ ACS
 - ◆ 1990 Census
 - ◆ 2000 Census

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

↳ EHF: Employment History

Files

↳ ICF: Individual

Characteristics File

↳ ECF: Employer

Characteristics File

↳ GAL: Geocoded Address

List

↳ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Infrastructure Files

EHF: Employment History Files

- Job-level EHF
 - ◆ complete in-state work history for each individual on Ulwage records.
 - ◆ one record for each employee-employer combination – a job
 - ◆ earnings and employment patterns

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
> EHF: Employment History Files
> ICF: Individual Characteristics File
> ECF: Employer Characteristics File
> GAL: Geocoded Address List
> Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

EHF: Employment History Files

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 - ◆ complete in-state work history for each individual on Ulwage records.
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 - ◆ earnings and employment patterns
- Employer and establishment-level employment history
 - ◆ QCEW-based employment-activity history for every SEIN (employer) and SEINUNIT (establishment)

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
▢ EHF: Employment History Files
▢ ICF: Individual Characteristics File
▢ ECF: Employer Characteristics File
▢ GAL: Geocoded Address List
▢ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

EHF: Employment History Files

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 - ◆ one record for each employee-employer combination – a job
 - ◆ earnings and employment patterns
- Employer and establishment-level employment history
 - ◆ QCEW-based employment-activity history for every SEIN (employer) and SEINUNIT (establishment)
- Comparison of employment and activity of SEINs between UI and QCEW files is done for QA purposes, and in preparation of weighting.

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
> EHF: Employment History Files
> ICF: Individual Characteristics File
> ECF: Employer Characteristics File
> GAL: Geocoded Address List
> Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PKs from wage records

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
↳ EHF: Employment History Files
↳ ICF: Individual Characteristics File
↳ ECF: Employer Characteristics File
↳ GAL: Geocoded Address List
↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
- records without a valid match flagged

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
↳ EHF: Employment History Files
↳ ICF: Individual Characteristics File
↳ ECF: Employer Characteristics File
↳ GAL: Geocoded Address List
↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

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- Demographic information from the PCF is merged with universe of PIKs from wage records
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- CPS and SIPP identifiers are merged on.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address List

▸ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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- Demographic information from the PCF is merged with universe of PIKs from wage records
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- ... gender, education, and age information from the CPS

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

↳ EHF: Employment History Files

↳ ICF: Individual

Characteristics File

↳ ECF: Employer

Characteristics File

↳ GAL: Geocoded Address List

↳ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
- records without a valid match flagged
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- ... gender, education, and age information from the CPS
- Data completion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
- records without a valid match flagged
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 - ◆ Age

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address List

▸ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
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- CPS and SIPP identifiers are merged on.
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- Data completion
 - ◆ Age
 - ◆ Gender

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address List

▸ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
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 - ◆ Gender
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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
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 - ◆ Age
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 - ◆ Education
 - ◆ County of residence

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address List

▸ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ICF: Individual Characteristics File

- Demographic information from the PCF is merged with universe of PIKs from wage records
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- are each imputed ten times

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▷ EHF: Employment History Files

▷ ICF: Individual

Characteristics File

▷ ECF: Employer

Characteristics File

▷ GAL: Geocoded Address List

▷ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ECF: Employer Characteristics File

- Two files: firm and establishment level, quarterly records

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files <ul style="list-style-type: none">▸ EHF: Employment History Files▸ ICF: Individual Characteristics File▸ ECF: Employer Characteristics File▸ GAL: Geocoded Address List▸ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

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The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files <ul style="list-style-type: none">▸ EHF: Employment History Files▸ ICF: Individual Characteristics File▸ ECF: Employer Characteristics File▸ GAL: Geocoded Address List▸ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

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The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files <ul style="list-style-type: none">▸ EHF: Employment History Files▸ ICF: Individual Characteristics File▸ ECF: Employer Characteristics File▸ GAL: Geocoded Address List▸ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

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 1. ES202
 2. UI: supplement information on the ES202, extend published BLS county-level employment data

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

↳ EHF: Employment History

Files

↳ ICF: Individual

Characteristics File

↳ ECF: Employer

Characteristics File

↳ GAL: Geocoded Address

List

↳ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ECF: Employer Characteristics File

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

↳ EHF: Employment History

Files

↳ ICF: Individual

Characteristics File

↳ ECF: Employer

Characteristics File

↳ GAL: Geocoded Address

List

↳ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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 3. GAL: establishment geocodes
 4. LDB (BLS) for backfilling NAICS information

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ECF: Employer Characteristics File

- Two files: firm and establishment level, quarterly records
- Inputs:
 1. ES202
 2. UI: supplement information on the ES202, extend published BLS county-level employment data
 3. GAL: establishment geocodes
 4. LDB (BLS) for backfilling NAICS information
- Longitudinal edits for consistency and data completion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History

Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address

List

▸ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

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 - ◆ impute SIC if NAICS non-missing and vice-versa

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History

Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address

List

▸ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ECF: Employer Characteristics File

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 - ◆ unconditional impute of missing SIC and NAICS codes

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History

Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address

List

▸ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

ECF: Employer Characteristics File

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files <ul style="list-style-type: none">↳ EHF: Employment History Files↳ ICF: Individual Characteristics File↳ ECF: Employer Characteristics File↳ GAL: Geocoded Address List↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

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- Inputs:
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 2. UI: supplement information on the ES202, extend published BLS county-level employment data
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 - ◆ unconditional impute of missing SIC and NAICS codes
 - ◆ geography conditional on industry

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files <ul style="list-style-type: none">▷ EHF: Employment History Files▷ ICF: Individual Characteristics File▷ ECF: Employer Characteristics File▷ GAL: Geocoded Address List▷ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES202 data

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES202 data
 2. Census Bureau's Business Register (BR)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES2002 data
 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
↳ EHF: Employment History Files
↳ ICF: Individual Characteristics File
↳ ECF: Employer Characteristics File
↳ GAL: Geocoded Address List
↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES202 data
 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)
 4. American Community Survey Place of Work file (ACS-POW)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES202 data
 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)
 4. American Community Survey Place of Work file (ACS-POW)
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The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
↳ EHF: Employment History Files
↳ ICF: Individual Characteristics File
↳ ECF: Employer Characteristics File
↳ GAL: Geocoded Address List
↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
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 1. ES202 data
 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)
 4. American Community Survey Place of Work file (ACS-POW)
- Addresses are
 1. geocoded

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
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 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)
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- Addresses are
 1. geocoded
 2. standardized

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
↳ EHF: Employment History Files
↳ ICF: Individual Characteristics File
↳ ECF: Employer Characteristics File
↳ GAL: Geocoded Address List
↳ Flow so far
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
Conclusion

GAL: Geocoded Address List

- ... is a data set containing unique commercial and residential addresses
- geocoded to the Census Block and latitude/longitude coordinates
- Inputs:
 1. ES202 data
 2. Census Bureau's Business Register (BR)
 3. Census Bureau's Master Address File (MAF)
 4. American Community Survey Place of Work file (ACS-POW)
- Addresses are
 1. geocoded
 2. standardized
 3. unduplicated (by firm name)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

▸ EHF: Employment History
Files

▸ ICF: Individual

Characteristics File

▸ ECF: Employer

Characteristics File

▸ GAL: Geocoded Address
List

▸ Flow so far

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

Flow so far

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

➤ EHF: Employment History

Files

➤ ICF: Individual

Characteristics File

➤ ECF: Employer

Characteristics File

➤ GAL: Geocoded Address

List

➤ Flow so far

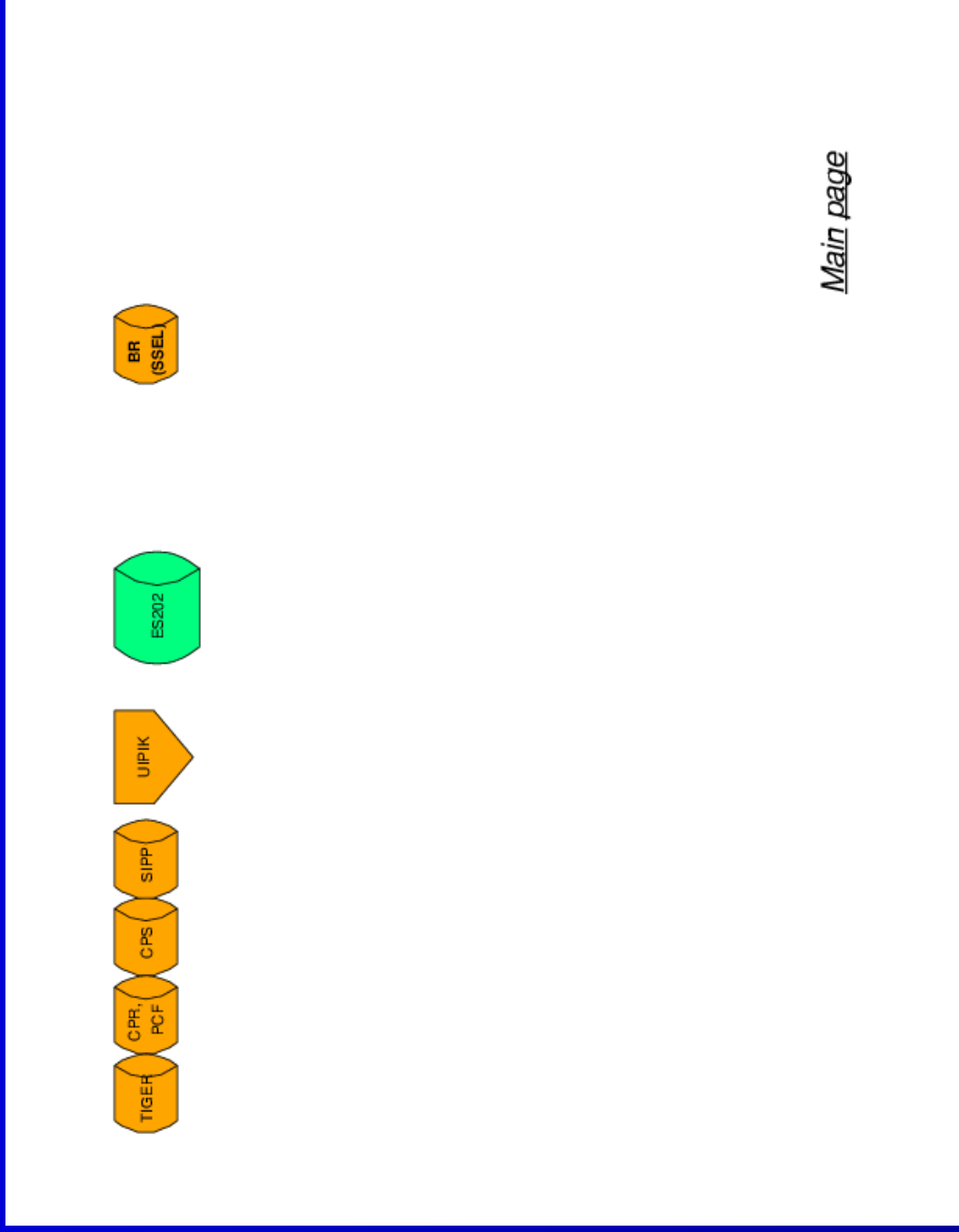
Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion



[Main page](#)

Flow so far

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

- EHF: Employment History Files
- ICF: Individual Characteristics File
- ECF: Employer Characteristics File
- GAL: Geocoded Address List

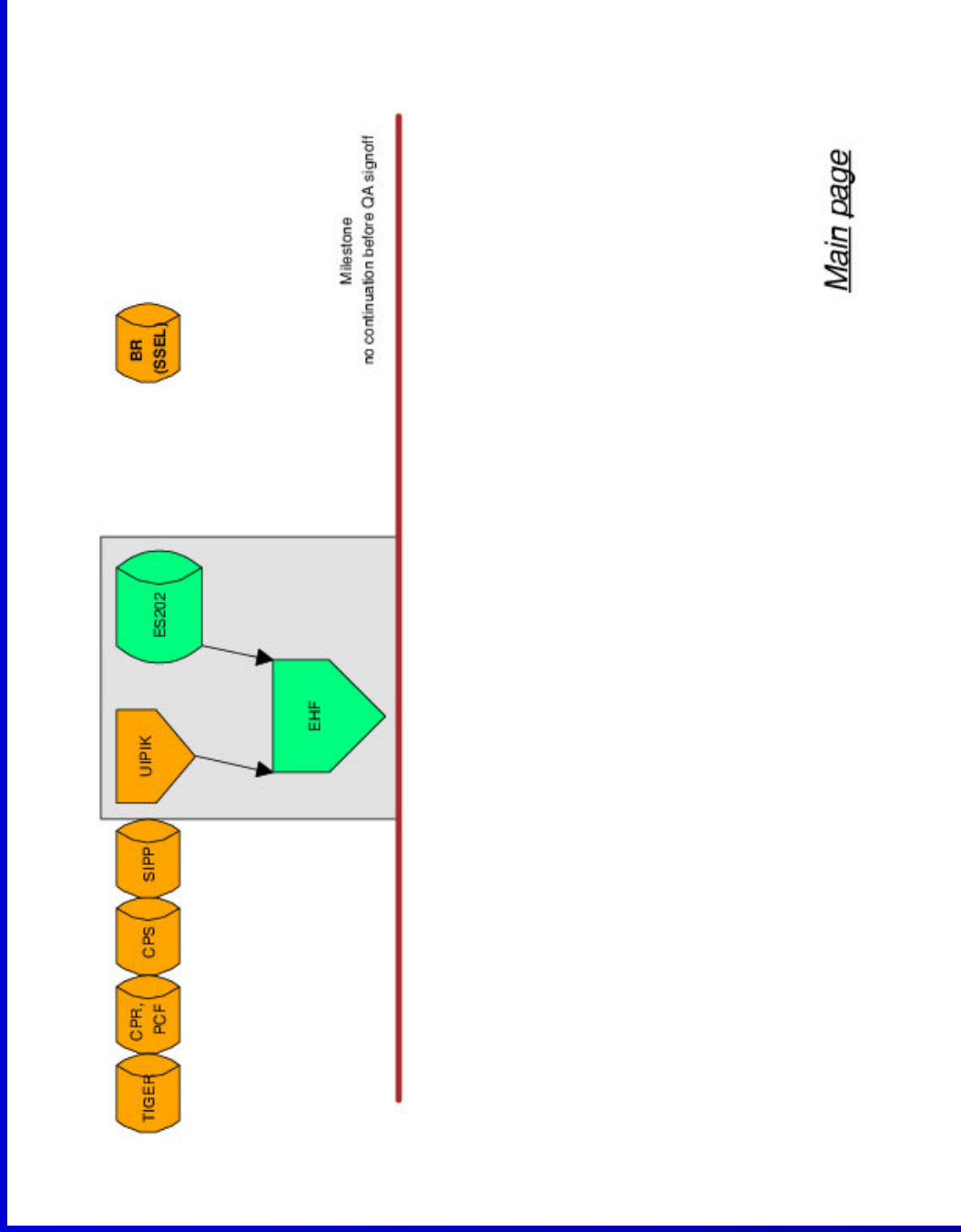
➤ Flow so far

Forming Aggregated Estimates: QWI

Disclosure-proofing the QWI

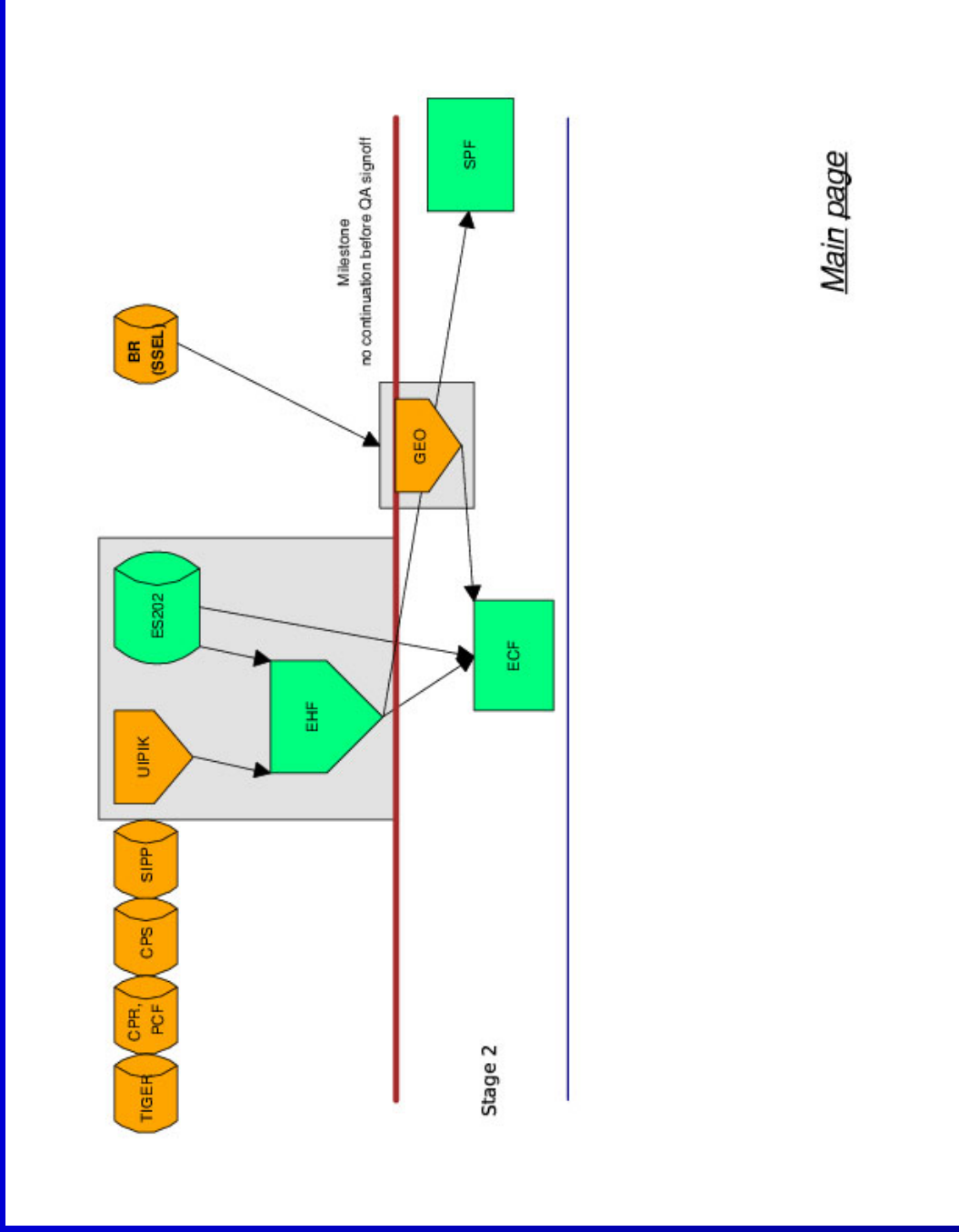
Publicly available files

Conclusion



[Main page](#)

Flow so far



The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

➤ EHF: Employment History

Files

➤ ICF: Individual

Characteristics File

➤ ECF: Employer

Characteristics File

➤ GAL: Geocoded Address

List

➤ Flow so far

Forming Aggregated

Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

[Main page](#)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment

characteristics to jobs

↳ U2W: Unit to Worker

Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Forming Aggregated Estimates: QWI

Correction of spurious worker flows

■ Firm identifier:

The LEHD Infrastructure Files	
Introduction	
Input Files	
Infrastructure Files	
Forming Aggregated Estimates: QWI	
↳ Correction of spurious worker flows	
↳ Solution:	
Successor-Predecessor File	
↳ Attaching establishment characteristics to jobs	
↳ U2W: Unit to Worker	
Impute	
↳ Probability Model	
↳ Implementation	
↳ Implementation	
↳ Computing the statistics	
Disclosure-proofing the QWI	
Publicly available files	
Conclusion	

Correction of spurious worker flows

- Firm identifier: state-specific account number

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
➤ Correction of spurious worker flows
➤ Solution:
Successor-Predecessor File
➤ Attaching establishment characteristics to jobs
➤ U2W: Unit to Worker Impute
➤ Probability Model
➤ Implementation
➤ Implementation
➤ Computing the statistics
Disclosure-proofing the QWI
Publicly available files
Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
○ Correction of spurious worker flows
○ Solution:
Successor-Predecessor File
○ Attaching establishment characteristics to jobs
○ U2W: Unit to Worker Impute
○ Probability Model
○ Implementation
○ Implementation
○ Computing the statistics
Disclosure-proofing the QWI
Publicly available files
Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:
 - ◆ change in legal form

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated

Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:
 - ◆ change in legal form
 - ◆ a merger

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated

Estimates: QWI

○ Correction of spurious
worker flows

○ Solution:

Successor-Predecessor
File

○ Attaching establishment
characteristics to jobs

○ U2W: Unit to Worker
Impute

○ Probability Model

○ Implementation

○ Implementation

○ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:
 - ◆ change in legal form
 - ◆ a merger
- Change in firm identifier

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:
 - ◆ change in legal form
 - ◆ a merger
- Change in firm identifier is the component determining when a worker changes employers

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated

Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment

characteristics to jobs

↳ U2W: Unit to Worker

Inpute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Correction of spurious worker flows

- Firm identifier:
- Account numbers can and do change:
 - ◆ change in legal form
 - ◆ a merger
- Change in firm identifier
- → non-economic change in identifier creates spurious flow

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Inpute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Solution: Successor-Predecessor File

- track large worker movements between SEINs

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

○ Correction of spurious
worker flows

○ Solution:
Successor-Predecessor
File

○ Attaching establishment
characteristics to jobs

○ U2W: Unit to Worker
Input

○ Probability Model

○ Implementation

○ Implementation

○ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Solution: Successor-Predecessor File

- track large worker movements between SEINs
- → link entities that have different account numbes, but constitute the same economic entitiy

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

○ Correction of spurious
worker flows

○ Solution:
Successor-Predecessor
File

○ Attaching establishment
characteristics to jobs

○ U2W: Unit to Worker
Impute

○ Probability Model

○ Implementation

○ Implementation

○ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Solution: Successor-Predecessor File

- track large worker movements between SEINs
- → link entities that have different account numbes, but constitute the same economic entity
- SPF provides a variety of link characteristics, based on the number of workers leaving an SEIN, in both absolute and relative terms, and the number of workers entering an SEIN, again in absolute and relative terms.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:
Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Inpute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Solution: Successor-Predecessor File

- track large worker movements between SEINs
- → link entities that have different account numbes, but constitute the same economic entity
- SPF provides a variety of link characteristics, based on the number of workers leaving an SEIN, in both absolute and relative terms, and the number of workers entering an SEIN, again in absolute and relative terms.
- QWI: if 80% of an SEIN's workers (the predecessor) are observed to move to a single successor, and that successor absorbs 80% of its employees from a single predecessor, then all flows between those two account numbers are filtered out, and treated as if they had never existed.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:
Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs
↳ U2W: Unit to Worker
Inpute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

- Correction of spurious
worker flows
- Solution:

Successor-Predecessor
File

➤ Attaching establishment
characteristics to jobs

➤ U2W: Unit to Worker
Input

- Probability Model
- Implementation
- Implementation
- Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem: no establishment identification on wage record

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:

The LEHD Infrastructure Files Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI <ul style="list-style-type: none">↳ Correction of spurious worker flows↳ Solution: Successor-Predecessor File
↳ Attaching establishment characteristics to jobs <ul style="list-style-type: none">↳ U2W: Unit to Worker Impute↳ Probability Model↳ Implementation↳ Computing the statistics
Disclosure-proofing the QWI
Publicly available files
Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

○ Correction of spurious
worker flows

○ Solution:

Successor-Predecessor
File

○ Attaching establishment
characteristics to jobs

○ U2W: Unit to Worker
Impute

○ Probability Model

○ Implementation

○ Implementation

○ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:
 1. distance between place-of-work and place-of-residence

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:
 1. distance between place-of-work and place-of-residence
 2. distribution of employment across establishments of multi-establishment firms.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▢ Correction of spurious
worker flows

▢ Solution:

Successor-Predecessor
File

▢ Attaching establishment
characteristics to jobs

▢ U2W: Unit to Worker
Impute

▢ Probability Model

▢ Implementation

▢ Implementation

▢ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:
 1. distance between place-of-work and place-of-residence
 2. distribution of employment across establishments of multi-establishment firms.
- Important practical aspects:

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious
worker flows

▷ Solution:

Successor-Predecessor
File

▷ Attaching establishment
characteristics to jobs

▷ U2W: Unit to Worker
Impute

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:
 1. distance between place-of-work and place-of-residence
 2. distribution of employment across establishments of multi-establishment firms.
- Important practical aspects:
 - ◆ Non-ignorable missing data imputation

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious
worker flows

▷ Solution:

Successor-Predecessor
File

▷ Attaching establishment
characteristics to jobs

▷ U2W: Unit to Worker
Impute

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Attaching establishment characteristics to jobs

- Goal: achieve a high level of accuracy and detail
- Problem:
- 30-40% of state-wide employment in multi-establishment firms
- Solution: probability model for employment location and imputation
- Key elements are:
 1. distance between place-of-work and place-of-residence
 2. distribution of employment across establishments of multi-establishment firms.
- Important practical aspects:
 - ◆ Non-ignorable missing data imputation
 - ◆ Several million imputations every quarter

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious
worker flows

▷ Solution:

Successor-Predecessor
File

▷ Attaching establishment
characteristics to jobs

▷ U2W: Unit to Worker
Impute

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

■ workers $i = 1, \dots, I$

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious
worker flows

→ Solution:

Successor-Predecessor
File

→ Attaching establishment
characteristics to jobs

→ U2W: Unit to Worker
Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious

worker flows

→ Solution:

Successor-Predecessor

File

→ Attaching establishment

characteristics to jobs

→ U2W: Unit to Worker

Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious

worker flows

→ Solution:

Successor-Predecessor

File

→ Attaching establishment

characteristics to jobs

→ U2W: Unit to Worker

Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment

characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

- ▷ Correction of spurious
worker flows
- ▷ Solution:

Successor-Predecessor
File

- ▷ Attaching establishment
characteristics to jobs

▷ U2W: Unit to Worker
Impute

- ▷ Probability Model
- ▷ Implementation
- ▷ Implementation
- ▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows
↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows
↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active
- \mathcal{I}_{jt} individuals employed at firm j

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows
↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active
- \mathcal{I}_{jt} individuals employed at firm j
- \mathcal{R}_{jt} set of active ($N_{jrt} > 0$) establishments

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows
↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active
- \mathcal{I}_{jt} individuals employed at firm j
- \mathcal{R}_{jt} set of active ($N_{jrt} > 0$) establishments
- $\mathcal{R}_{jt}^i \subset \mathcal{R}_{jt}$ set of active establishments that are feasible for worker i .

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▫ Correction of spurious
worker flows
▫ Solution:

Successor-Predecessor
File

▫ Attaching establishment
characteristics to jobs

▫ U2W: Unit to Worker

Impute

▫ Probability Model

▫ Implementation

▫ Implementation

▫ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active
- \mathcal{I}_{jt} individuals employed at firm j
- \mathcal{R}_{jt} set of active ($N_{jrt} > 0$) establishments
- $\mathcal{R}_{jt}^i \subset \mathcal{R}_{jt}$ set of active establishments that are feasible for worker i .
- **Feasibility:** an establishment $r \in \mathcal{R}_{jt}^i$ if $N_{jrs} > 0$ for every quarter s that i was employed at j .

U2W: Unit to Worker Impute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▫ Correction of spurious
worker flows
▫ Solution:

Successor-Predecessor
File

▫ Attaching establishment
characteristics to jobs

▫ U2W: Unit to Worker

Impute

▫ Probability Model

▫ Implementation

▫ Implementation

▫ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- workers $i = 1, \dots, I$
- firms $j = 1, \dots, J$
- active establishments at firm j R_{jt}
- quarter t employment of establishment r in firm j N_{jrt}
- y_{ijt} establishment at which i was employed
- \mathcal{J}_t firms active
- \mathcal{I}_{jt} individuals employed at firm j
- \mathcal{R}_{jt} set of active ($N_{jrt} > 0$) establishments
- $\mathcal{R}_{jt}^i \subset \mathcal{R}_{jt}$ set of active establishments that are feasible for worker i .
- Feasibility: an establishment $r \in \mathcal{R}_{jt}^i$ if $N_{jrs} > 0$ for every quarter s that i was employed at j .

Probability Model

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious
worker flows

➤ Solution:

Successor-Predecessor
File

➤ Attaching establishment
characteristics to jobs

➤ U2W: Unit to Worker
Impute

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious

worker flows

→ Solution:

Successor-Predecessor

File

→ Attaching establishment

characteristics to jobs

→ U2W: Unit to Worker

Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

(1)

$$p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_j^i} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_j^i} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Inpute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_j^i} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

x_{ijrt} time-varying vector, worker and establishment

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_t^i} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

x_{ijrt} time-varying vector, worker and establishment

β effect on probability of being employed at a particular establishment

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_j^i} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

x_{ijrt} time-varying vector, worker and establishment

β effect on probability of being employed at a particular establishment

Currently:

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious
worker flows

→ Solution:

Successor-Predecessor
File

→ Attaching establishment
characteristics to jobs

→ U2W: Unit to Worker

Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_{jt}} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

x_{ijrt} time-varying vector, worker and establishment

β effect on probability of being employed at a particular establishment

Currently:

- ♦ x_{ijrt} is linear spline in distance between residence and establishment

Probability Model

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious
worker flows

→ Solution:

Successor-Predecessor
File

→ Attaching establishment
characteristics to jobs

→ U2W: Unit to Worker

Impute

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

$$p_{ijrt} = \Pr(y_{ijt} = r)$$

$$(1) \quad p_{ijrt} = \frac{e^{\alpha_{jrt} + x'_{ijrt}\beta}}{\sum_{s \in \mathcal{R}_{jt}} e^{\alpha_{jst} + x'_{ijst}\beta}}$$

α_{jrt} establishment- and quarter-specific effect

x_{ijrt} time-varying vector, worker and establishment

β effect on probability of being employed at a particular establishment

Currently:

- ♦ x_{ijrt} is linear spline in distance between residence and establishment
- ♦ α_{jrt} is a hierarchical Bayesian model based on N_{jrt} is

Implementation

Using Minnesota data,

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious
worker flows

➤ Solution:

Successor-Predecessor
File

➤ Attaching establishment
characteristics to jobs

➤ U2W: Unit to Worker
Impute

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

Using Minnesota data,
compute posterior modal value of α_{jrt}

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

Using Minnesota data,
compute posterior modal value of α_{jrt}
evaluate the posterior mode of $p(\beta|\alpha, x, y)$

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker
Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

The LEHD Infrastructure Files Introduction	Input Files
	Infrastructure Files
	Forming Aggregated Estimates: QWI <ul style="list-style-type: none">➤ Correction of spurious worker flows➤ Solution: Successor-Predecessor File➤ Attaching establishment characteristics to jobs➤ U2W: Unit to Worker Impute➤ Probability Model
Disclosure-proofing the QWI	Publicly available files
	Conclusion

Using Minnesota data,
compute posterior modal value of α_{jrt}
evaluate the posterior mode of $p(\beta|\alpha, x, y)$
maximize

$$\log p(\beta|\alpha, x, y) \propto \sum_{t=1}^T \sum_{j \in \mathcal{J}_t} \sum_{i \in \mathcal{I}_{jt}} \sum_{r \in \mathcal{R}_{jt}^i} d_{ijrt} \left(\alpha_{jrt} + x'_{ijrt} \beta - \log \left(\sum_{s \in \mathcal{R}_{jt}^i} e^{\alpha_{jst} + x'_{ijst} \beta} \right) \right)$$

Implementation

- use mean and variance of β from Minnesota data

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious

worker flows

➤ Solution:

Successor-Predecessor

File

➤ Attaching establishment

characteristics to jobs

➤ U2W: Unit to Worker

Inpute

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

- use mean and variance of β from Minnesota data
- take 10 draws of β from the normal approximation (at the mode) to $p(\beta|\alpha, x, y)$.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment

characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

- use mean and variance of β from Minnesota data
- take 10 draws of β from the normal approximation (at the mode) to $p(\beta|\alpha, x, y)$.
- use QCEW employment counts, compute 10 values of α_{jt}

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor

File

↳ Attaching establishment

characteristics to jobs

↳ U2W: Unit to Worker

Input

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Implementation

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- use mean and variance of β from Minnesota data
- take 10 draws of β from the normal approximation (at the mode) to $p(\beta|\alpha, x, y)$.
- use QCEW employment counts, compute 10 values of α_{jt}
- The drawn values of α and β are used to draw 10 imputed values of place of work from to the posterior predictive distribution

$$(2) p(\tilde{y}|x, y) = \int \int p(\tilde{y}|\alpha, \beta, x, y) p(\alpha|N) p(\beta|\alpha, x, y) d\alpha d\beta$$

Implementation

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious
worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

- use mean and variance of β from Minnesota data
- take 10 draws of β from the normal approximation (at the mode) to $p(\beta|\alpha, x, y)$.
- use QCEW employment counts, compute 10 values of α_{jt}
- The drawn values of α and β are used to draw 10 imputed values of place of work from to the posterior predictive distribution

$$(2) p(\tilde{y}|x, y) = \int \int p(\tilde{y}|\alpha, \beta, x, y) p(\alpha|N) p(\beta|\alpha, x, y) d\alpha d\beta$$

- → 10 establishment identifiers associated with a job spell

Computing the statistics

■ We now have:

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

↳ Correction of spurious

worker flows

↳ Solution:

Successor-Predecessor
File

↳ Attaching establishment
characteristics to jobs

↳ U2W: Unit to Worker

Impute

↳ Probability Model

↳ Implementation

↳ Implementation

↳ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
- ◆ Jobs identified

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious

worker flows

➤ Solution:

Successor-Predecessor
File

➤ Attaching establishment
characteristics to jobs

➤ U2W: Unit to Worker

Impute

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics (age, gender)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious

worker flows

➤ Solution:

Successor-Predecessor
File

➤ Attaching establishment

characteristics to jobs

➤ U2W: Unit to Worker

Input

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

➤ Correction of spurious
worker flows

➤ Solution:

Successor-Predecessor
File

➤ Attaching establishment
characteristics to jobs

➤ U2W: Unit to Worker
Impute

➤ Probability Model

➤ Implementation

➤ Implementation

➤ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics (geography and industry)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

○ Correction of spurious
worker flows

○ Solution:

Successor-Predecessor
File

○ Attaching establishment
characteristics to jobs

○ U2W: Unit to Worker
Impute

○ Probability Model

○ Implementation

○ Implementation

○ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
↳ Correction of spurious worker flows
↳ Solution: Successor-Predecessor File
↳ Attaching establishment characteristics to jobs
↳ U2W: Unit to Worker Impute
↳ Probability Model
↳ Implementation
↳ Computing the statistics
Disclosure-proofing the QWI
Publicly available files
Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics
- Now compute

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious
worker flows

▷ Solution:

Successor-Predecessor
File

▷ Attaching establishment
characteristics to jobs

▷ U2W: Unit to Worker
Input

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics
- Now compute
 1. For each job, the relevant variables, defined at the person-level (indicators)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious

worker flows

▷ Solution:

Successor-Predecessor

File

▷ Attaching establishment

characteristics to jobs

▷ U2W: Unit to Worker

Input

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics
- Now compute
 1. For each job, the relevant variables, defined at the person-level (indicators)
 2. Aggregate (typically sum) to the establishment level

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▷ Correction of spurious

worker flows

▷ Solution:

Successor-Predecessor

File

▷ Attaching establishment

characteristics to jobs

▷ U2W: Unit to Worker

Inpute

▷ Probability Model

▷ Implementation

▷ Implementation

▷ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

Computing the statistics

- We now have:
 - ◆ Jobs identified
 - ◆ Jobholder's demographics
 - ◆ Establishment's characteristics
- Now compute
 1. For each job, the relevant variables, defined at the person-level (indicators)
 2. Aggregate (typically sum) to the establishment level
 3. → establishment-level statistics, available in RDC

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious

worker flows

→ Solution:

Successor-Predecessor

File

→ Attaching establishment

characteristics to jobs

→ U2W: Unit to Worker

Input

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

→ Correction of spurious

worker flows

→ Solution:

Successor-Predecessor

File

→ Attaching establishment

characteristics to jobs

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Input

→ Probability Model

→ Implementation

→ Implementation

→ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▢ Correction of spurious

worker flows

▢ Solution:

Successor-Predecessor

File

▢ Attaching establishment

characteristics to jobs

▢ U2W: Unit to Worker

Inpute

▢ Probability Model

▢ Implementation

▢ Implementation

▢ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▢ Correction of spurious

worker flows

▢ Solution:

Successor-Predecessor

File

▢ Attaching establishment

characteristics to jobs

▢ U2W: Unit to Worker

Inpute

▢ Probability Model

▢ Implementation

▢ Implementation

▢ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

▸ Correction of spurious

worker flows

▸ Solution:

Successor-Predecessor

File

▸ Attaching establishment

characteristics to jobs

▸ U2W: Unit to Worker

Inpute

▸ Probability Model

▸ Implementation

▸ Implementation

▸ Computing the statistics

Disclosure-proofing the QWI

Publicly available files

Conclusion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

↳ Noise-infusion

↳ Item suppression

Publicly available files

Conclusion

Disclosure-proofing the QWI

Noise-infusion

■ First layer: workplace-level aggregation

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI <ul style="list-style-type: none">➤ Noise-infusion➤ Item suppression
Publicly available files
Conclusion

Noise-infusion

- First layer: workplace-level aggregation
 - ◆ infusion of specially constructed noise:

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI <ul style="list-style-type: none">➤ Noise-infusion➤ Item suppression
Publicly available files
Conclusion

Noise-infusion

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 - ◆ infusion of specially constructed noise:
 - ◆

$$(3) \ p(\delta_j) = \begin{cases} (b - \delta) / (b - a)^2, & \delta \in [a, b] \\ (b + \delta - 2) / (b - a)^2, & \delta \in [2 - b, 2 - a] \end{cases}$$

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➢ Noise-infusion

➢ Item suppression

Publicly available files

Conclusion

Noise-infusion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➤ Noise-infusion

➤ Item suppression

Publicly available files

Conclusion

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- ◆ Result: random noise factor centered around 1 with distortion of at least $a - 1$ and at most $b - 1$.

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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

▸ Noise-infusion

▸ Item suppression

Publicly available files

Conclusion

Noise-infusion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➤ Noise-infusion

➤ Item suppression

Publicly available files

Conclusion

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- ◆ Result: random noise factor centered around 1 with distortion of at least $a - 1$ and at most $b - 1$.
- Important properties:
 1. for a given workplace, distortion is always distorted in the same direction (increased or decreased) by the same percentage amount in every period.

Noise-infusion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

▸ Noise-infusion

▸ Item suppression

Publicly available files

Conclusion

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- ◆ Result: random noise factor centered around 1 with distortion of at least $a - 1$ and at most $b - 1$.
- Important properties:
 1. for a given workplace, distortion is always distorted in the same direction (increased or decreased) by the same percentage amount in every period.
 2. when estimates are aggregated, the effects of the distortion cancel out for the vast majority of the estimates.

Item suppression

■ Second layer: after aggregations

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
↳ Noise-infusion
↳ Item suppression
Publicly available files
Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➤ Noise-infusion

➤ Item suppression

Publicly available files

Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.
 - ◆ → suppression of these estimates

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➤ Noise-infusion

➤ Item suppression

Publicly available files

Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.
 - ◆ → suppression of these estimates
 - ◆ Some of the estimates are based on noisy data

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

➤ Noise-infusion

➤ Item suppression

Publicly available files

Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.
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 - ◆ Some of the estimates are based on noisy data
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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI
↳ Noise-infusion

↳ Item suppression

Publicly available files

Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.
 - ◆ → suppression of these estimates
 - ◆ Some of the estimates are based on noisy data
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The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI
↳ Noise-infusion

↳ Item suppression

Publicly available files

Conclusion

Item suppression

- Second layer: after aggregations
 - ◆ Some estimates are based on fewer than three persons or firms.
 - ◆ → suppression of these estimates
 - ◆ Some of the estimates are based on noisy data
 - ◆ → flagged as “substantially distorted”

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI
↳ Noise-infusion

↳ Item suppression

Publicly available files

Conclusion

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

➤ Publicly available files

Conclusion

Publicly available files

Publicly available files

■ Published QWI

The LEHD Infrastructure Files
Introduction
Input Files
Infrastructure Files
Forming Aggregated Estimates: QWI
Disclosure-proofing the QWI
Publicly available files
→ Publicly available files
Conclusion

Publicly available files

- Published QWI
→ <http://lehd.dsd.census.gov>

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

Publicly available files

- Published QWI
→ <http://lehd.dsd.census.gov>
- RDC

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

Publicly available files

- Published QWI
→ <http://lehd.dsd.census.gov>
- RDC
 - ◆ Employer characteristics files ECF → LEHD-ECF

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

Publicly available files

- Published QWI
→ <http://lehd.dsd.census.gov>
- RDC
 - ◆ Employer characteristics files ECF → LEHD-ECF
 - ◆ Establishment level flow files - Firm-level QWI → LEHD-QWI

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

Publicly available files

- Published QWI
→ <http://lehd.dsd.census.gov>
- RDC
 - ◆ Employer characteristics files ECF → LEHD-ECF
 - ◆ Establishment level flow files - Firm-level QWI → LEHD-QWI
 - ◆ LEHD Business Register Bridge (LEHD-BRB)

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

Publicly available files

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

- Published QWI
→ <http://lehd.dsd.census.gov>
- RDC
 - ◆ Employer characteristics files ECF → LEHD-ECF
 - ◆ Establishment level flow files - Firm-level QWI → LEHD-QWI
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 - ◆ Human Capital files LEHD-HCF

Publicly available files

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files
→ Publicly available files

Conclusion

■ Published QWI

→ <http://lehd.dsd.census.gov>

■ RDC

- ◆ Employer characteristics files ECF → LEHD-ECF
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- ◆ LEHD Business Register Bridge (LEHD-BRB)
- ◆ Human Capital files LEHD-HCF

→ <http://www.ces.census.gov>

The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

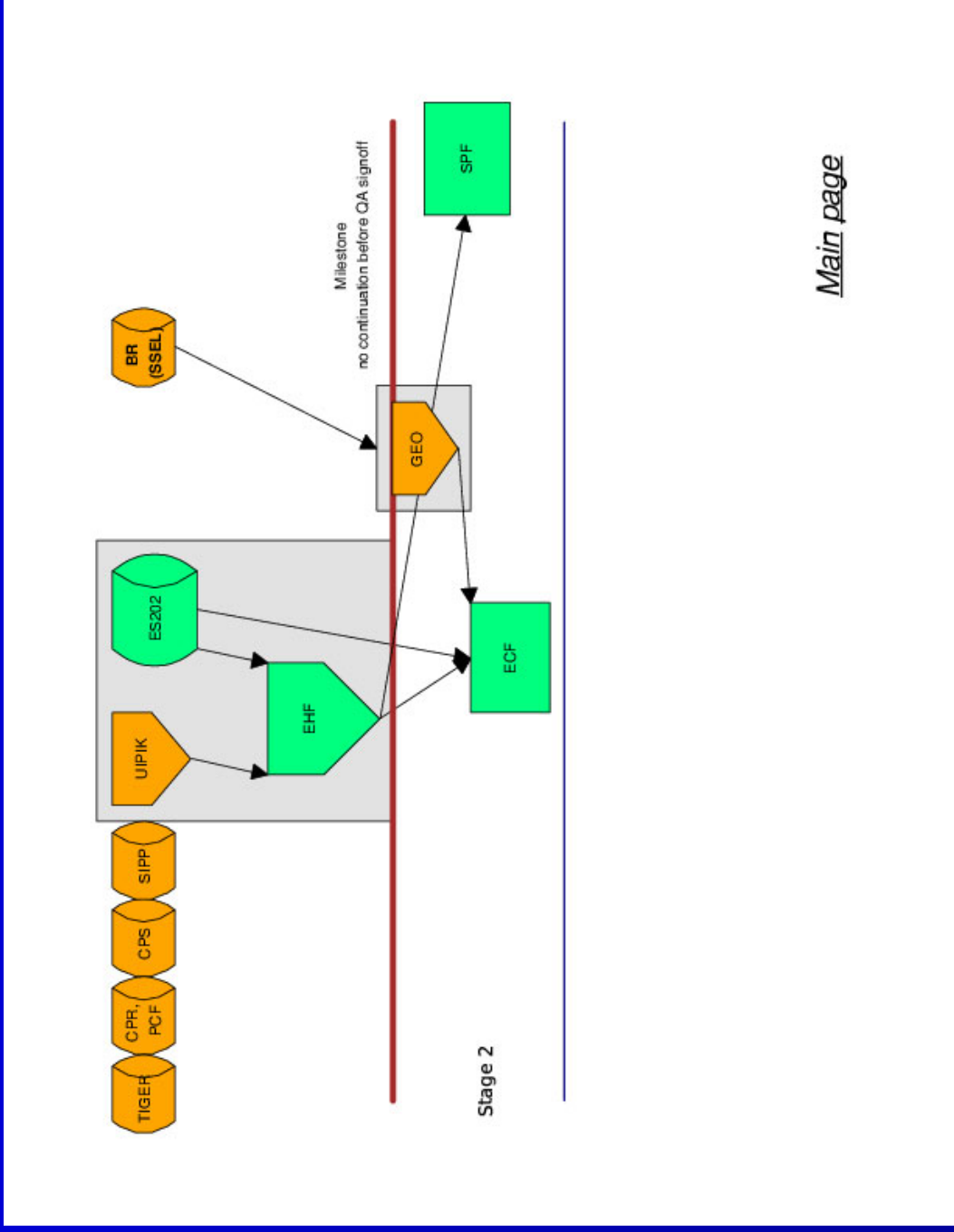
Publicly available files

Conclusion

➤ Flow so far

Conclusion

Flow so far



The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

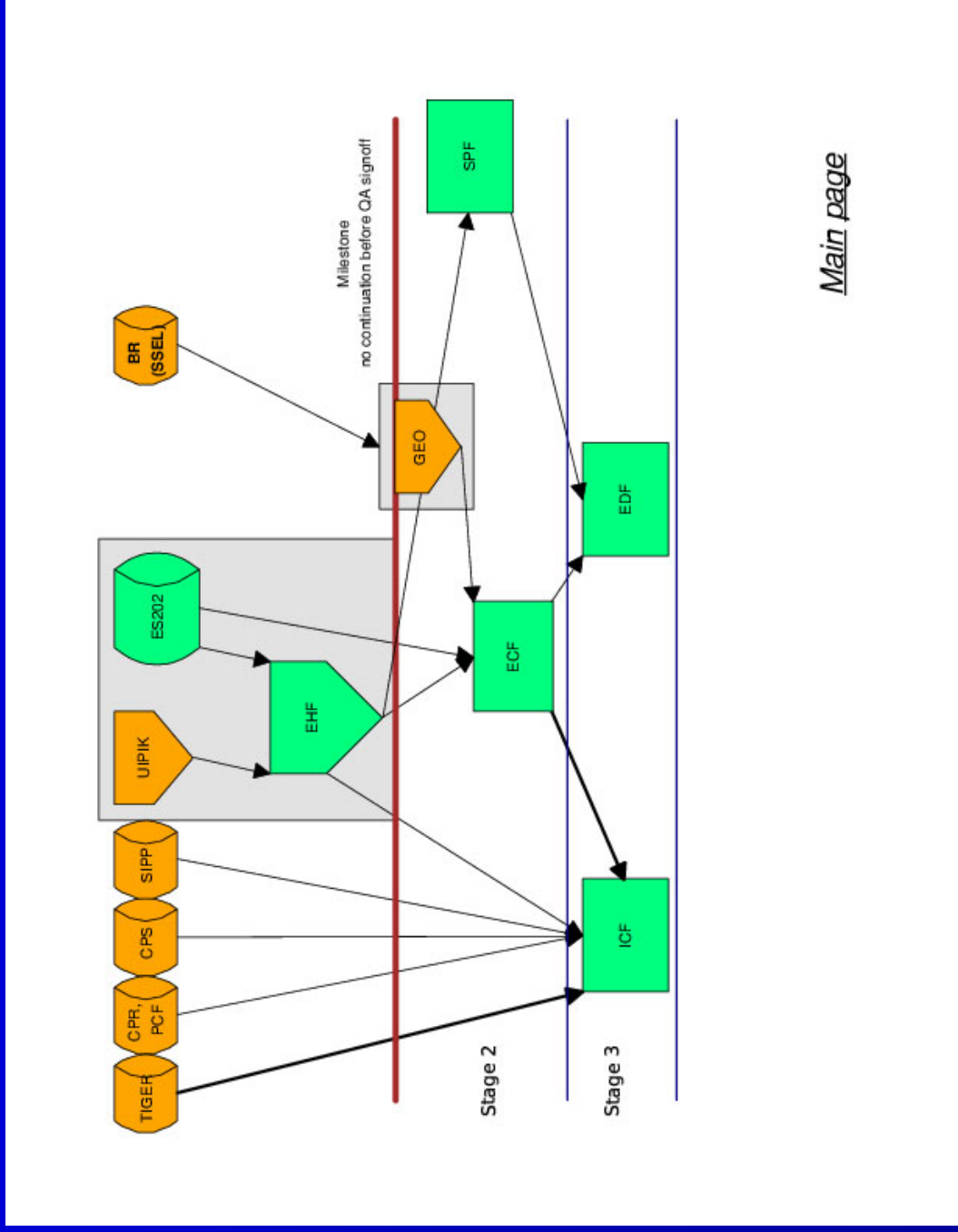
Disclosure-proofing the QWI

Publicly available files

Conclusion

➤ Flow so far

Flow so far



The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

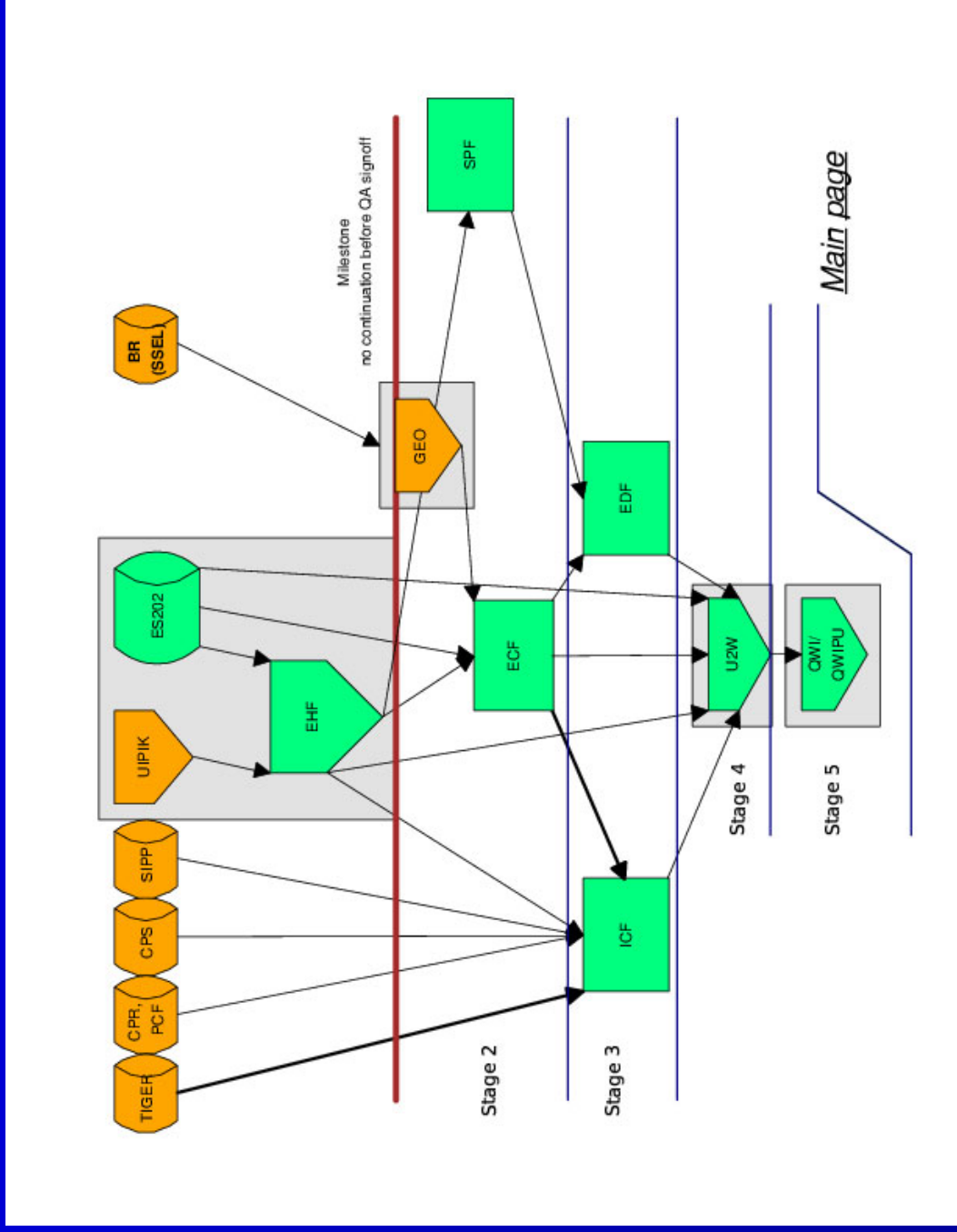
Disclosure-proofing the QWI

Publicly available files

Conclusion

➤ Flow so far

Flow so far



The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

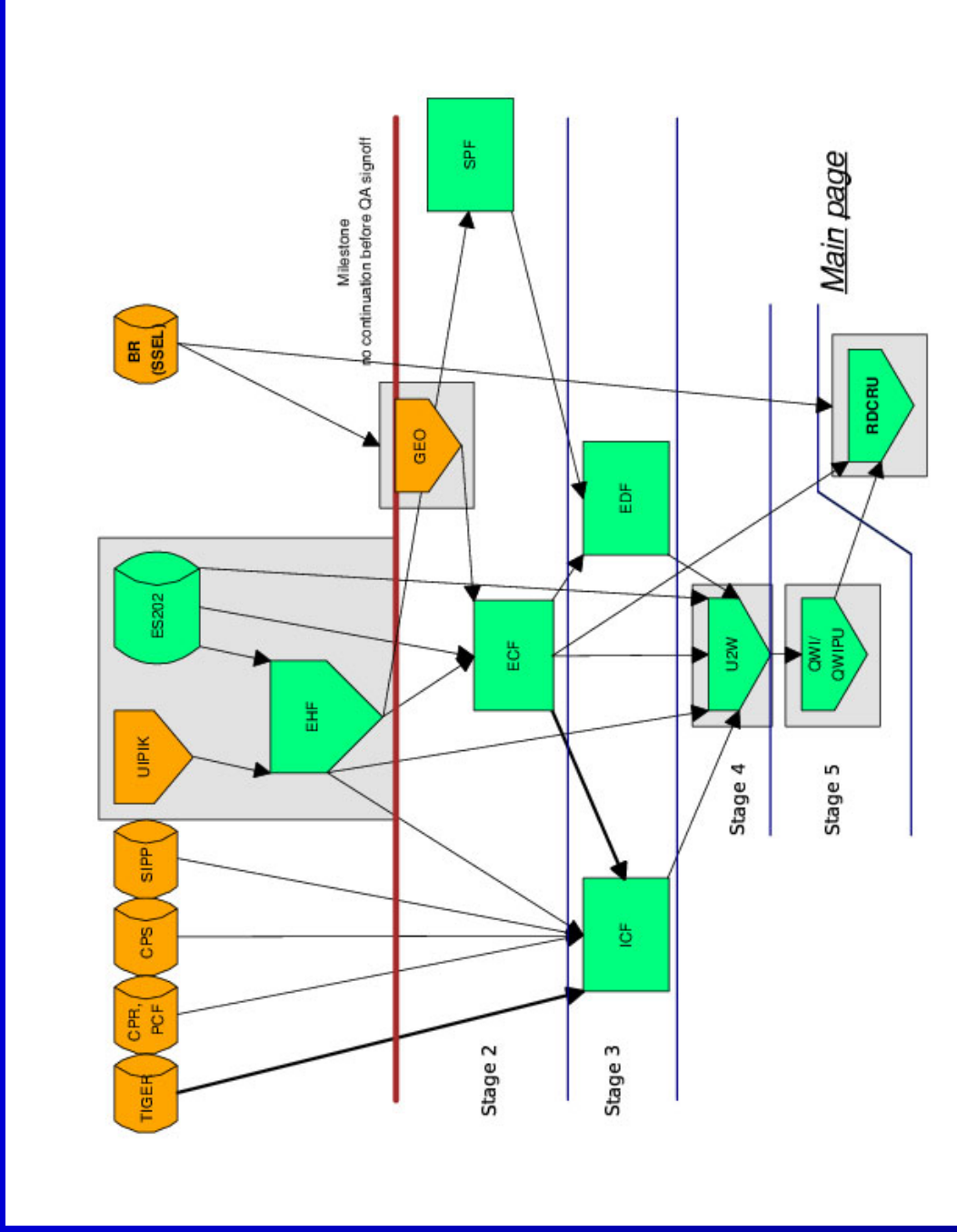
Disclosure-proofing the QWI

Publicly available files

Conclusion

➤ Flow so far

Flow so far



The LEHD Infrastructure Files
Introduction

Input Files

Infrastructure Files

Forming Aggregated
Estimates: QWI

Disclosure-proofing the QWI

Publicly available files

Conclusion

➤ Flow so far