Motivation
Problem
Approach
Results
Discussion

How Transparency and Reproducibility Can Increase Credibility in Policy Analysis

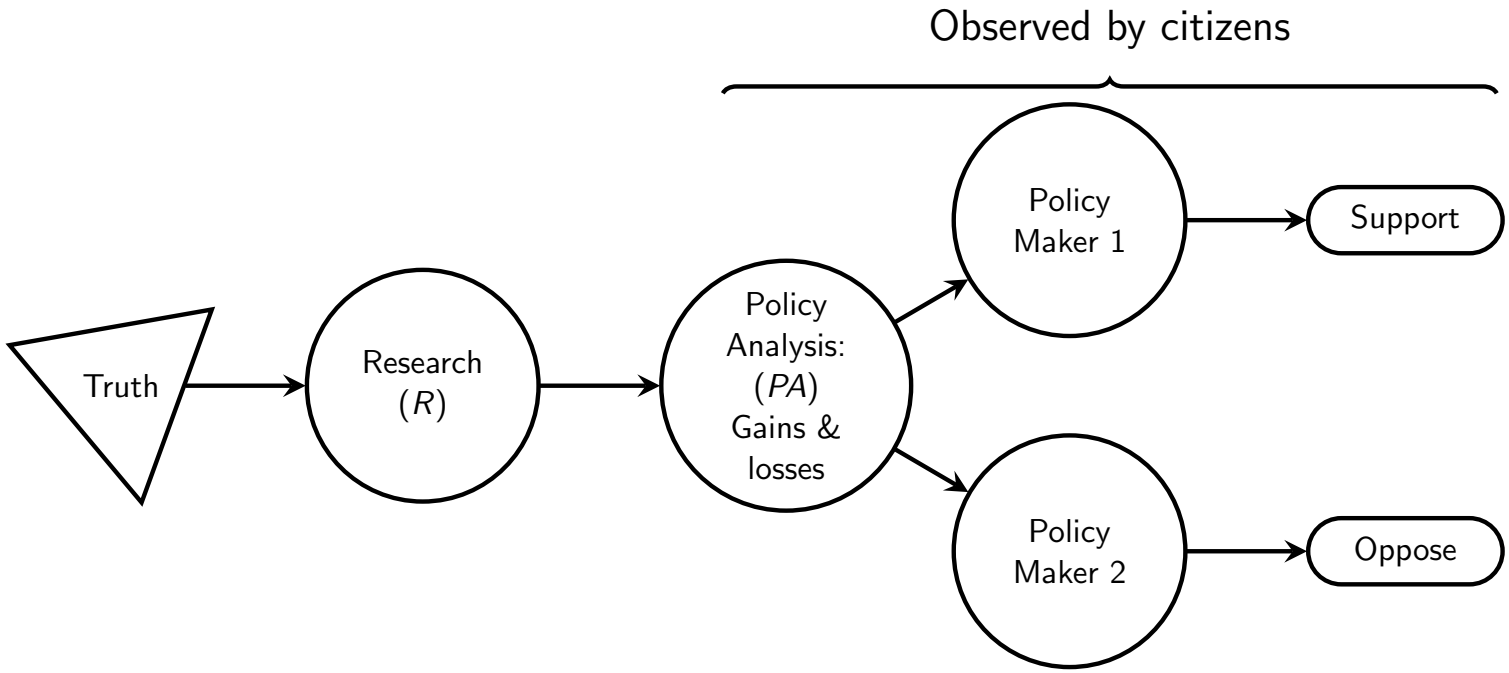
A Case Study of the Minimum Wage Policy Estimates

Fernando Hoces de la Guardia
RAND Corporation

Research Programming Group, RAND
August 3, 2017

Motivation
Problem
Approach
Results
Discussion

Motivation: Simplified Model of Connection Between Evidence and Policy



Motivation: Credibility Crisis

Motivation
Problem
Approach
Results
Discussion

"I'm sorry, Jeannie, your answer was correct, but Kevin shouted his incorrect answer over yours, so he gets the points."

Motivation
Problem
Approach
Results
Discussion

Motivation: Major Push In Science to Increase Quality Through Transparency and Reproducibility

Credible research is key step to achieve the ideal of common evidence across different policy makers.

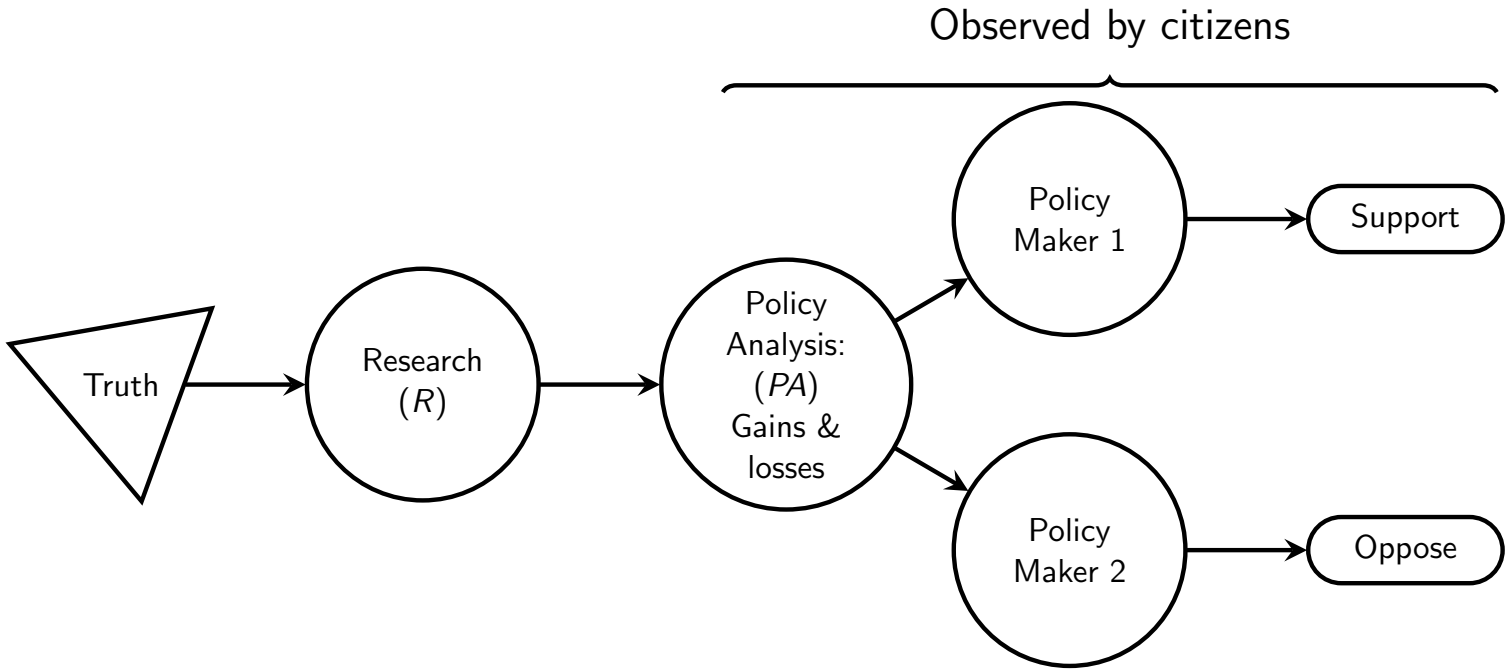


Figure: Simplified Model of Connection Between Evidence and Policy

Next step: increase the credibility of policy analysis.

Problem: Policy Analysis Often Has Low Credibility [Manski, 2013]

- **The Problem:** Little is known about the boundaries of the point estimates provided in policy reports.
- **Manski Proposes:** In increasing order of desirability: (1) display standard errors; (2) bound estimated effects; (3) add [policy] decision criteria to the analysis (best).

Problem: Policy Analysis Often Has Low Credibility [Manski, 2013]

- **The Problem:** Little is known about the boundaries of the point estimates provided in policy reports.
- **Manski Proposes:** In increasing order of desirability: (1) display standard errors; (2) bound estimated effects; (3) add [policy] decision criteria to the analysis (best).

Contribution: Bring Open Science To Policy Analysis

As a complement to Manski's prescription, this work incorporates guidelines and tools created in response to the reproducibility crisis in science into policy analysis. This methodological development is implemented in the case study.

Relevance

Why does the **problem** matter?

- Policy makers can cherry-pick facts
- Unclear how research affects policy estimates
- Hinders automation and/or systematic improvements of reports

Why does the **contribution** matter?

- ↓Costs of producing new PA estimates
- Path towards updating PAs systematically
- Strong positive spillovers across reports
- Clarifies normative v. positive debate

Relevance

Why does the **problem** matter?

- Policy makers can cherry-pick facts
- Unclear how research affects policy estimates
- Hinders automation and/or systematic improvements of reports

Why does the **contribution** matter?

- ↓Costs of producing new PA estimates
- Path towards updating PAs systematically
- Strong positive spillovers across reports
- Clarifies normative v. positive debate

The Transparent and Reproducible (TR) Approach to Policy Analysis

1. Comparison of Credibility Crises in Research and Policy Analysis
2. Translation of Guidelines and Tools to The Policy Analysis Setting
3. Application to Case Study: Policy Analysis on Minimum Wage
   - Demonstrate how to achieve highest standards of TR
   - Use sensitivity analysis to explore biggest policy unknowns
   - Surprisingly academic debate around one specific parameter seems less relevant from policy perspective

Comparison of Low Transparency and Reproducibility (TR) in Research and Policy Analysis

	Research	Policy Analysis
Output	Peer reviewed publication	Client-oriented policy report
Problems of low TR	Ex: Publication Bias.	Ex:Low credibility.
Common Solutions	Disclosure of key details. Open data and materials.	
Common Tools	Dynamic documentation. Distributed version control.	
Specific Solutions	Ex:Test for reproducibility	Ex: Develop reproducibility
Who increases TR	Researchers, Funders, Journals	**Not** the policy analysts (Policy schools? Think tanks? Media? Bloggers?)

Motivation
Problem
Approach
Results
Discussion

We don't know how the sausage is made!

Motivation
Problem
Approach
Results
Discussion

We don't know how the sausage is made!

Let's follow science, open up the kitchen.
And publish the cook book with the recipe.

Description of Case study

"The Effects of a Minimum-Wage Increase on Employment and Family Income" Congressional Budget Office (2014)

Description: CBO estimated the effects of a raise in the federal minimum wage from \$7.25/hr to \$10.10/hr.

Main policy estimates:

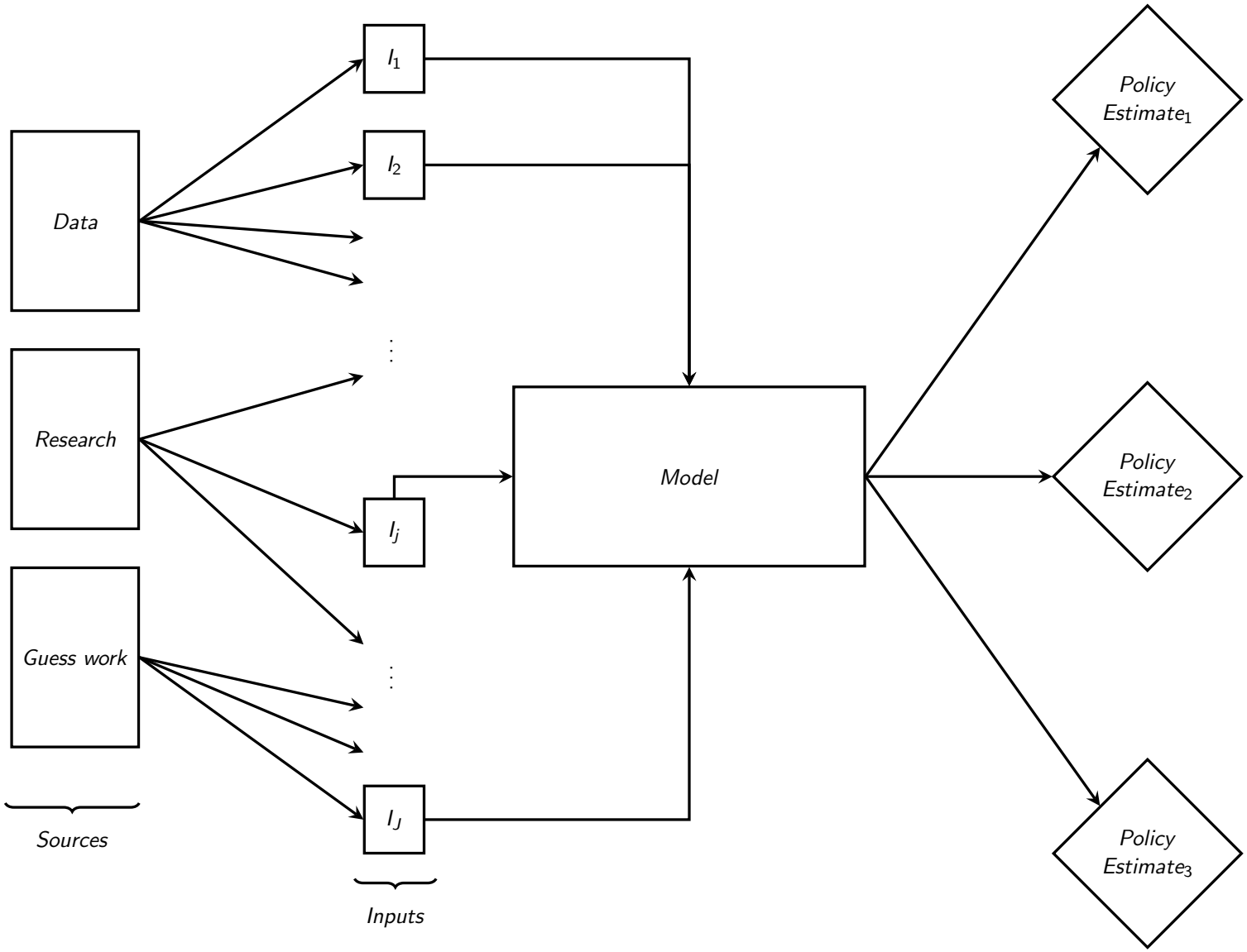
- 500,000 jobs would be lost.
- 16.5 million workers would receive a salary increase.
- Distributional effects: below poverty line (PL) +\$5billion; between one and three PL +\$12billion; between three and six PL +\$2billion; above six PL -\$17billion

Key research estimate: Elasticity of labor demand for teenagers in the labor force.

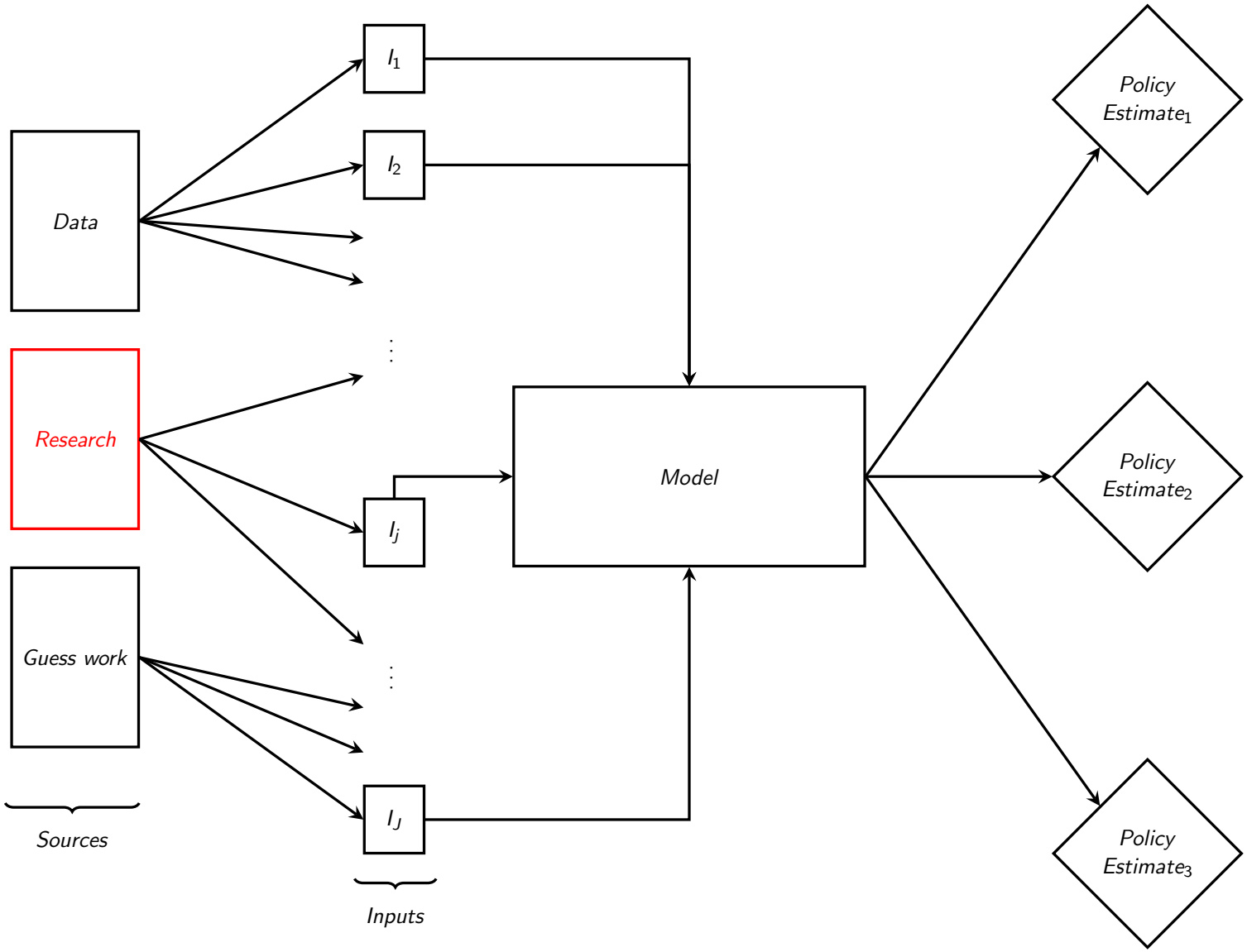
Results

1. Guidelines for TR Policy Analysis
2. Application to Case Study: Policy Analysis on Minimum Wage
   - Score the current report
   - Use guidelines and tools demonstrate high TR
   - Perform sensitivity analysis to identify biggest gaps in (policy relevant) knowledge

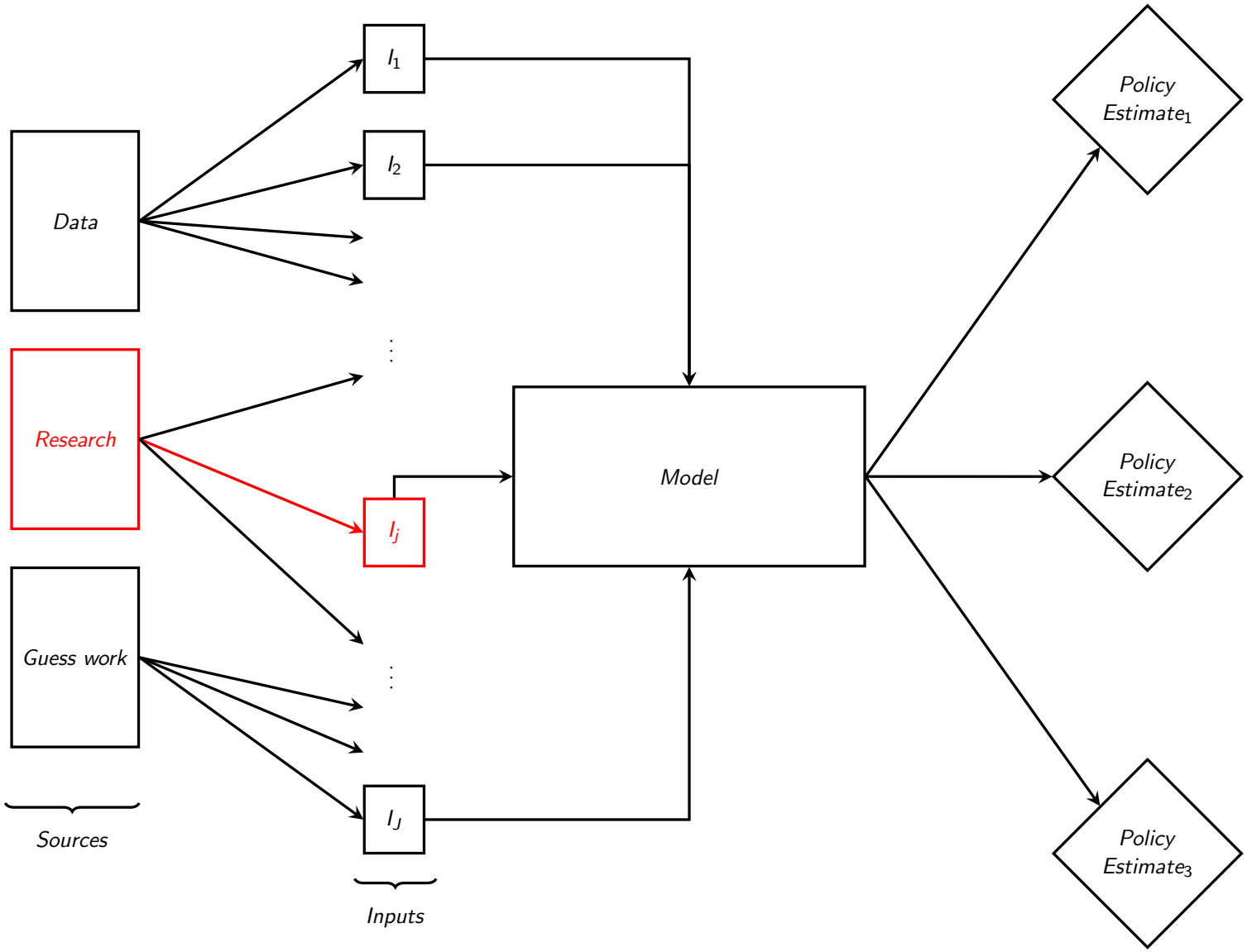
Guidelines Goal: Map the complete policy analysis. Transparent & Reproducible



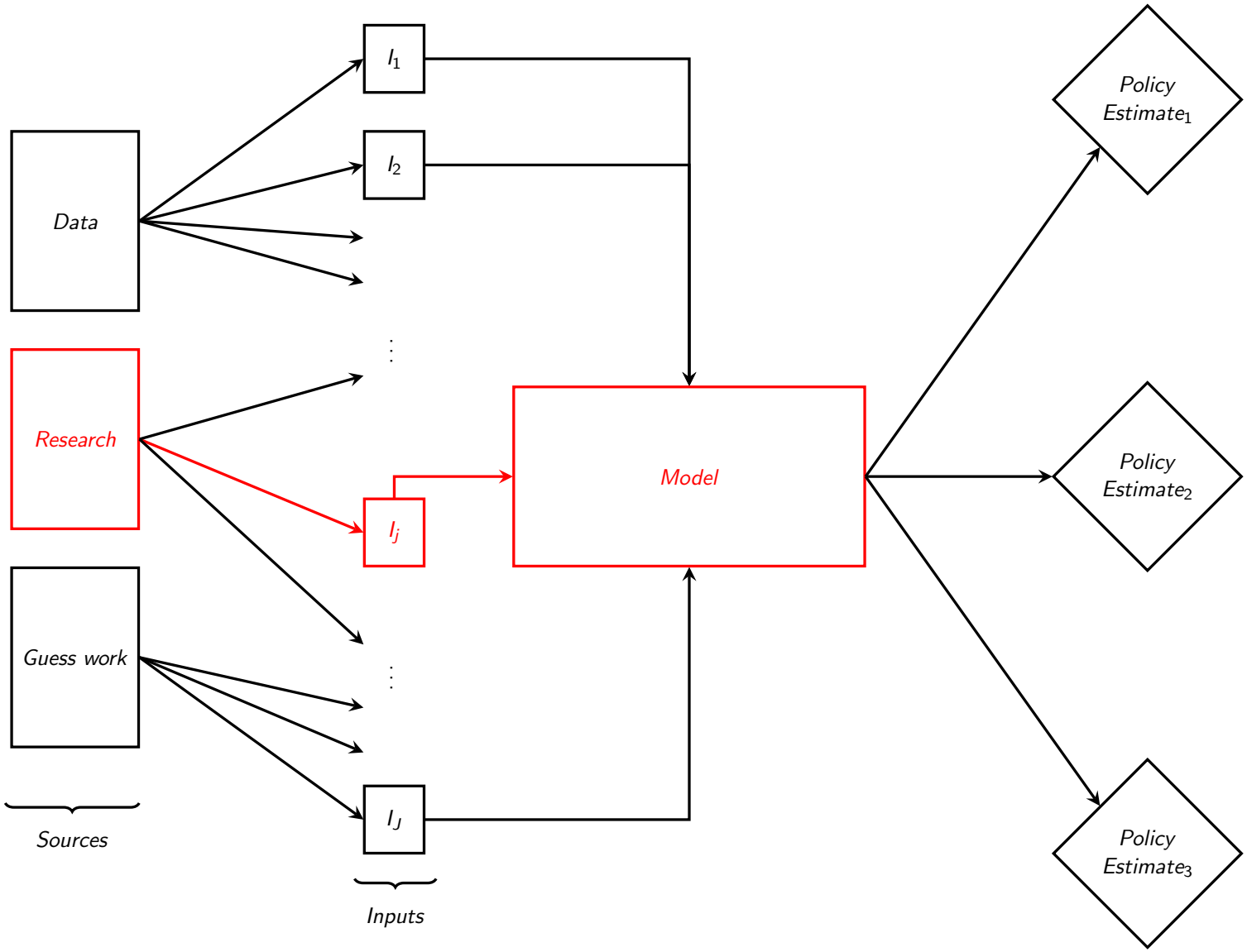
Guidelines Goal: Map the complete policy analysis. Transparent & Reproducible



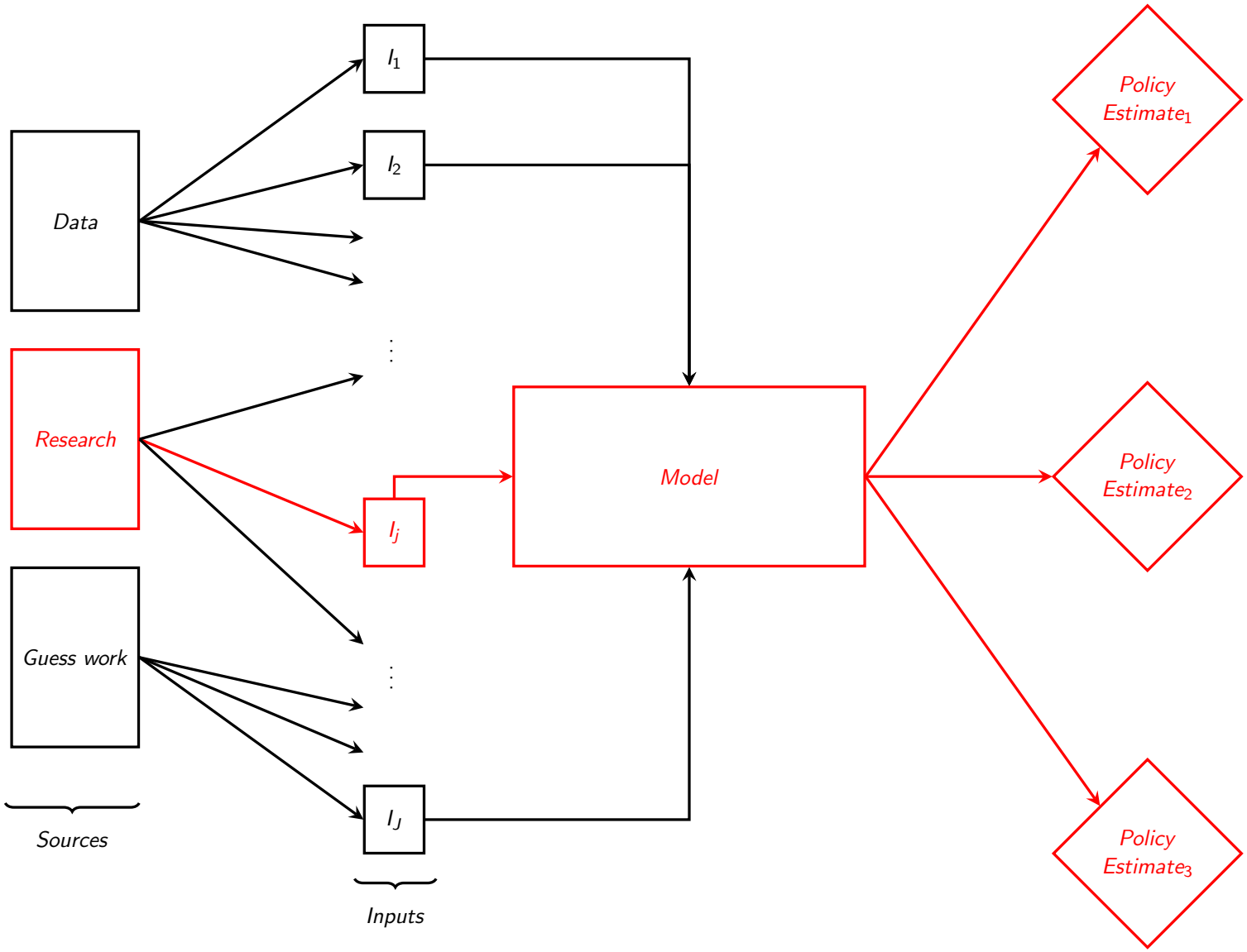
Guidelines Goal: Map the complete policy analysis. Transparent & Reproducible



Guidelines Goal: Map the complete policy analysis. Transparent & Reproducible



Guidelines Goal: Map the complete policy analysis. Transparent & Reproducible



Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

Before: Applying Guidelines to CBO Report

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

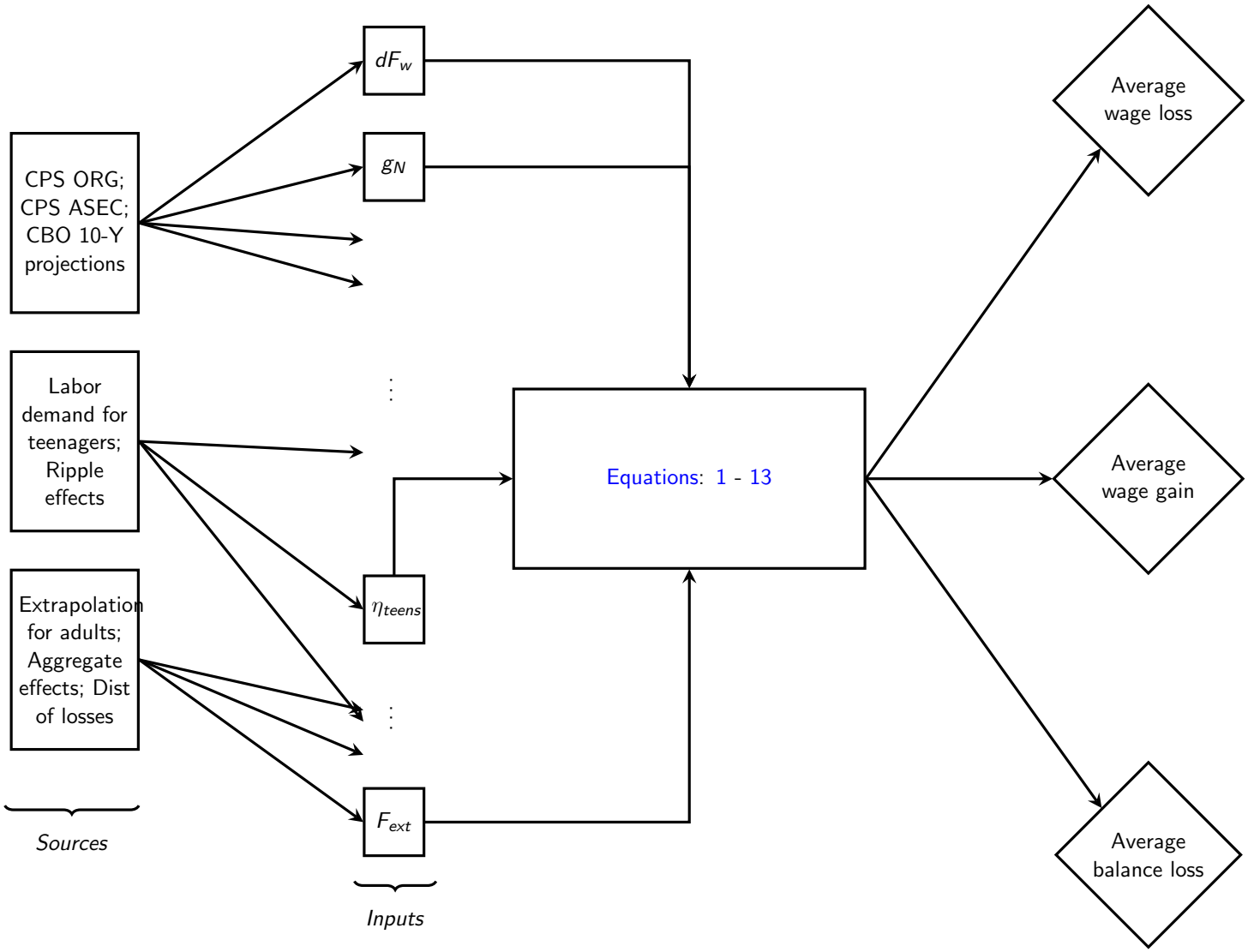
From TOP guidelines [Nosek et al., 2015] v1.0.1

Motivation
Problem
Approach
Results
Discussion

After: Applying Guidelines to Build Dynamic Document

DEMO .

Map the complete policy analysis. Example with Case Study



Clear Display of Policy Estimates: Step 1/3

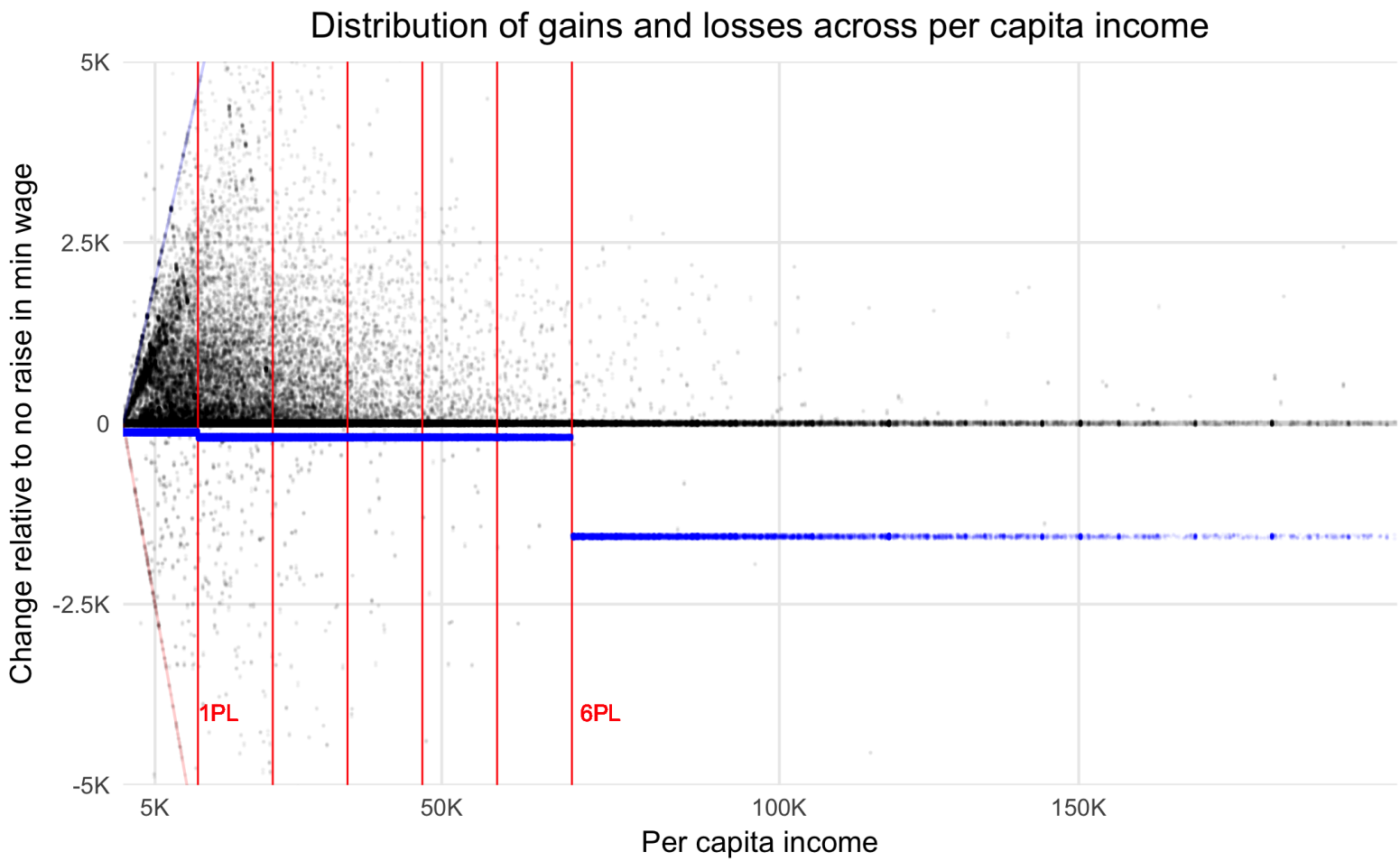


Figure: Gains and losses. Different Units

Clear Display of Policy Estimates: Step 2/3

Motivation
Problem
Approach
Results
Discussion

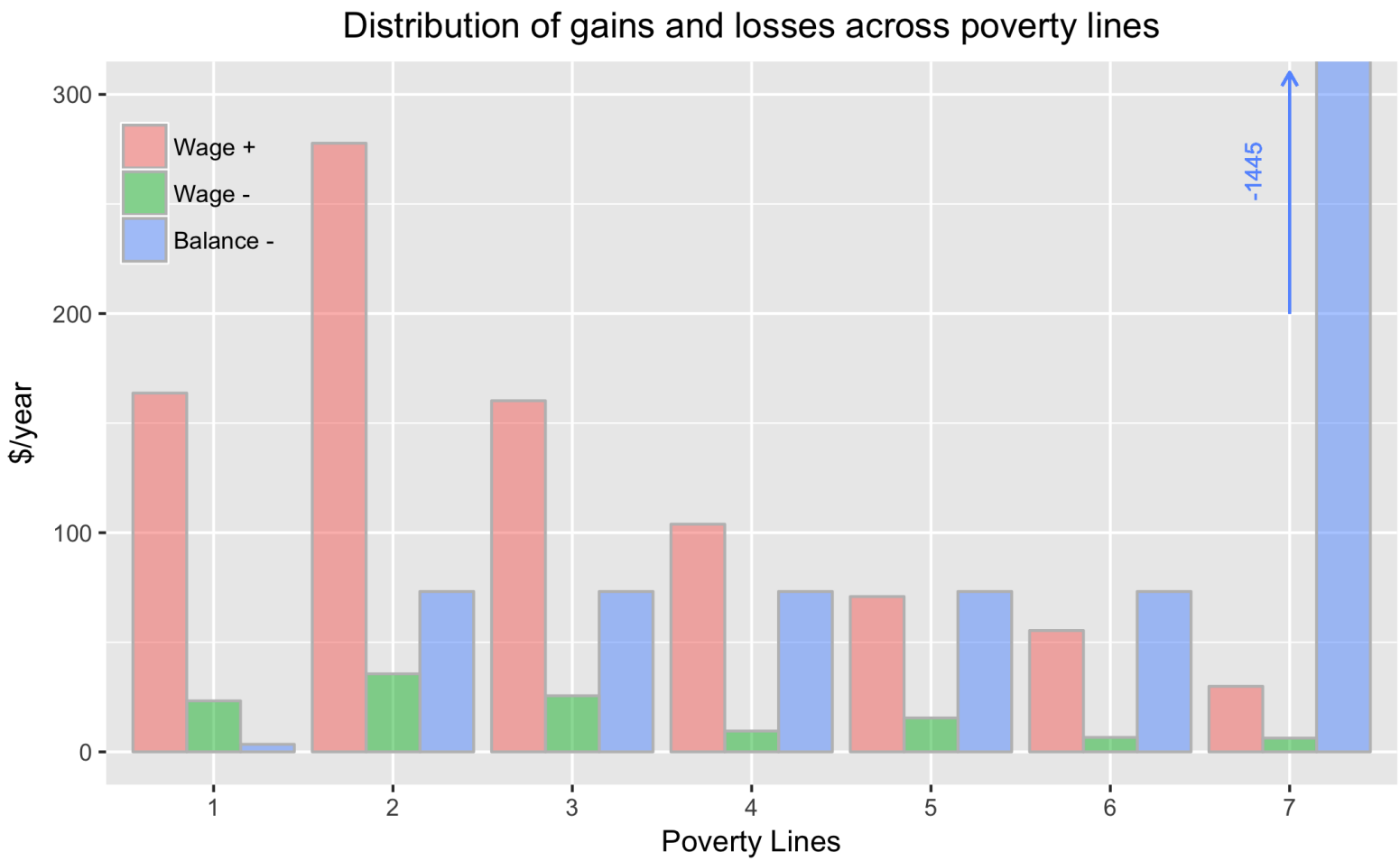


Figure: Gains and losses. Different Denominator

Clear Display of Policy Estimates: Step 3/3

Motivation
Problem
Approach
Results
Discussion

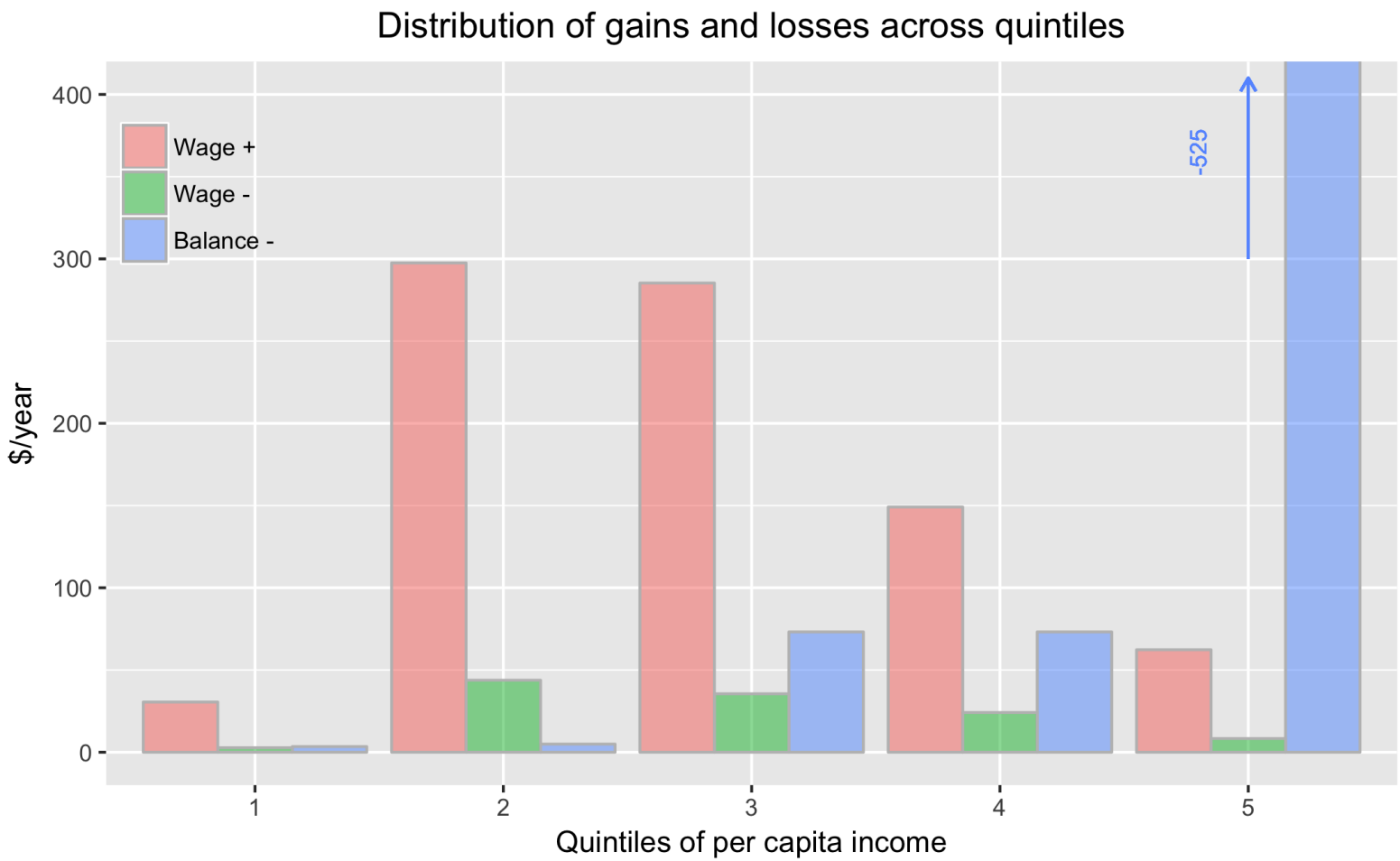


Figure: Gains and losses. Same units and denominator

Sensitivity Analysis: Status Quo

Motivation
Problem
Approach
Results
Discussion

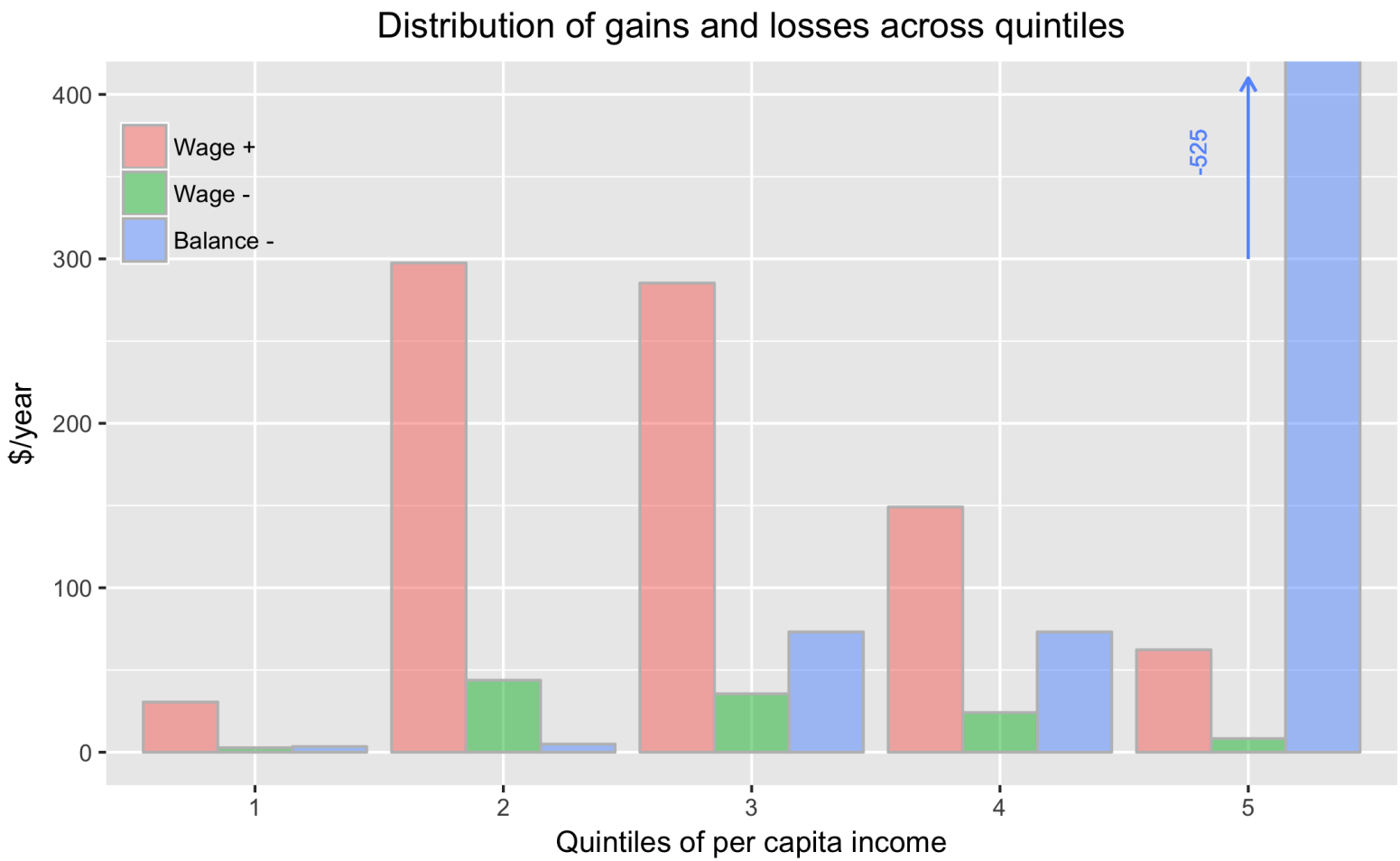


Figure: Default settings

SA: Change in Elasticity of Labor Demand

Motivation
Problem
Approach
Results
Discussion

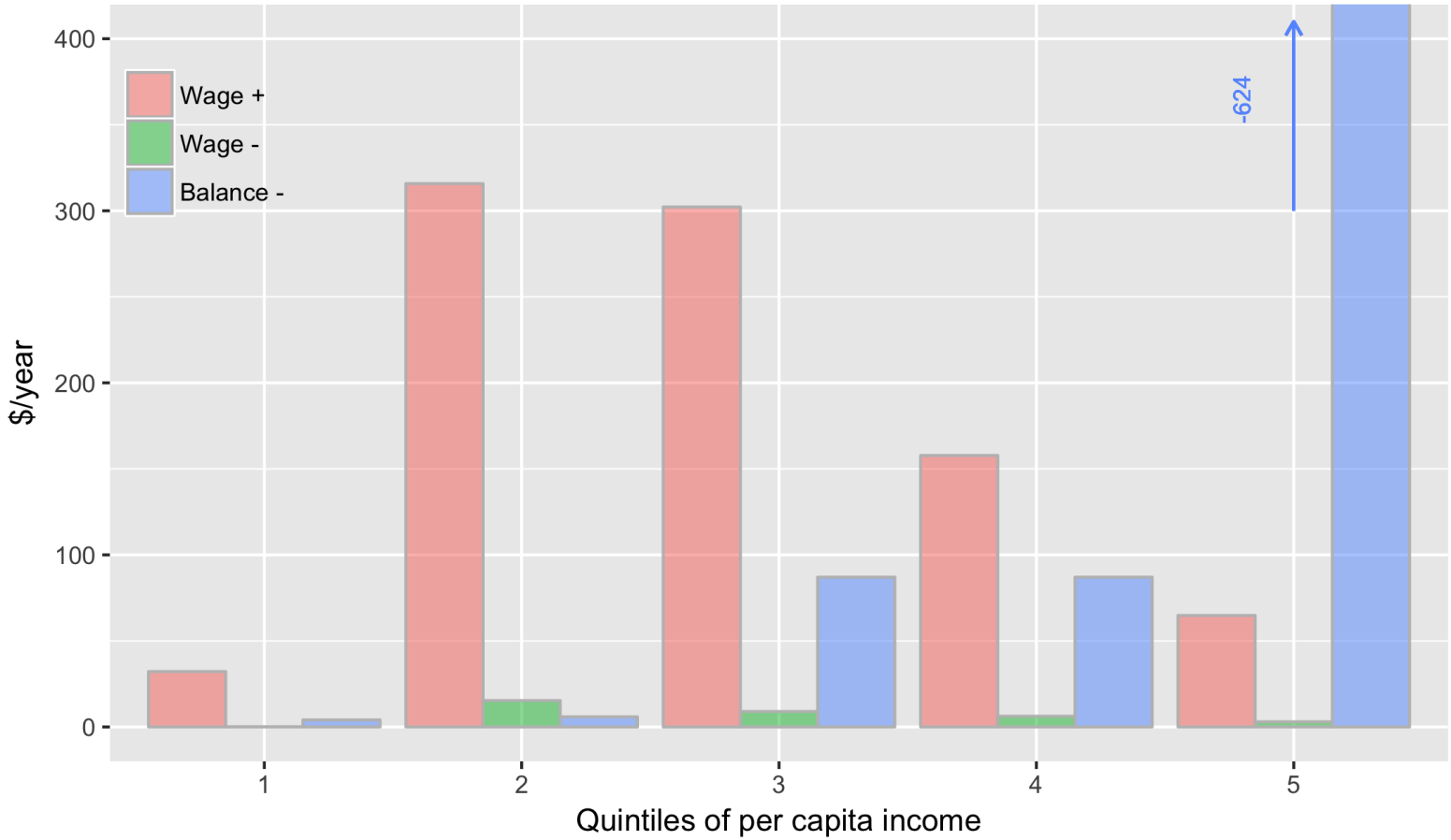


Figure: From $\eta_{lit}^{teens} = -0.1$ to $\eta_{lit}^{teens} = -0.01(\Delta^{-}90\%)$

Sensitivity Analysis: Status Quo

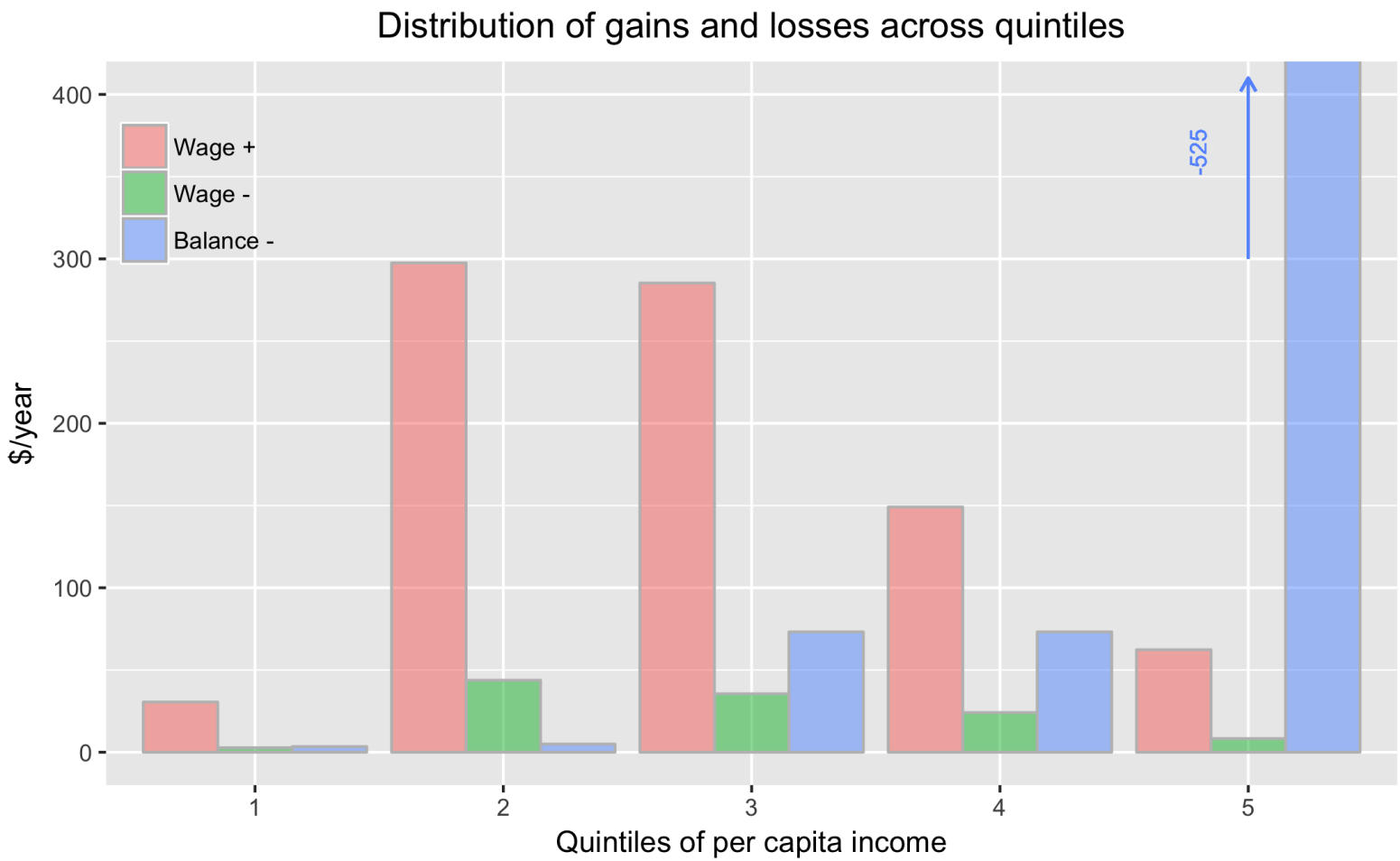


Figure: Default settings

SA: Change in Distribution of Balance Loses

Motivation
Problem
Approach
Results
Discussion

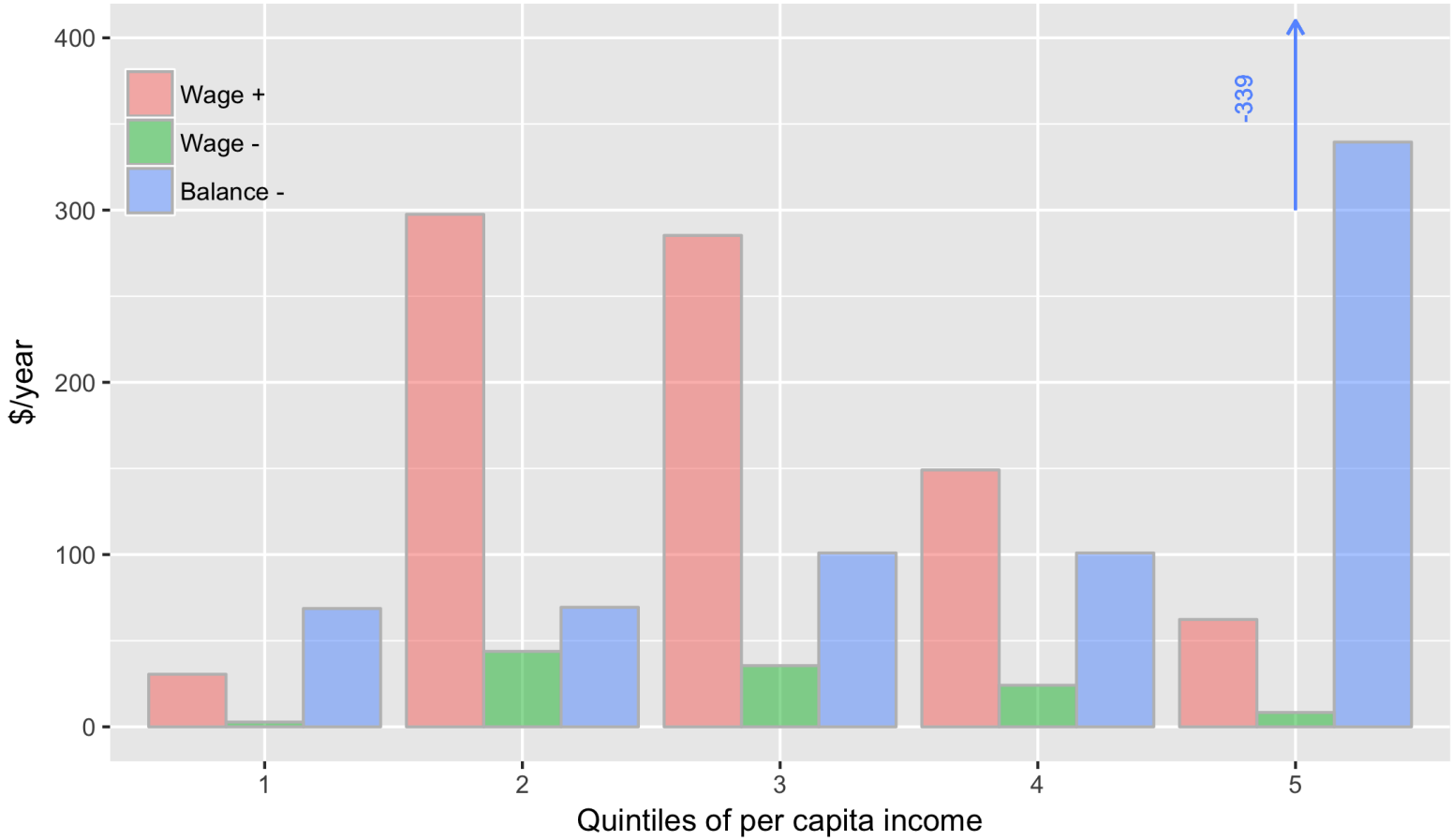


Figure: From $(1PL, 6PL) \sim (1\%, 29\%, 70\%)$ to $(20\%, 40\%, 40\%)$

Comparing the Trade-offs: A Toy Example

Model for the normative comparison made by a policy maker (welfare function):

$$W(\rho) = \sum_{i \in N} (\omega_{wg} wg_i + \omega_{wl} wl_i + \omega_{bl} bl_i)\, \omega_i^d(Q_i, \rho)$$

with:

$$\omega_i^d(Q_i, \rho) = \frac{(1 - \rho(Q_i - Q_{median}))}{\sum_i \omega_i^d(Q_i)} Q_{max} \quad \text{for } \rho \in \left(-\frac{1}{2}, \frac{1}{2}\right)$$

$\rho > 0$ represent positive valuation of progressive redistribution.
$\rho < 0$ represents positive valuation of regressive redistribution (dis-utility from self loss greater than utility from others gain).

Normative Valuations and Redistribiutional Preferences
Toy Example ($\omega_{WG} = \omega_{WL} = \omega_{BL} = 1$)

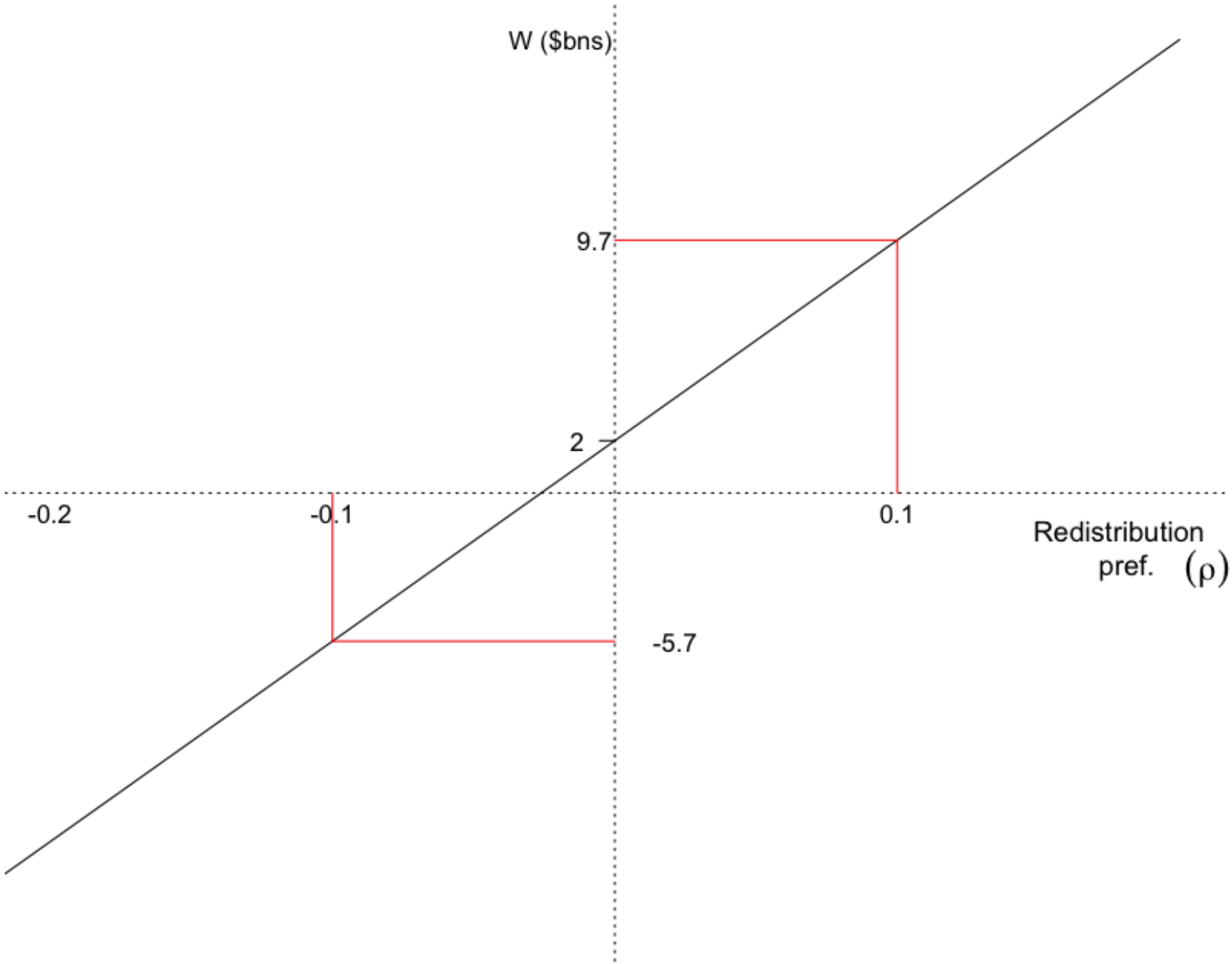
Motivation

Problem

Approach

Results

Discussion



Sensitivity Analysis For Multiple Parameters

Table: $\%\Delta W$ for a $\%\Delta$ in inputs. Two sample policy makers: dislikes ($W(-0.1) = -\$5.3bn$) and likes ($W(0.1) = \$10.1bn$) redistribution

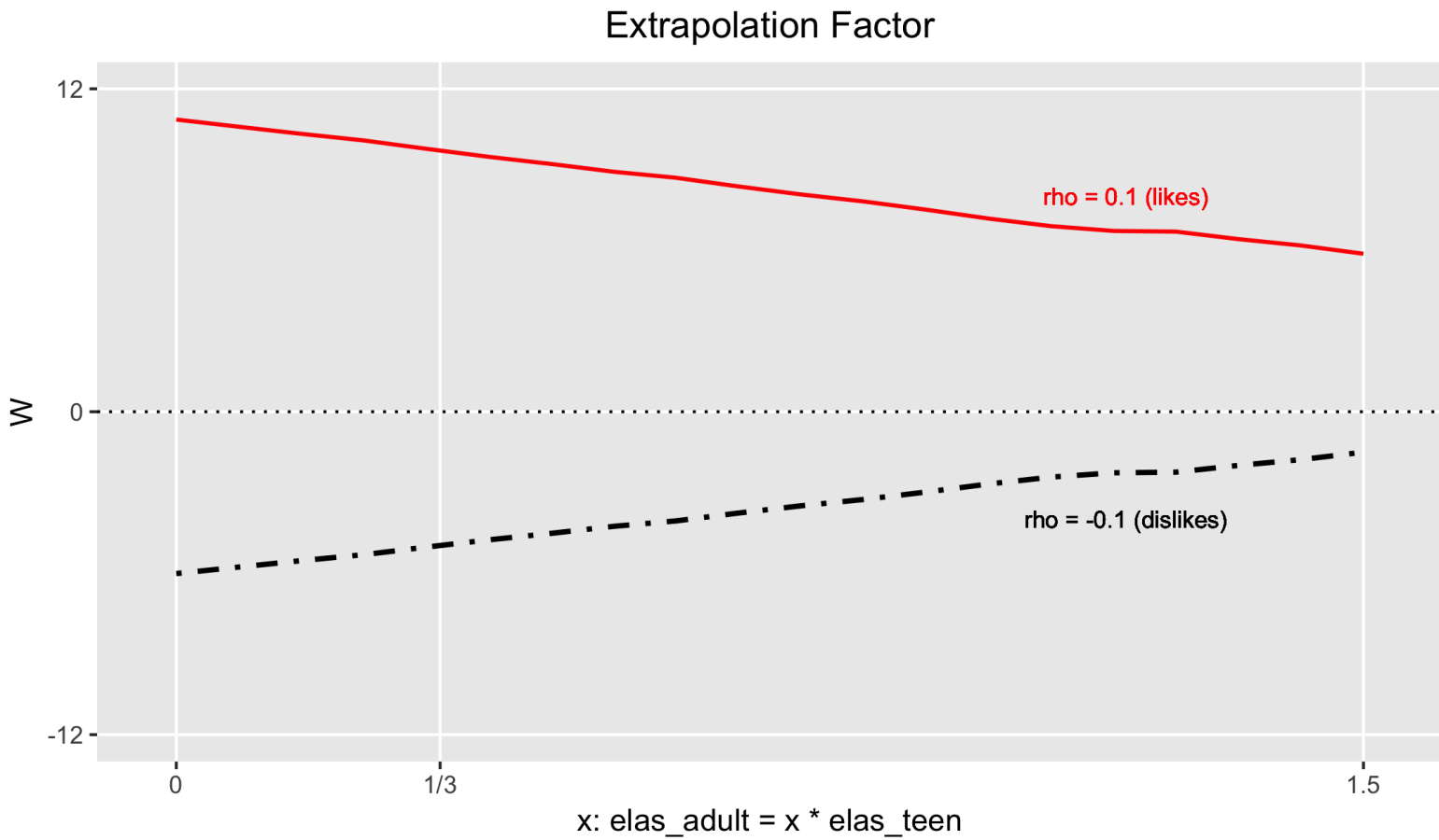
		Re-distributional Preferences			
		Dislikes ($\rho = -0.1$)		Likes ($\rho = 0.1$)	
Source	Input	$10\%\Delta^+$	$10\%\Delta^-$	$10\%\Delta^+$	$10\%\Delta^-$
Data					
	Annual wage growth (g_w)	-3%	2%	-2%	1%
	Annual growth in N	0.8%	-0.9%	0.5%	-0.5%
Research					
	η_{teen}	-4%	4%	-2%	2%
	Ripple Scope $(8.7, 11.5)$	37%	-24%	21%	-14%
	Ripple Intensity ($50\%\Delta w$)	5%	-5%	3%	-3%
Guess Work					
	Extrapolation factor (F_{ex})	-3%	2%	-1%	1%
	Non compliance (α_1)	-7%	7%	-4%	4%
	Substitution factor (F_{sub})		20%		-8%
	Net benefits	-5%	5%	2%	-2%
	Distribution of balance losses				
	Current: $(1\%, 29\%, 70\%)$				
	$(1\%, 4\%, 95\%)$		22%		13%
	$(5\%, 35\%, 60\%)$		-17%		-9%
	$1/N$		-129%		-73%

Welfare Effects: Elasticity of Labor Demand

$$W(\eta(F_{ext}, F_{adj}, \eta_{lit}))$$

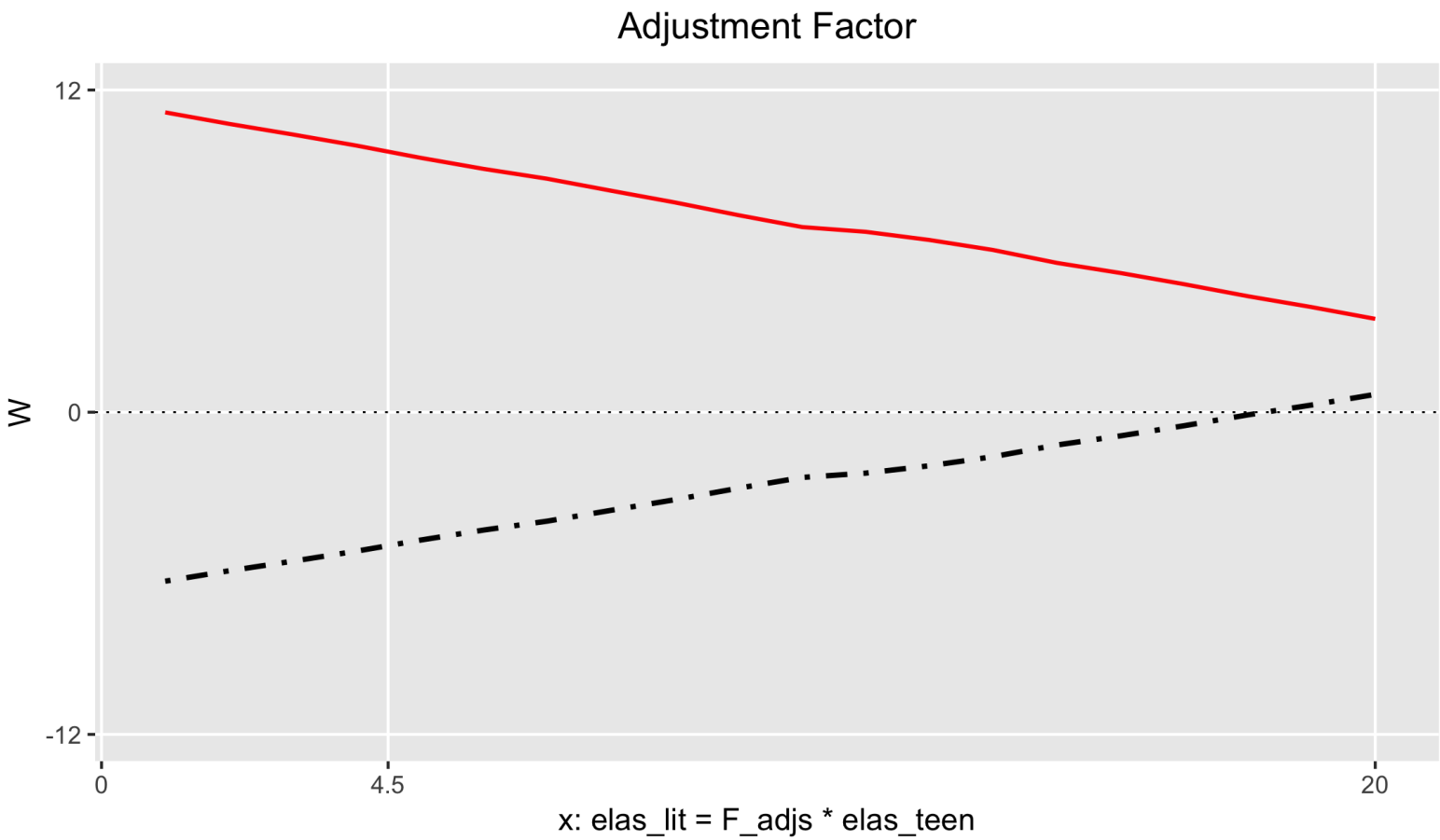
Welfare Effects: Elasticity of Labor Demand

$$W(\eta(F_{ext}, F_{adj}, \eta_{lit}))$$



Welfare Effects: Elasticity of Labor Demand

$$W(\eta(\ F_{ext}\ ,\ F_{adj}\ ,\ \eta_{lit}\ ))$$

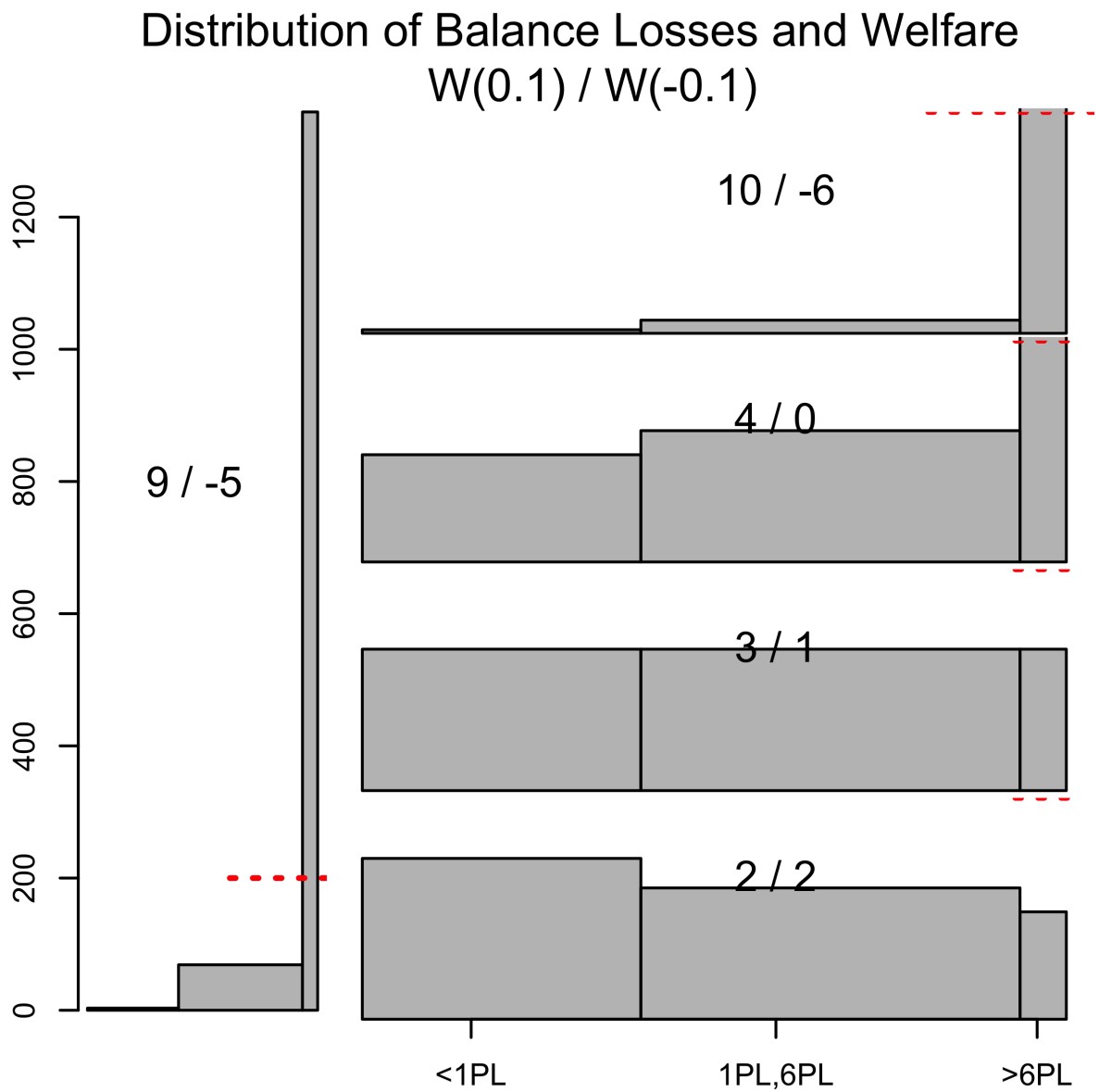


Motivation
Problem
Approach
Results
Discussion

Welfare Effects: Elasticity of Labor Demand

$$W(\eta(\, F_{ext}\, ,\, F_{adj}\, ,\, \eta_{lit}\,))$$

Much More Policy Relevant To Lear Who Pays For Wage Raise



Discussion

- Let's assume this becomes the new status quo.
  - Costs of producing the next report on effects of min wage will be very small.
  - Every additional effort will imply improvements on the "state of the art" report (e. g. *dBL*; $\eta(MW), \alpha_1(MW)$)
  - Learning about one parameter (QALYs, DWL) will update estimates *across* reports.
  - Much easier to have a substantive and normative policy debate (next step:`Shiny App!`)
- Who should work on this:
  - Analytic reviewers of report; Research division within agencies; Study Commissions ("MWSC or MSWC?" [Card and Krueger, 2016])
  - Public policy schools.
  - Think tanks; Bank of knowledge [Clemens and Kremer, 2016].

Discussion

- Let's assume this becomes the new status quo.
  - Costs of producing the next report on effects of min wage will be very small.
  - Every additional effort will imply improvements on the "state of the art" report (e. g. *dBL*; $\eta(MW), \alpha_1(MW)$)
  - Learning about one parameter (QALYs, DWL) will update estimates *across* reports.
  - Much easier to have a substantive and normative policy debate (next step:`Shiny App!`)
- Who should work on this:
  - Analytic reviewers of report; Research division within agencies; Study Commissions ("MWSC or MSWC?" [Card and Krueger, 2016])
  - Public policy schools.
  - Think tanks; Bank of knowledge [Clemens and Kremer, 2016].

Motivation
Problem
Approach
Results
Discussion

Thank you.

https://fhoces.github.io

Back-up slides

Pierre Azoulay, Christian Fons-Rosen, and Joshua S Graff Zivin. Does science advance one funeral at a time? Technical report, National Bureau of Economic Research, 2015.

Charles Brown. Minimum wages, employment, and the distribution of income. *Handbook of labor economics*, 3: 2101–2163, 1999.

David Card and Alan Krueger. Interview with card and krueger. http://davidcard.berkeley.edu/interviews/interview%20with%20Card%20and%20Krueger.pdf, April 2016. (Accessed on 10/26/2016).

Michael A Clemens and Michael Kremer. The new role for the world bank. *The Journal of Economic Perspectives*, 30(1): 53–76, 2016.

Daniel R Feenberg, Ina Ganguli, Patrick Gaule, and Jonathan Gruber. It's good to be first: Order bias in reading and citing nber working papers. Technical report, National Bureau of Economic Research, 2015.

Charles F Manski. *Public policy in an uncertain world: analysis and decisions*. Harvard University Press, 2013.

Sendhil Mullainathan and Eldar Shafir. *Scarcity: Why having too little means so much*. Macmillan, 2013.

David Neumark and William L Wascher. *Minimum wages*. MIT Press, 2008.

BA Nosek, G Alter, GC Banks, D Borsboom, SD Bowman, SJ Breckler, S Buck, CD Chambers, G Chin, G Christensen, et al. Promoting an open research culture: Author guidelines for journals could help to promote transparency, openness, and reproducibility. *Science (New York, NY)*, 348(6242): 1422, 2015.

Sandra M Nutley, Isabel Walter, and Huw TO Davies. *Using evidence: How research can inform public services*. Policy press, 2007.

Snapshots of DD.

https://rpubs.com/fhoces/dd_cbo_test1

1 Introduction
2 Employment effects
2.1 Data, wages, and forecast
2.2 Get the N
2.3 Get the $\eta \times \Delta w$
2.4 Other factors
2.5 Computing effects on employment
3 Distributional effects
3.1 Computing Family income
3.2 Imputing policy effects
3.3 Computing family income under status quo and minimum wage increase
3.4 Other considerations
4 Results

Reader Companion for CBO report on Min Wage (Preliminary Version. Do Not Circulate)

Fernando Hoces de la Guardia + (hopefully) a lot more people

Last edit: 2016-10-16

1 Introduction

The role of policy analysis is to connect research with policy. Because of heavy time constrains, policy analyses are typically ambiguous regarding the details of how the analysis was carried out. This creates three problems: (i) its hard to understand the connection between research and policy, (ii) allows policy makers to cherry pick policy reports, and (iii) hinders systematic improvement and/or automation of parts of the analysis. In this document we demonstrate the use of a reproducible workflow to reduce the ambiguity in policy analysis.

Here we attempt to contribute to the policy discussion of the minimum wage. The minimum wage is a contentious policy issue in the US. Increasing it has positive and negative effects that different policymakers value differently. We aim to add clarity on what those effects are, how much do we know about them, and how those effects vary when elements of the analysis change. We select the most up-to-date, non-partisan, policy analysis of the effects of raising the minimum wage, and build an open-source reproducible analysis on top of it.

In 2014 the Congressional Budget Office published the report titled "The Effects of a Minimum-Wage Increase on Employment and Family Income". The report receive wide attention from key stakeholders and has been used extensible as an input in the debate around the minimum wage[1]. To this date we consider the CBO report to be the best non-partisan estimation of the effects of raising the minimum wage at the federal level. Although there was disagreement among experts around some technical issues, this disagreement has been mainly circumscribed around one of the many inputs used in the analysis, and we can fit the opposing positions in to our framework.

Our purposes are twofold: First, promote the technical discussion around a recurrent policy issue (minimum wage) by making explicit and visible all the components and key assumptions of its most up-to-date official policy analysis. Second, demonstrate how new scientific practices of transparency and reproducibility (T & R) can be applied to policy analysis. We encourage the reader to collaborate in this document and help develop an ever-improving version of the important policy estimates[2] (re)produced here.

Snapshots of DD.

Refe

Appe

Emp

Wag

Inco

1 Introduction

2 Employment effects

2.1 Data, wages, and forecast

2.2 Get the N

2.3 Get the $\eta \times \Delta w$

2.4 Other factors

2.5 Computing effects on employment

3 Distributional effects

3.1 Computing Family income

3.2 Imputing policy effects

3.3 Computing family income under status quo and minimum wage increase

3.4 Other considerations

4 Results

2 Employment effects

At a general level the effects on employment ($\widehat{\Delta E}$) will be calculated using a more detailed version of the following equation:

$$\widehat{\Delta E} = N \times \eta \times \%\Delta w + \text{Other factors}$$

Where N represents the relevant population, η the elasticity of labor demand, Δw the relevant percentual variation in wages, and the *Other factors* will encapsulate effects on employment through an increase in the aggregate demand.

To describe the methodology behind each of those four components we first describe the data used, the wage variable choose, and the procedure used to forecast the wage and population distribution of 2016 using data from 2013.

2.1 Data, wages, and forecast

To simulate the policy effects we need the distribution of wages and employment under the status quo. From the perspective of 2013, this implies forecasting to 2016 data on employment and wages.

2.1.1 Data

The Current Population Survey (CPS) was used to compute the effects on employment. From the analysis in the section on distributional effects we can deduce that the data corresponds to the Outgoing Rotation Group (ORG). CPS is a monthly cross sectional survey. The same individual is interviewed eight times over a period of 12 months. The interviews take place in the first and last 4 months of that period. By the 4th and 12th interview, individuals are asked detailed information on earnings. The CPS ORG file contains the information on this interviews for a given year. We analyze the data for 2013.

Currently three versions of these data sets can be found online: CPS raw files, ORG NBER and ORG CEPR. The analysis will be performed using the CPER ORG data base.

The weights used in our analysis will be `orgwgt/12`

2.1.1.1 Code to load the data

`R`
`Stata`

Snapshots of DD.

2 Employment effects

2.1 Data, wages, and forecast

2.2 Get the N

2.3 Get the $\eta \times \Delta w$

2.4 Other factors

2.5 Computing effects on employment

3 Distributional effects

3.1 Computing Family income

3.2 Imputing policy effects

3.3 Computing family income under status quo and minimum wage increase

3.4 Other considerations

4 Results

performed using the CPER ORG data base.

The weights used in our analysis will be `orgwgt/12`

2.1.1.1 Code to load the data

R

```
call.cps.org.data <- function(){
  data_use <- "CPER_ORG"

  # Using CEPR ORG data
  if (data_use == "CPER_ORG") {
  # Checking if working directory contains data, download if not.
    if ( !("cepr_org_2013.dta" %in% dir()) ) {
        # create name of file to store data
        tf <- "cepr_org_2013.zip"

        # download the CPS repwgts zipped file to the local computer
        download.file(url =  "http://ceprdata.org/wp-content/cps/data/cepr_org_2013.zip", tf , mode
= "wb" )

        # unzip the file's contents and store the file name within the temporary directory
        fn <- unzip( zipfile = tf , overwrite = T )
    }
    df <- read.dta("cepr_org_2013.dta")
  }

  # Using NBER ORG data
  if (data_use == "NBER_ORG") {
    # Checking if working directory contains data, download if not.
    if ( !("morg13.dta" %in% dir()) ) {
      # Downloading data 53mb
      df <- read.dta("http://www.nber.org/morg/annual/morg13.dta")
    }
    df <- read.dta("morg13.dta")
```

Snapshots of DD.

References

Appendix
Employment
Wages
Income

es, and

× Δw
:ors
g effects on
l effects
g Family
policy effects
g family
tus quo and
ncrease
siderations

2.5 Computing effects on employment

Putting all elements together we get:

$$\widehat{\Delta E} = \sum_{g \in \{A,T\}} \left(\widehat{N_g^{final}} \times \widehat{\eta^g_{w \leq MW}} \times \overline{\%\Delta w^g} \right) - \widehat{OF}$$

2.5.1 Code to compute each component

`R`
`Stata`

Components of Elasticities

	Adult	Teen
η_{lit}	-0.03	-0.10
$\eta_{w \leq MW'}$	-0.23	-0.13
F_{adj}	4.50	4.50
$\overline{\%\Delta w}$	13.81	16.65
$\widehat{\eta_{w \leq MW}}$	-0.15	-0.45

Using all the components described above we get $\widehat{\Delta E}$ = -478 thousand jobs. The report however computes F^g_{adjs} in a different fashion and gets a value of 4.5 (when computing the values of F^g_{adjs} from the table below - as oppose to using historical values - we get $\widehat{\Delta E}$ = -321 thousand jobs).

3 Distributional effects

In the first step towards obtaining the policy estimates presented in the introduction we concluded with

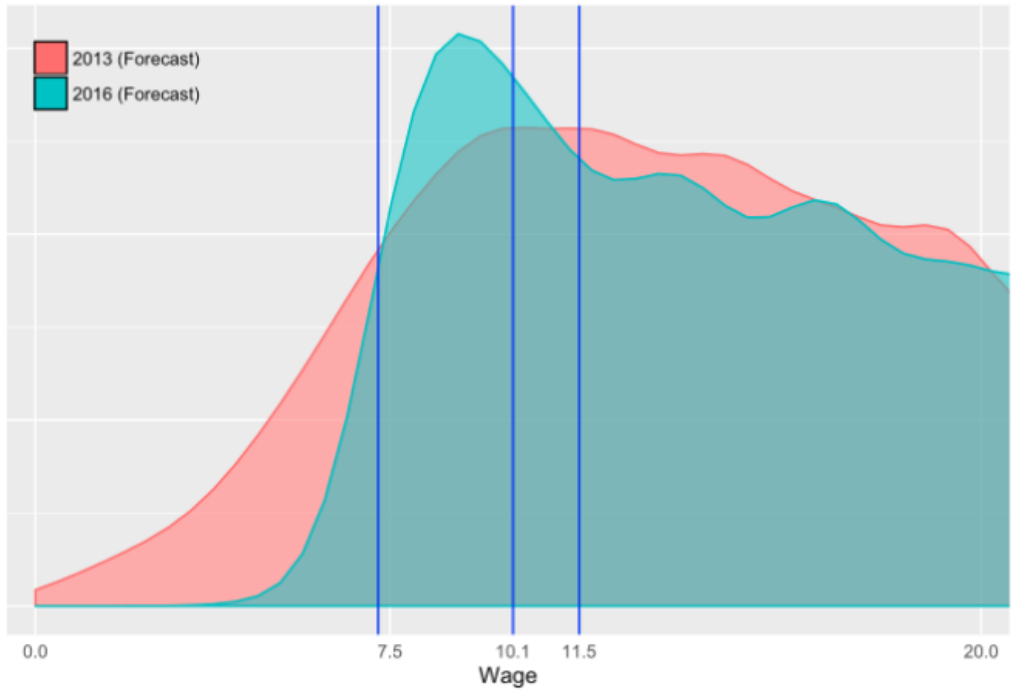
References

Appendix
Employment
Wages
Income

Snapshots of DD.

R
Stata

Figure 4: Distribution of wages in 2013 and 2016(forecast)



Comparison of 2013 and 2016 under the status quo

	2013	2016: status quo
Salary workers	122,593,557	129,545,571
Median wage	17.79	20.56

Snapshots of DD.

Final replication output (nothing in the "learn more" button yet)

Policy estimates in CBO report and Replication Results

	Effects/Policy Estimates	Replication
wage gains (billions of $)	31	53.4
wage losses (bns of $)	~5	7.4
Balance losses (bns of $)	~24	43.9
Net effect (bns of $)	2	2
# of Wage gainers (millions)	16.5	23.1/16.9
#of Wage losers (millions)	0.5	0.5

	<1PL	[1PL, 3PL)	[3PL, 6PL)	>6PL
Balance losses (bns of $)	~0.3	~3.4	~3.4	~17
Net effect (bns of $)	5	12	2	-17
Replication loses	-0.4	-6.4	-6.4	-30.8
Replication NE	17.6	14.6	-0.1	-30.1

Learn more

References

Appendix
Employment
Wages
Income

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Before: Applying Guidelines to CBO Report

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Hinders automation and/or systematic improvements of reports

- Large effort (Res. & PA) to quantify the effects of policies. Effort tends to end with the publication (of paper or report).
- Policy estimates are insensitive to variations in key parameters after publication (interest rate, important prices, cost of technology, etc.).
- We are learning that even the best of analysts, with negligible time constraints, have important biases in their work [Azoulay et al., 2015, Feenberg et al., 2015, Mullainathan and Shafir, 2013].

References

Appendix
Employment
Wages
Income

Hinders automation and/or systematic improvements of reports

- Large effort (Res. & PA) to quantify the effects of policies. Effort tends to end with the publication (of paper or report).
- Policy estimates are insensitive to variations in key parameters after publication (interest rate, important prices, cost of technology, etc.).
- We are learning that even the best of analysts, with negligible time constraints, have important biases in their work [Azoulay et al., 2015, Feenberg et al., 2015, Mullainathan and Shafir, 2013].

Hinders automation and/or systematic improvements of reports

- Large effort (Res. & PA) to quantify the effects of policies. Effort tends to end with the publication (of paper or report).
- Policy estimates are insensitive to variations in key parameters after publication (interest rate, important prices, cost of technology, etc.).
- We are learning that even the best of analysts, with negligible time constraints, have important biases in their work [Azoulay et al., 2015, Feenberg et al., 2015, Mullainathan and Shafir, 2013].

Policy Makers Can Cherry Pick Facts

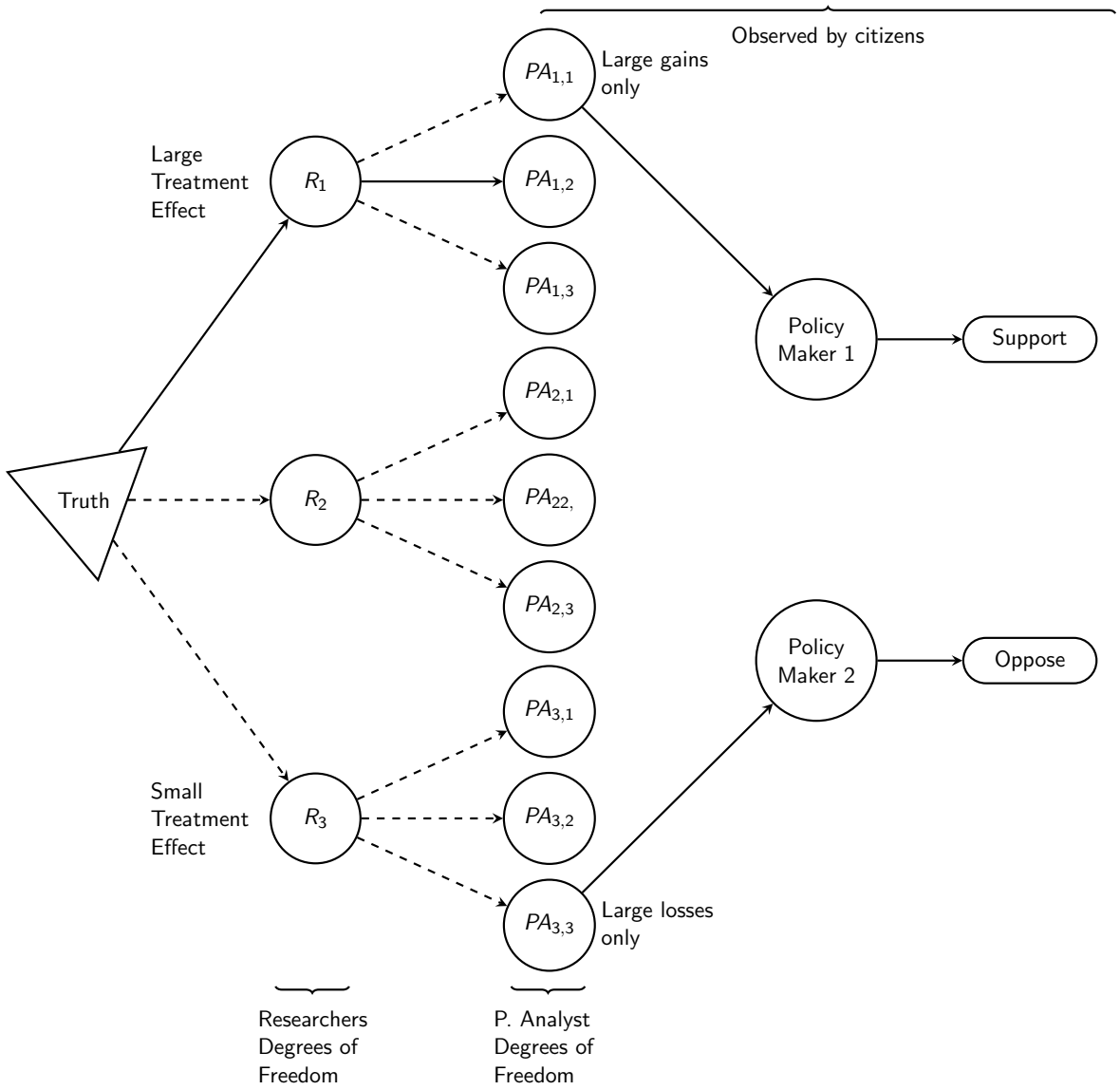
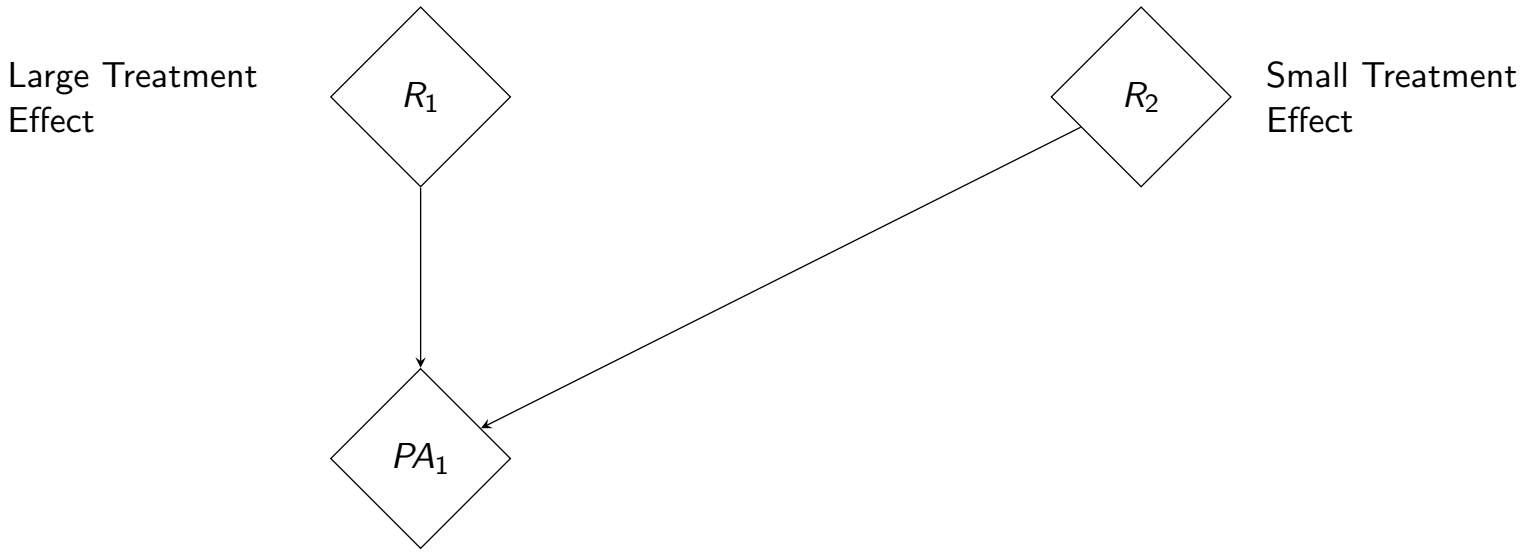


Figure: Policy-making with low TR in research and policy analysis

Threatens the credibility of the policy estimates

References

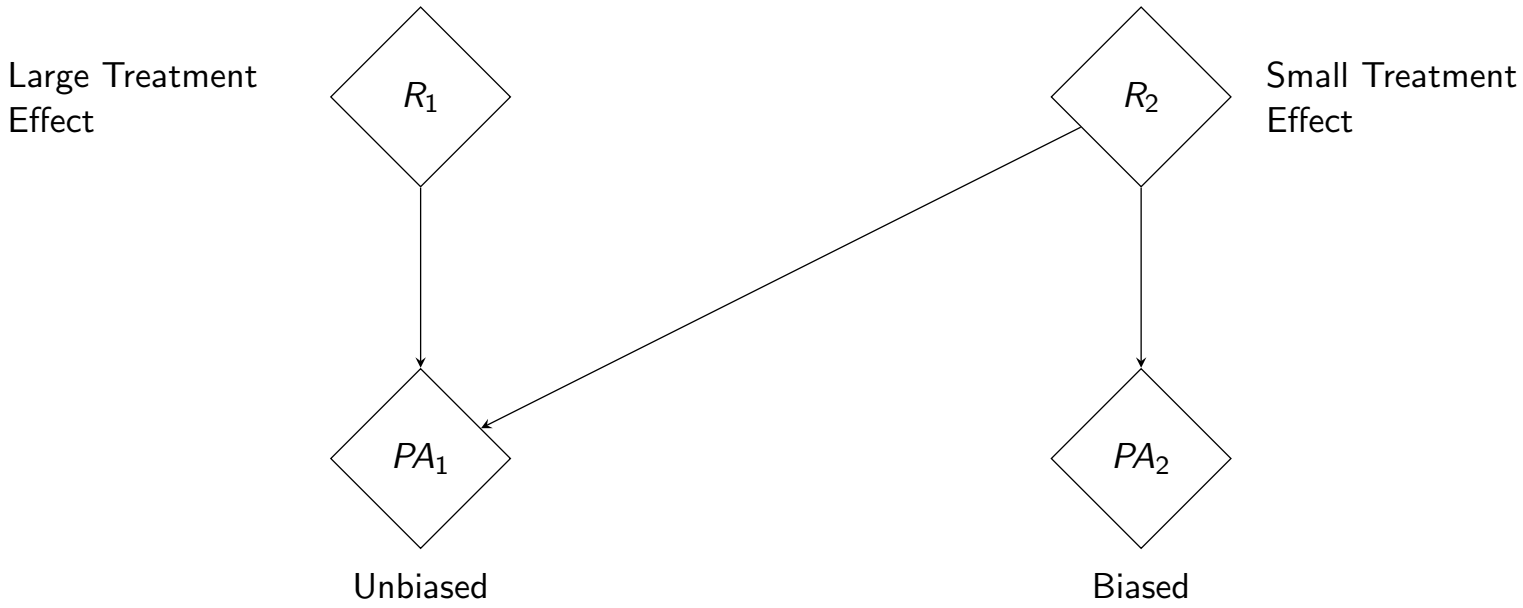
Appendix
Employment
Wages
Income



Threatens the credibility of the policy estimates

References

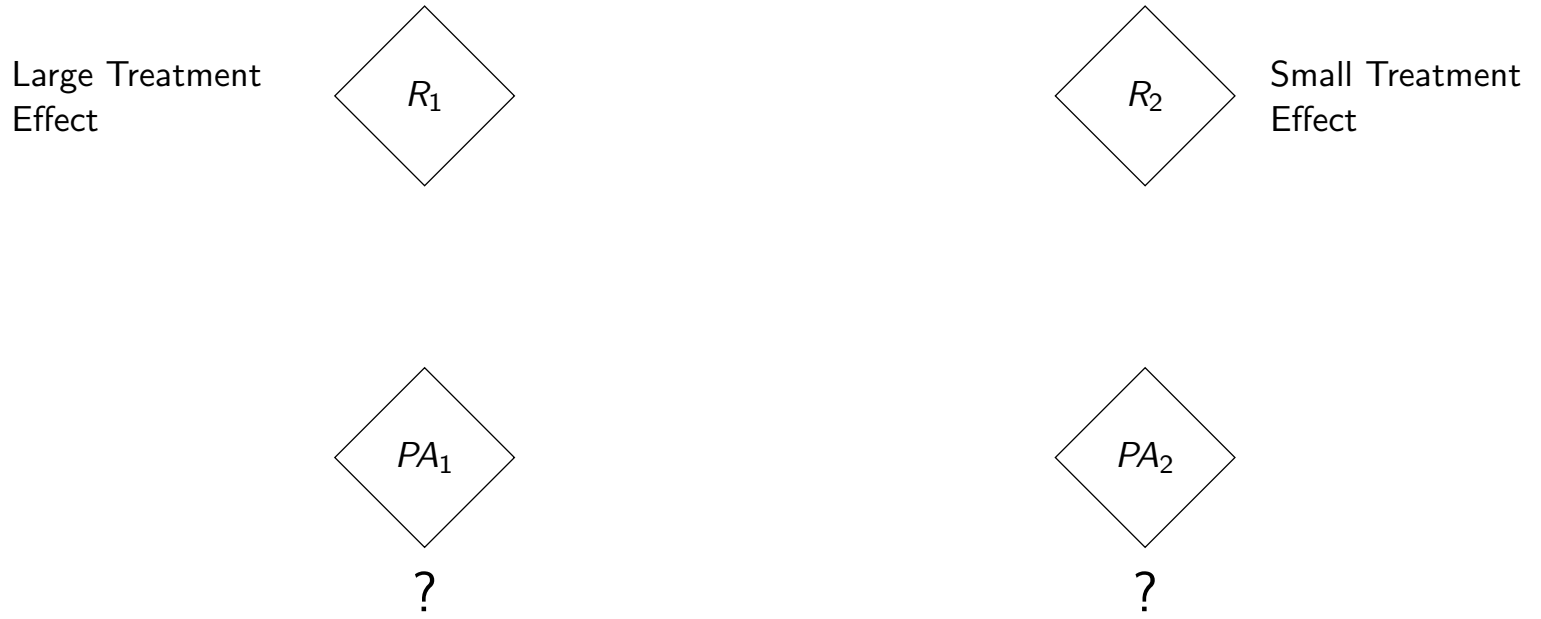
Appendix
Employment
Wages
Income



Threatens the credibility of the policy estimates

References

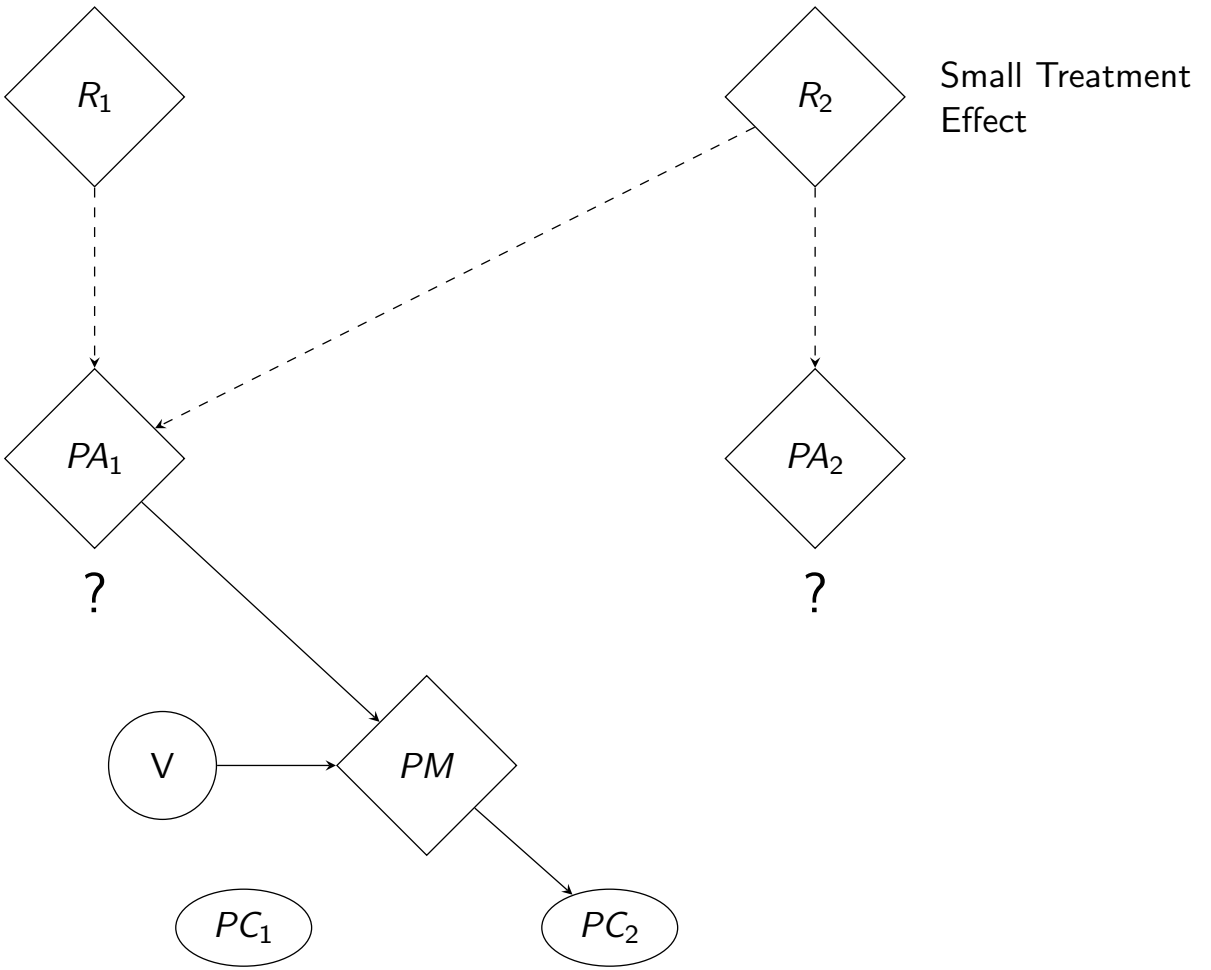
Appendix
Employment
Wages
Income



Threatens the credibility of the policy estimates

References

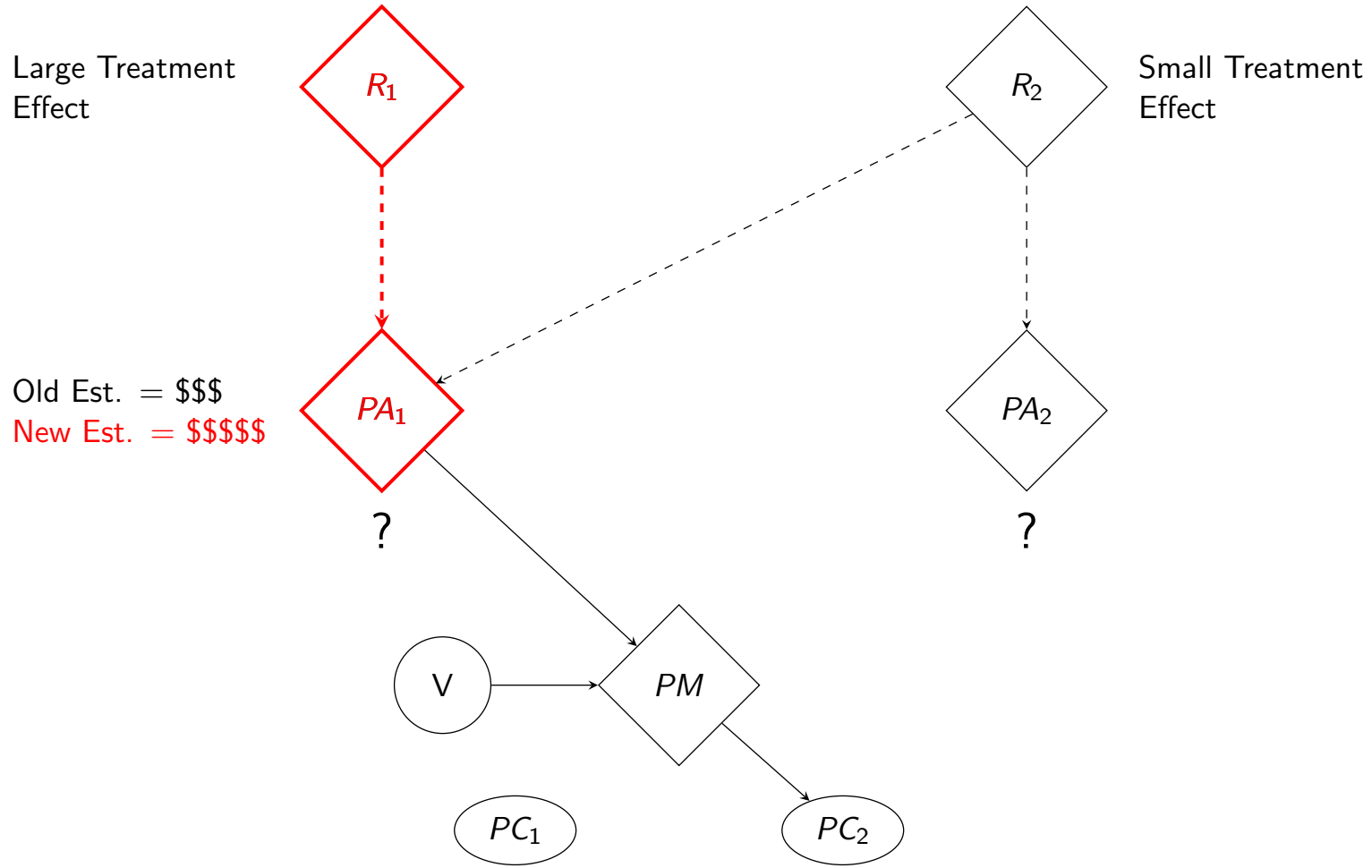
Appendix
Employment
Wages
Income



References
Appendix
Employment
Wages
Income

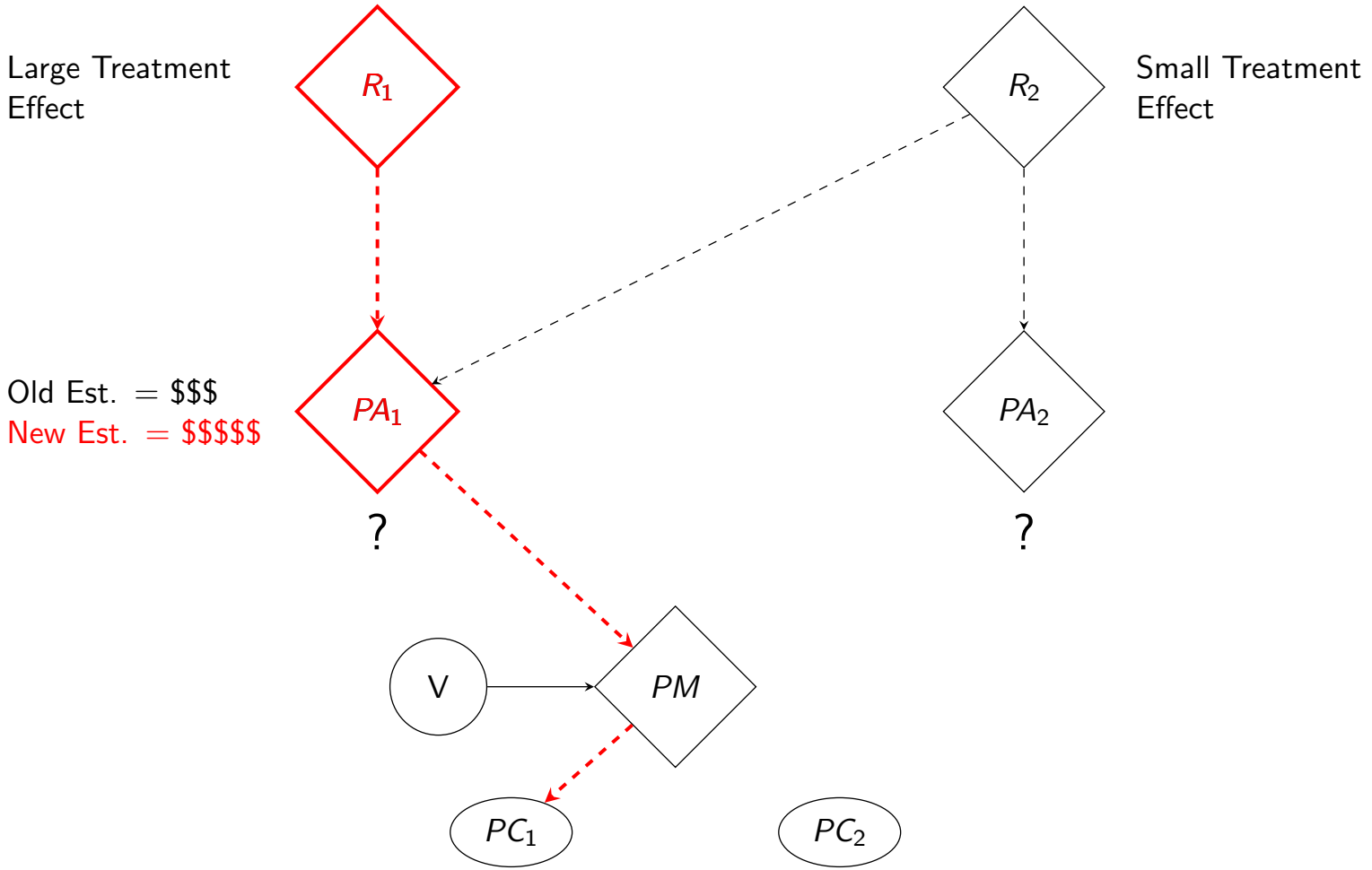
Threatens the credibility of the policy estimates

"When the facts change, _____. What do you do Sir/Madam?"



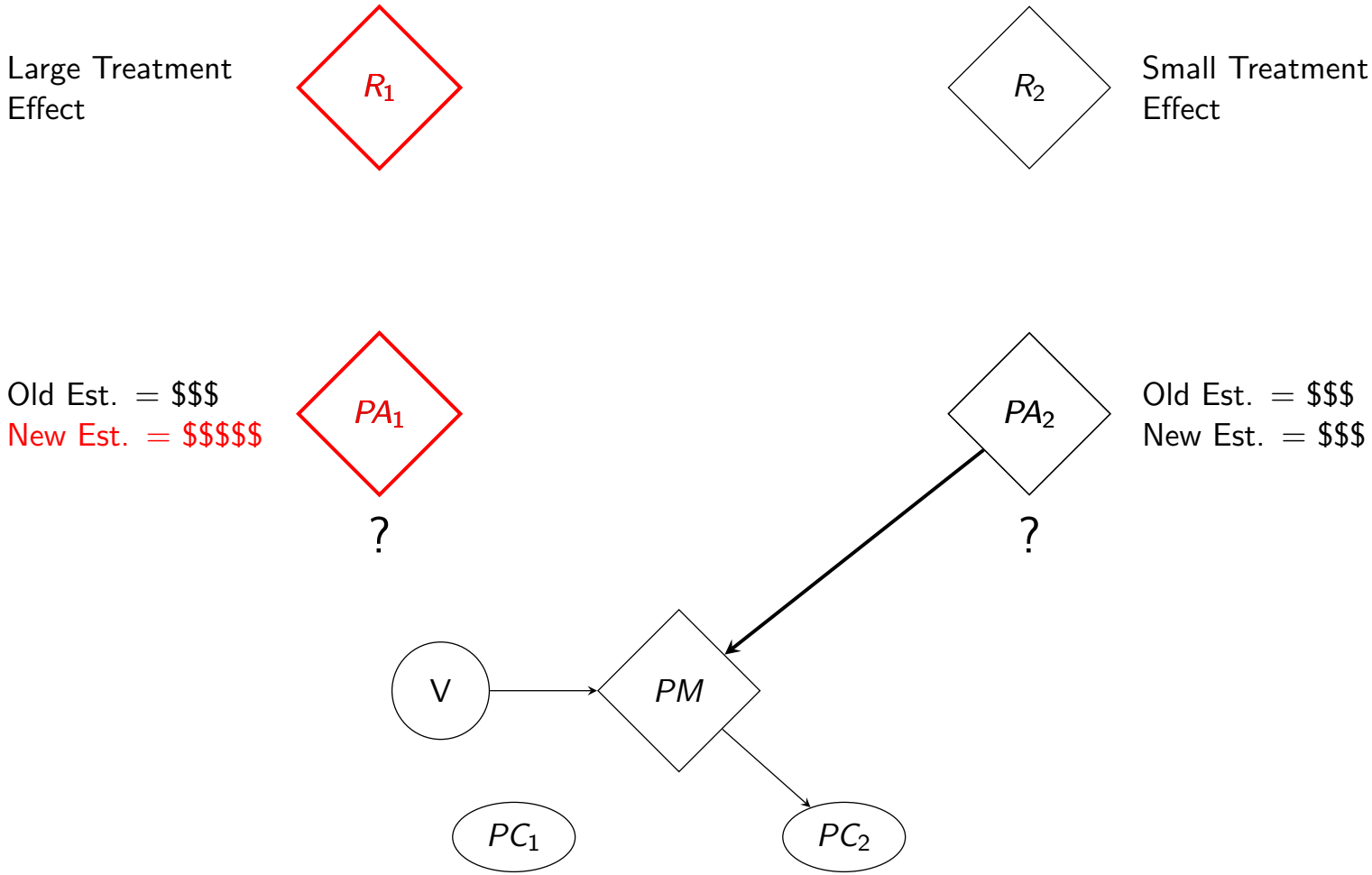
Threatens the credibility of the policy estimates

"When the facts change, I change my mind. What do you do Sir/Madam?" [J.M. Keynes]



Threatens the credibility of the policy estimates

"When the facts change, **I change my facts!**. What do you do Sir/Madam?" [?]



References

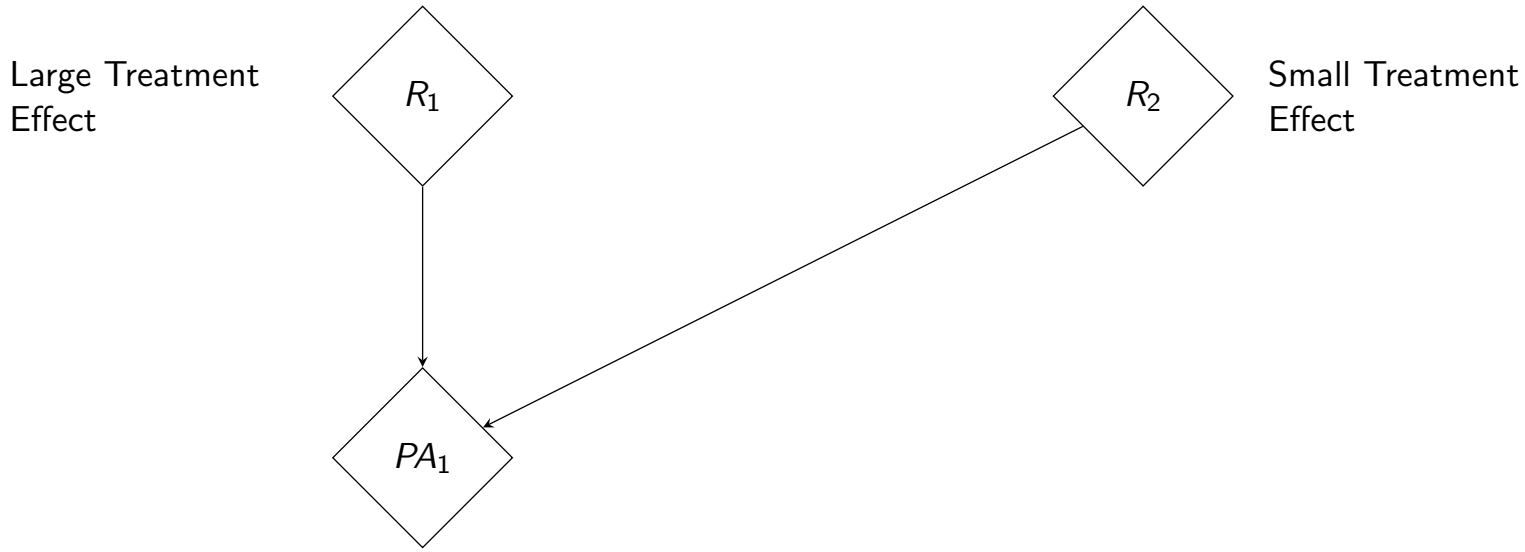
Appendix
Employment
Wages
Income

Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.



References

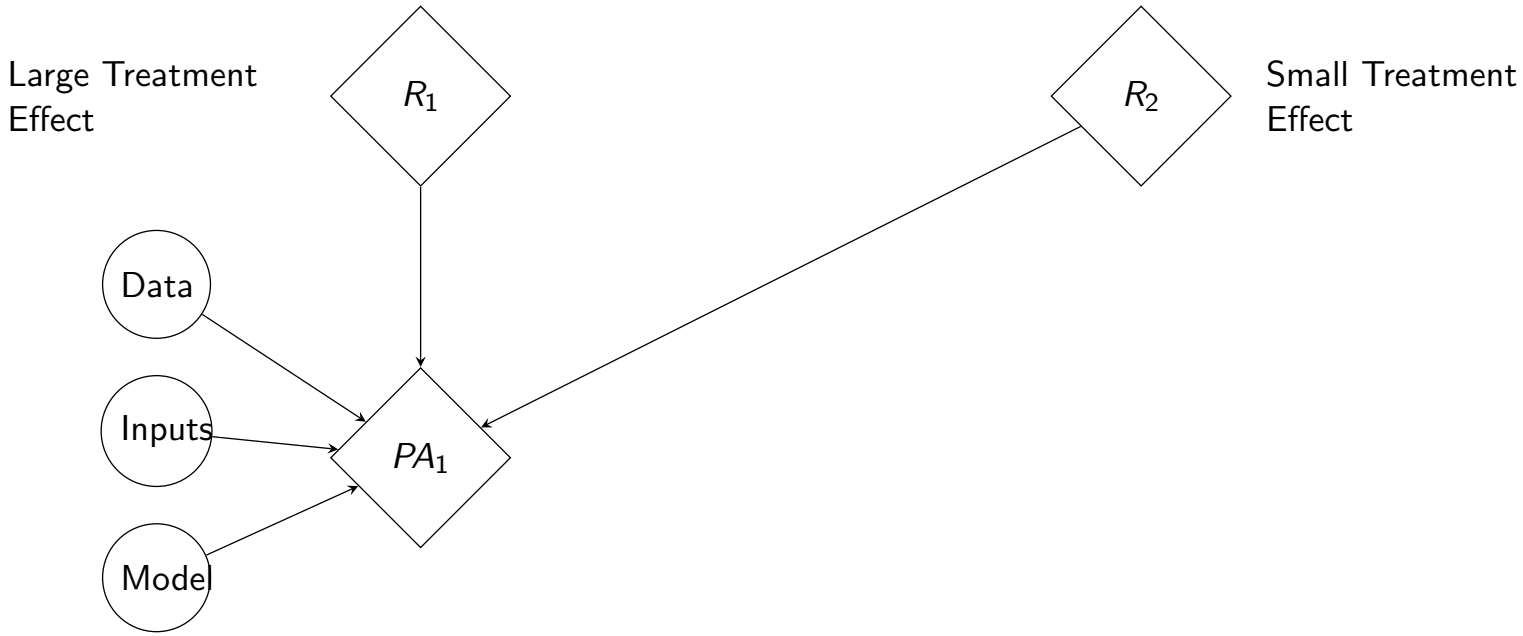
Appendix
Employment
Wages
Income

Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.

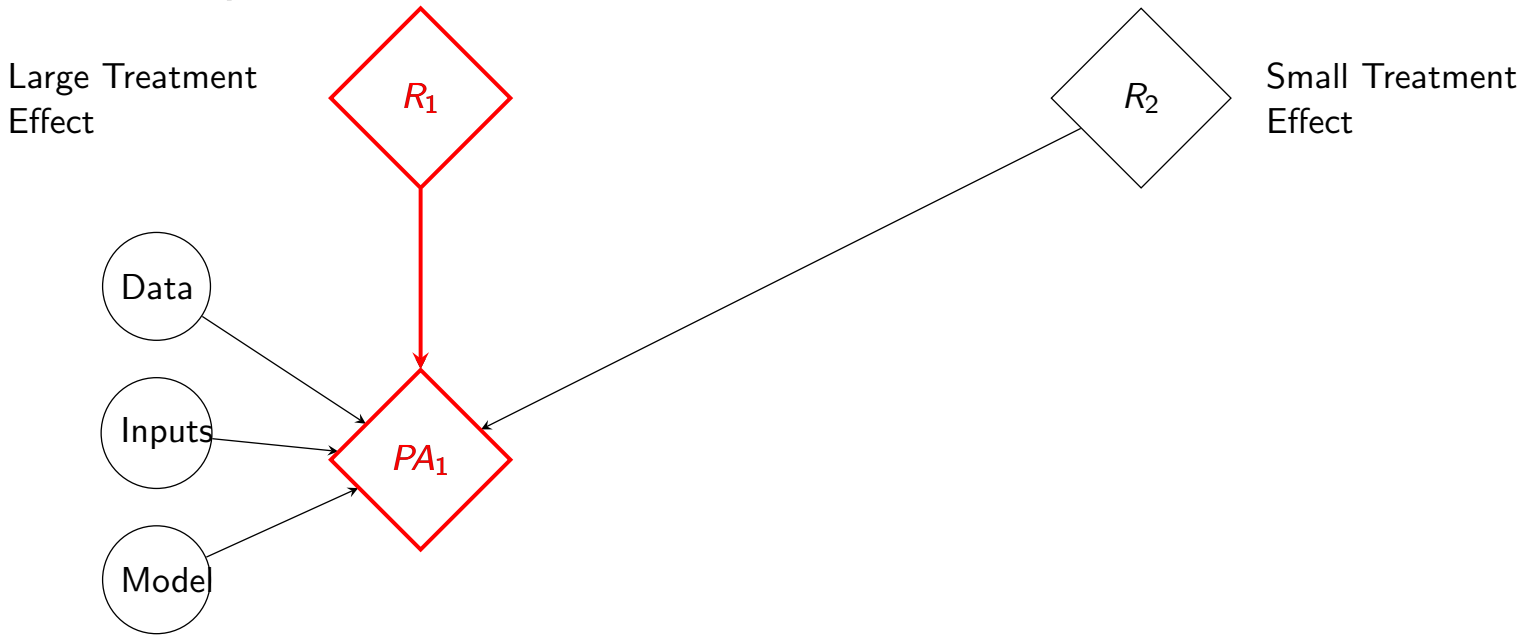


Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.



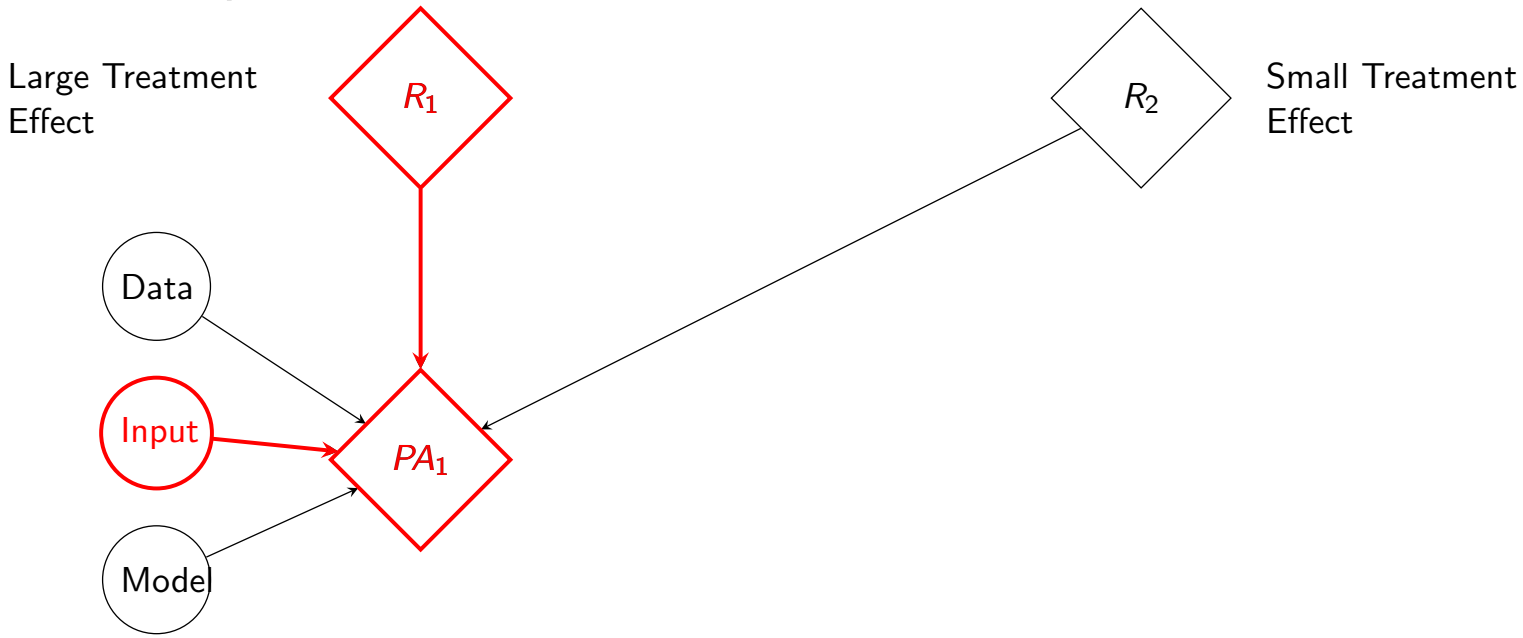
References
Appendix
Employment
Wages
Income

Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.



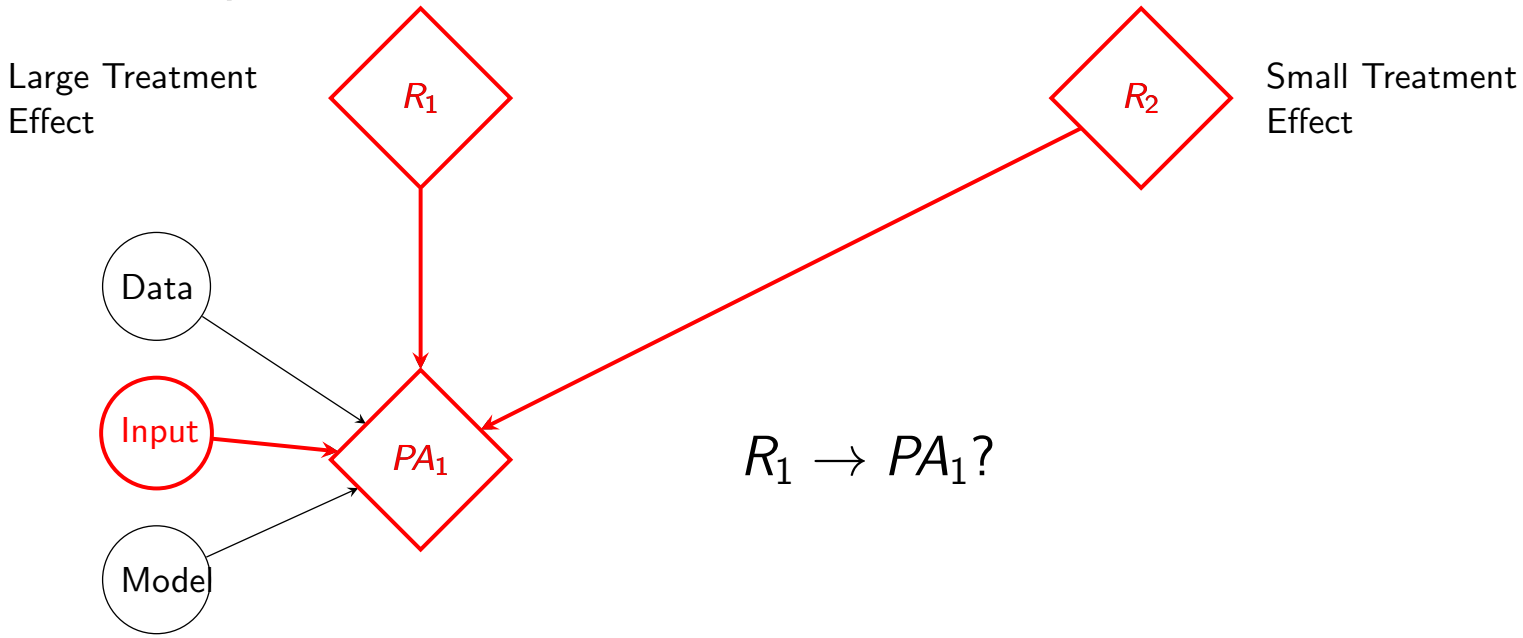
References
Appendix
Employment
Wages
Income

Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.



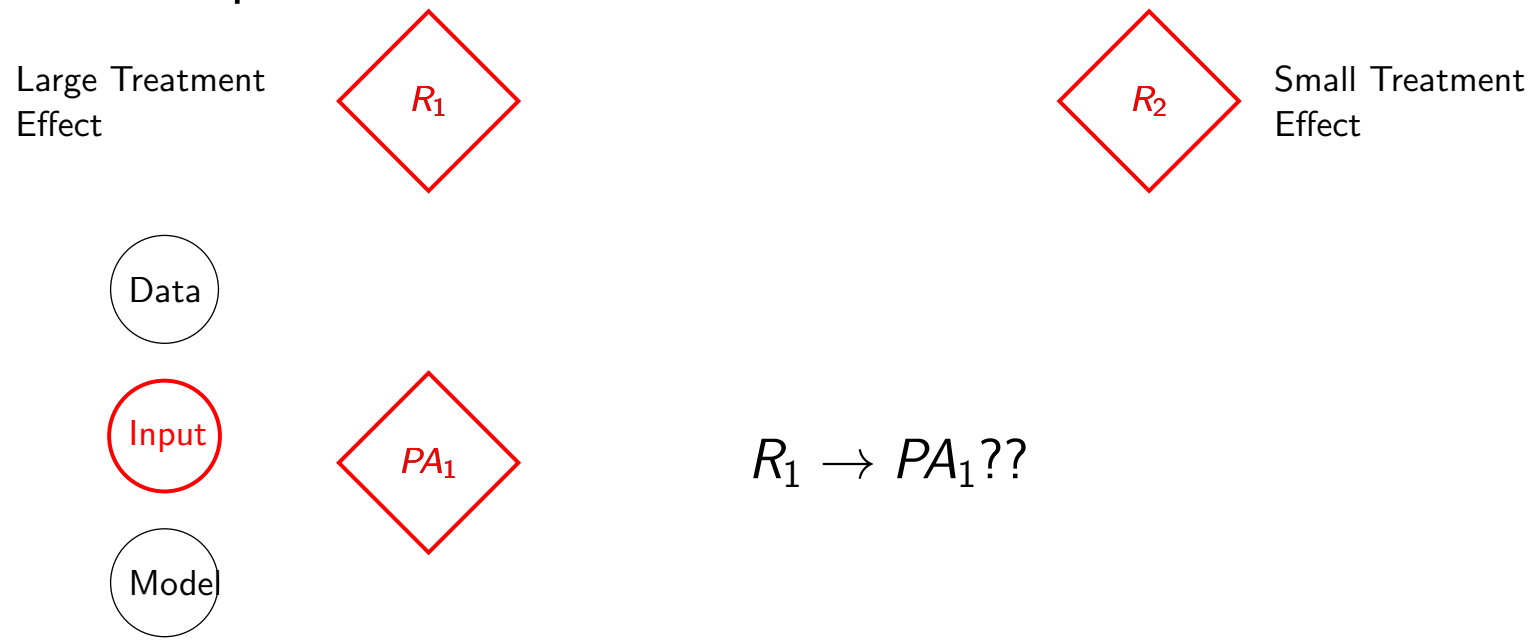
References
Appendix
Employment
Wages
Income

Hard to understand what is the impact of research on policy estimates

What is the impact of R_1 on policy analysis? Can we separate it from a change in inputs? What about R_2?

With the final policy estimate and citations to original research, we can only speculate of impact.

If we see only the final policy estimate, nothing can be said about impact.



Why so little evidence on the role of evidence?

References

Appendix
Employment
Wages
Income

Complex issue

Why so little evidence on the role of evidence?

References

Appendix
Employment
Wages
Income

Complex issue

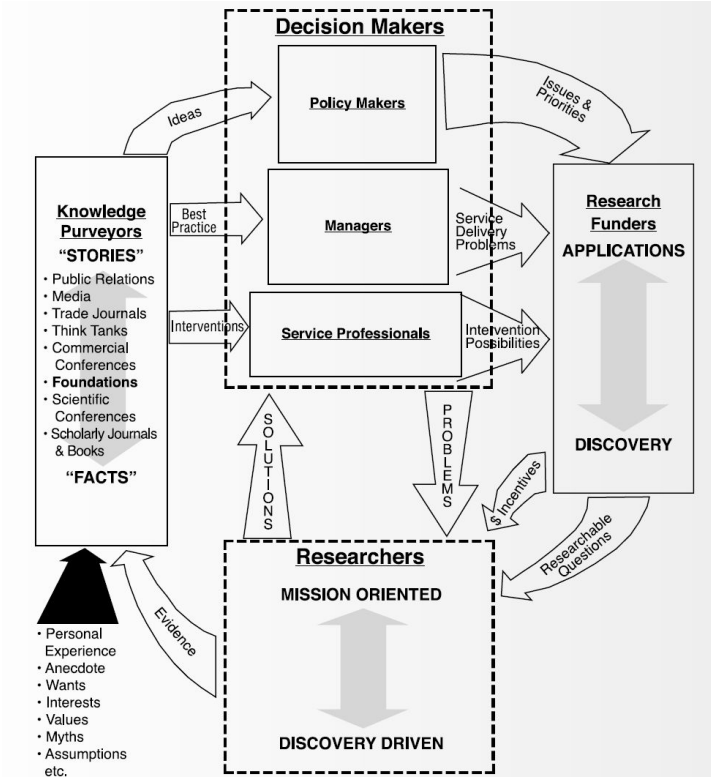
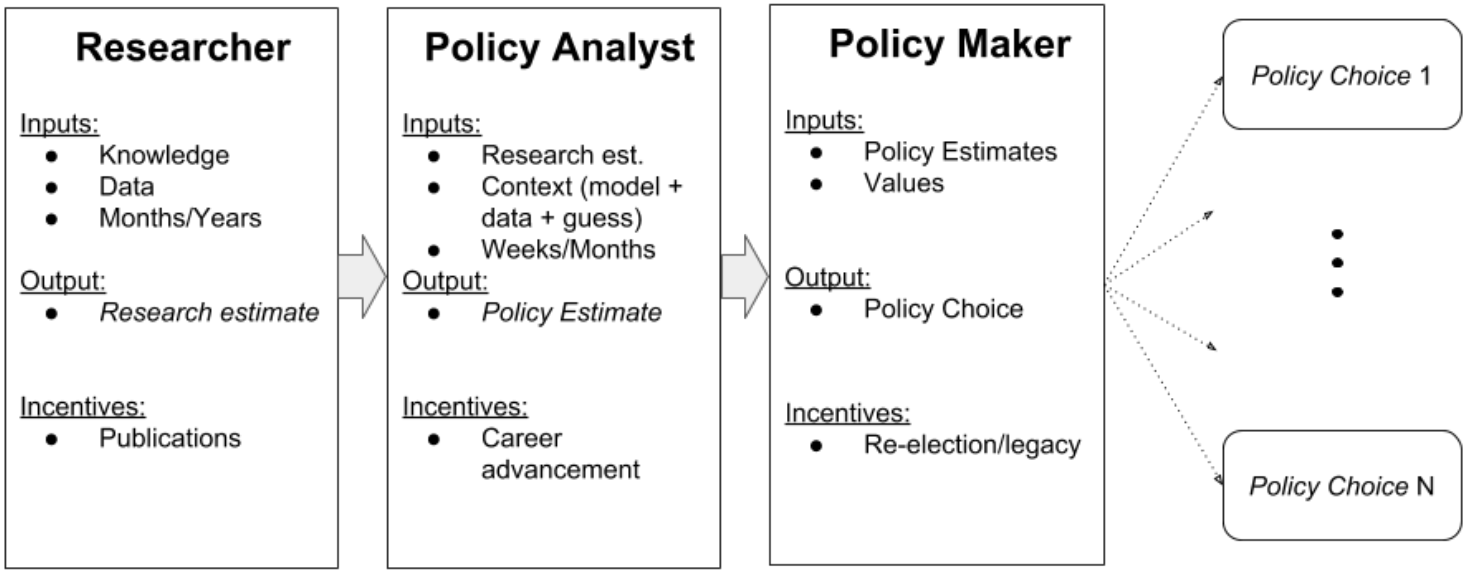


Figure: Reproduced from Nutley et al. [2007] citing CHSRF (2000)

Simpler conceptual model

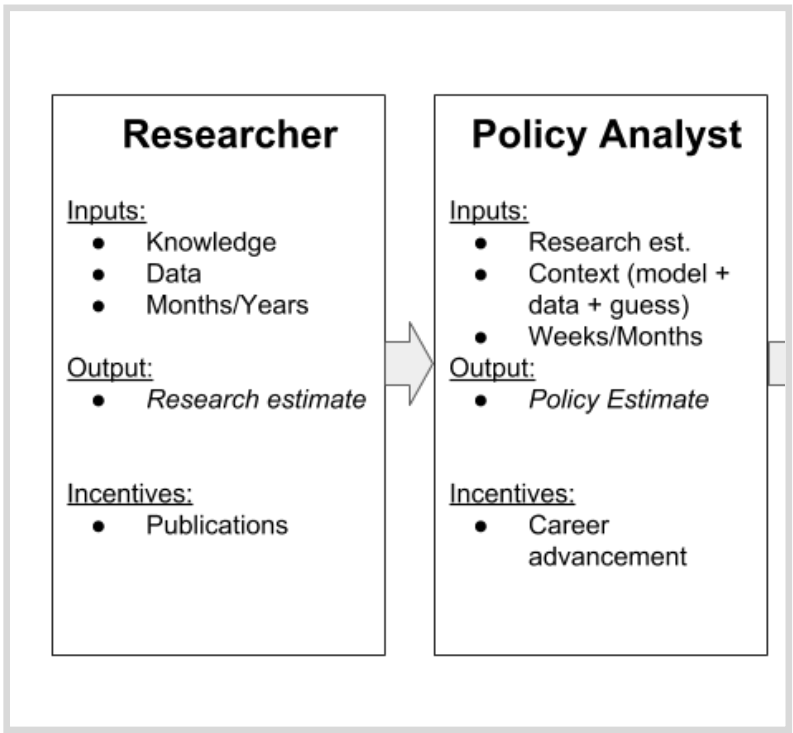


References

Appendix
Employment
Wages
Income

Context: The Role of Evidence in Policy

How does research affect policy analysis?

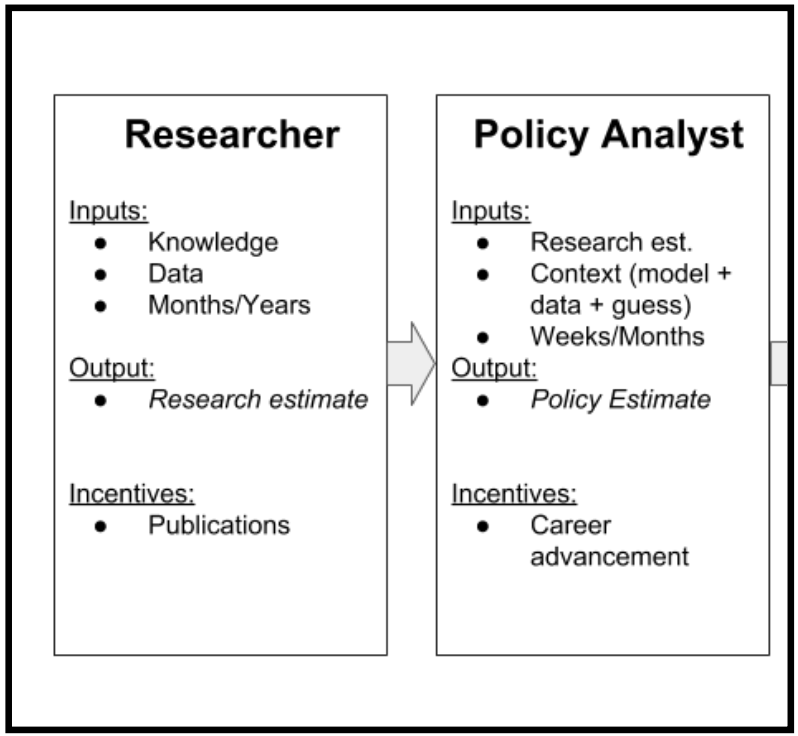


References

Appendix
Employment
Wages
Income

Context: The Role of Evidence in Policy

How does research affect policy analysis?



References
Appendix
Employment
Wages
Income

Reasons for Selecting the Case Study

- *Scalable*: CBO's reputation: among the most transparent and rigorous policy analysis offices. Lessons from TR that apply to CBO should apply also to most agencies. Additionally the policy issue is widely known which facilitates parallels.
- *Recurrent*: This policy analysis will be conducted again in the future. The case study can be directly used in future calculations.

References

Appendix
Employment
Wages
Income

Reasons for Selecting the Case Study

- *Feasible*: available data, good description of the analysis, and only one policy lever to analyze.
- *Relevant*:

Figure: Google Search Intensity of "Minimum Wage"

Clear connection between sources and inputs

Source	Input
Data	
CPS ORG 2013 (CEPR version)	Number of salary workers in 2013 ($\widehat{N^g_{final}}$ $g \in \{teen, adult\}$); Fraction of workers below the new minimum wage ($P_{\hat{w} \leq MW^1 \mid g}$); Average wage variation for those below the new min wage ($\overline{\%\Delta w^g}$); Non-compliance rate (α_1^g)
CPS ASEC 2012 (CEPR version)	Wages and Non-Wage Income distribution (dF_w, dF_{nw}); Household size (N_h); Hours/weeks worked ($\hat{w}, \hat{h}$)
State level Min. Wage (DOL)	Trends in state min. wage (MW_t^s)
10-year economic forecast (CBO)	Predicted worker growth by 2016 (in 2013) ($\hat{g_N}$); Wage growth in by 2016 ($\hat{g_w}$); Non-wage growth by 2016 ($\hat{g_{nw}}$)
Research	
Elasticity of labor demand for teenagers	$\eta^{lit}_{teen} = -0.1$
Ripple effects	From $R_{lb} = \$8.7$ to $R_{ub} = \$11.5$ with a "ripple" intensity of $R_I = 50\%$
Guess Work	
Extrapolation factor from teenagers to adults	$F_{ex} = 1/3$
Net benefits	$\hat{NB} = \$2 billion$
Adjustment to account for effective wage variation and affected population	$F_{adj} = 4.5$
Aggregate consumption effects on employment	$\hat{OF} = 40,000$ *new jobs*
Distribution of balance loses	$dBL = (1\%, 29\%, 70\%)$ if income $\in [0, 1PL, 6PL, +)$
Fract. of wage loses used to pay wage gains	$F_{subs} = 1$
Job killing process: fraction of jobs	Cut wages in half for twice the number of jobs destroyed

Fully specified model

Model	Policy estimate (per quintile)
Predicted household income with and without min wage increase. **Depends on**: $\widehat{N^g_{final}}, P_{\hat{w} \leq MW^1 \mid g}, \overline{\%\Delta w^g}, \alpha^g_1, dF_w, dF_{nw}, N_h, \hat{w}, \hat{h}, MW^s_t, \hat{g_N}, \hat{g_w}, \hat{g_{nw}}, \eta^{lit}_{teen}, R_{lb}, R_{ub}, R_I, F_{ex}, F_{adj}, \hat{OF}$	Average gain in per capita income due to net wage increase. $(\overline{WG_q})$
Predicted household income with and without min wage increase. **Depends on**: $\widehat{N^g_{final}}, P_{\hat{w} \leq MW^1 \mid g}, \overline{\%\Delta w^g}, \alpha^g_1, dF_w, dF_{nw}, N_h, \hat{w}, \hat{h}, MW^s_t, \hat{g_N}, \hat{g_w}, \hat{g_{nw}}, \eta^{lit}_{teen}, F_{ex}, F_{adj}, \hat{OF}$	Average loss in per capita income due to net wage decrease. $(\overline{WL_q})$
Distribution of balance loses **Depends on**: $\overline{WG_q}(\cdot), \overline{WL_q}(\cdot), \hat{NB}, F_{subs}, dBL$	Average loss in per capita income to balance wage gains. $(\overline{BL_q})$
Equations; Back	

References

Appendix
Employment
Wages
Income

Example: Verifying dis-employment by looking for elasticity values in report. **Before**

Steps taken to verify the analysis & employment variation ($\widehat{\Delta E} \times 1000$) at each line[1]

1. Find an elasticity: -0.1 (page 25): $\widehat{\Delta E} \approx 300$
2. What about adults? $\eta^{adults} = \frac{1}{3}\eta^{teens}$ (page 28): $\widehat{\Delta E} \approx 100$
3. What about the adjustment? $\widetilde{\eta^{g}_{w \leq MW}} = \frac{\eta^{g}_{lit}}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}}$ (page 26-28 + 2 papers): $\widehat{\Delta E} \approx 1,100$
4. The adjustment factors $\frac{1}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}} = F^{g}_{adj}$ are not computed from the data (3.2 teens, 19.5 adults). Instead: $F^{teen}_{adj} = F^{adult}_{adj} = 4.5$ (page 28) $\widehat{\Delta E} \approx 500$

Steps 2-4 took several days of work!

[1] Assuming target population $\approx$ 22 million, $\overline{\Delta w_{w \leq MW'}} \approx 14\%$, and non-compliance $\approx 15\%$

References

Appendix
Employment
Wages
Income

Example: Verifying dis-employment by looking for elasticity values in report. **Before**

Steps taken to verify the analysis & employment variation ($\widehat{\Delta E} \times 1000$) at each line[1]

1. Find an elasticity: -0.1 (page 25): $\widehat{\Delta E} \approx 300$
2. What about adults? $\eta^{adults} = \frac{1}{3}\eta^{teens}$ (page 28): $\widehat{\Delta E} \approx 100$
3. What about the adjustment? $\widetilde{\eta^{g}_{w \leq MW}} = \frac{\eta^{g}_{lit}}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}}$ (page 26-28 + 2 papers): $\widehat{\Delta E} \approx 1,100$
4. The adjustment factors $\frac{1}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}} = F^{g}_{adj}$ are not computed from the data (3.2 teens, 19.5 adults). Instead: $F^{teen}_{adj} = F^{adult}_{adj} = 4.5$ (page 28) $\widehat{\Delta E} \approx 500$

Steps 2-4 took several days of work!

[1] Assuming target population $\approx$ 22 million, $\overline{\Delta w_{w \leq MW'}} \approx 14\%$, and non-compliance $\approx 15\%$

References

Appendix
Employment
Wages
Income

Example: Verifying dis-employment by looking for elasticity values in report. **Before**

Steps taken to verify the analysis & employment variation ($\widehat{\Delta E} \times 1000$) at each line[1]

1. Find an elasticity: -0.1 (page 25): $\widehat{\Delta E} \approx 300$
2. What about adults? $\eta^{adults} = \frac{1}{3}\eta^{teens}$ (page 28): $\widehat{\Delta E} \approx 100$
3. What about the adjustment? $\widetilde{\eta^{g}_{w \leq MW}} = \frac{\eta^{g}_{lit}}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}}$ (page 26-28 + 2 papers): $\widehat{\Delta E} \approx 1,100$
4. The adjustment factors $\frac{1}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}} = F^{g}_{adj}$ are not computed from the data (3.2 teens, 19.5 adults). Instead: $F^{teen}_{adj} = F^{adult}_{adj} = 4.5$ (page 28) $\widehat{\Delta E} \approx 500$

Steps 2-4 took several days of work!

[1] Assuming target population $\approx$ 22 million, $\overline{\Delta w_{w \leq MW'}} \approx 14\%$, and non-compliance $\approx 15\%$

References

Appendix
Employment
Wages
Income

Example: Verifying dis-employment by looking for elasticity values in report. **Before**

Steps taken to verify the analysis & employment variation ($\widehat{\Delta E} \times 1000$) at each line[1]

1. Find an elasticity: -0.1 (page 25): $\widehat{\Delta E} \approx 300$
2. What about adults? $\eta^{adults} = \frac{1}{3}\eta^{teens}$ (page 28): $\widehat{\Delta E} \approx 100$
3. What about the adjustment? $\widetilde{\eta^{g}_{w \leq MW}} = \frac{\eta^{g}_{lit}}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}}$ (page 26-28 + 2 papers): $\widehat{\Delta E} \approx 1,100$
4. The adjustment factors $\frac{1}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}} = F^{g}_{adj}$ are not computed from the data (3.2 teens, 19.5 adults). Instead: $F^{teen}_{adj} = F^{adult}_{adj} = 4.5$ (page 28) $\widehat{\Delta E} \approx 500$

Steps 2-4 took several days of work!

[1] Assuming target population $\approx$ 22 million, $\overline{\Delta w_{w \leq MW'}} \approx 14\%$, and non-compliance $\approx 15\%$

References

Appendix
Employment
Wages
Income

Example: Verifying dis-employment by looking for elasticity values in report. **Before**

Steps taken to verify the analysis & employment variation ($\widehat{\Delta E} \times 1000$) at each line[1]

1. Find an elasticity: -0.1 (page 25): $\widehat{\Delta E} \approx 300$
2. What about adults? $\eta^{adults} = \frac{1}{3}\eta^{teens}$ (page 28): $\widehat{\Delta E} \approx 100$
3. What about the adjustment? $\widetilde{\eta^{g}_{w \leq MW}} = \frac{\eta^{g}_{lit}}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}}$ (page 26-28 + 2 papers): $\widehat{\Delta E} \approx 1,100$
4. The adjustment factors $\frac{1}{p^{g}_{w \leq MW}} \times \frac{\%\Delta MW}{\%\Delta w^{g}} = F^{g}_{adj}$ are not computed from the data (3.2 teens, 19.5 adults). Instead: $F^{teen}_{adj} = F^{adult}_{adj} = 4.5$ (page 28) $\widehat{\Delta E} \approx 500$

Steps 2-4 took several days of work! •

[1] Assuming target population $\approx$ 22 million, $\overline{\Delta w_{w \leq MW'}} \approx 14\%$, and non-compliance $\approx 15\%$

References
Appendix
Employment
Wages
Income

Equations from Model in DD

$$\widehat{\Delta E} = N \times \eta \times \%\Delta w + \text{Other factors} \tag{1}$$

$$\widehat{N^s_{final}} = g_N(\hat{t}'|t) \times \hat{N}^s_t \times P(\hat{w}' \leq MW^{new}|s) \times (1 - \hat{\alpha}^s_1 - \hat{\alpha}^s_2) \tag{2}$$

The elasticity for adults from the literature is define as the one for teenagers with an extrapolation factor.

$$\eta^{adults}_{lit} = \eta^{teens}_{lit} \times F_{extrapolation} \tag{3}$$

Adjustments to the elasticity of labor demand

Following Neumark and Wascher [2008], Brown [1999]. First:

$$\eta^s_{lit} = p^s_{w \leq MW} \eta^s_{w \leq MW} + (1 - p^s_{w \leq MW}) \eta^s_{w > MW} \qquad s = \{teens, adu$$

Second, assume $\eta^s_{w \leq MW} = 0$:

$$\eta^s_{w \leq MW} = \frac{\eta^s_{lit}}{p^s_{w \leq MW}} \qquad s = \{teens, adults\}$$

And third, adjust for the effective average wage variation for each group ($\overline{\%\Delta w^s}$):

$$\widetilde{\eta^s_{w \leq MW}} = \frac{\eta^s_{lit}}{p^s_{w \leq MW}} \times \frac{\%\Delta MW}{\overline{\%\Delta w^s}} = \eta^s_{lit} \times F^s_{adjs} \qquad s = \{teens, adul$$

(4)

References
Appendix
Employment
Wages
Income

Final Effect on Employment

$$\widehat{\Delta E} = \sum_{g \in \{A,T\}} \left(\widehat{N_g^{final}} \times \widetilde{\eta_{w \leq MW}^{g}} \times \overline{\%\Delta w^g} \right) - \widehat{OF} \tag{5}$$

References
Appendix
Employment
Wages
Income

Effect on Wages

$$w'' = \begin{cases} w' & if \quad w \in U[0,1] < \alpha_1 \\ w^{new} & o/w \end{cases} \tag{6}$$

$$w^{new} = \begin{cases} w'/2 & if \quad w \in U[0,1] < \alpha_{aux} \\ \widetilde{w^{new}} & o/w \end{cases} \tag{7}$$

Ripple Effects

$$\widetilde{w^{new}} = \begin{cases} MW' & if \quad w' < R_{lb} \\ MW' + R^l(w' - R^s_{lb}) & if \quad w' \in [R_{lb}, MW') \\ w' + R^l(R^s_{ub} - w') & if \quad w' \in [MW', R_{ub}) \\ w' & o/w \end{cases} \tag{8}$$

Computing Income

$$y'_{i,h} = \sum_{i \in N_h} \left(g_{nw}(t'|t) nw_i + w'_i \right) / N_h$$

$$y''_{i,h} = \sum_{i \in N_h} \left(g_{nw}(t'|t) nw_i + w''_i \right) / N_h \tag{9}$$

Final Policy Estimates

$$WG_i = \left(y''_i - y'_i \right) \mathbf{I} \left(y''_i > y'_i \right) \tag{10}$$

$$WL_i = \left(y'_i - y''_i \right) \mathbf{I} \left(y''_i < y'_i \right) \tag{11}$$

$$BL = \sum_i WG_i - F_{sub} \sum_i WL_i; \quad BL_i = BL \times dBL \tag{12}$$

$$\overline{WG_Q} = \frac{\sum_{i \in Q} WG_i}{N_{pop}/5} \quad \overline{WL_Q} = \frac{\sum_{i \in Q} WL_i}{N_{pop}/5}$$

$$\overline{BL_Q} = \frac{\sum_{i \in Q} BL_i}{N_{pop}/5} \tag{13}$$

References
Appendix
Employment
Wages
Income

Summary of Adapted Guidelines

Standard	Level 0	Level 1	Level 2	Level 3
Workflow	Policy estimates vaguely described	All the inputs, and their corresponding sources, used in the calculations are listed	Lvl 1 + Policy estimates are listed, in same unit if possible	Lvl 2 + all the components can be modified with little effort
Data	Report says nothing	Clearly stated whether all, some components, or none of the data is available, with instructions for access when possible.	Lvl 1 + report and data are in same place	Lvl 2 + Report has specific lines of code that call the data and changes in the data produce traceable changes in the report
Methods & Code	Key assumption are listed	Methods are described in prose. Large amount of work is required to reproduce qualitatively similar estimates	Methods and described in prose, with detailed formulas, and code is provided as supplementary material	Lvl 2 + All is in the same document where changes in the code affect the output automatically

From TOP guidelines [Nosek et al., 2015] v1.0.1

References

Appendix
Employment
Wages
Income

Summary of TOP Guidelines

	Level 0	Level 1	Level 2	Level 3
Citation Standards	Journal encourages citation of data, code, and materials, or says nothing	Journal describes citation of data in guidelines to authors with clear rules and examples.	Article provides appropriate citation for data and materials used consistent with journal's author guidelines.	Article is not published until providing appropriate citation for data and materials following journal's author guidelines.
Data Transparency	Journal encourages data sharing, or says nothing	Article states whether data are available, and, if so, where to access them.	Data must be posted to a trusted repository. Exceptions must be identified at article submission.	Data must be posted to a trusted repository, and reported analyses will be reproduced independently prior to publication.
Analytic Methods (Code) Transparency	Journal encourages code sharing, or says nothing	Article states whether code is available, and, if so, where to access them.	Code must be posted to a trusted repository. Exceptions must be identified at article submission.	Code must be posted to a trusted repository, and reported analyses will be reproduced independently prior to publication.
Research Materials Transparency	Journal encourages materials sharing, or says nothing	Article states whether materials are available, and, if so, where to access them.	Materials must be posted to a trusted repository. Exceptions must be identified at article submission.	Materials must be posted to a trusted repository, and reported analyses will be reproduced independently prior to publication.
Design and Analysis Transparency	Journal encourages design and analysis transparency, or says nothing	Journal articulates design transparency standards	Journal requires adherence to design transparency standards for review and publication	Journal requires and enforces adherence to design transparency standards for review and publication
Preregistration of studies	Journal says nothing	Article states whether preregistration of study exists, and, if so, where to access it.	Article states whether preregistration of study exists, and, if so, allows journal access during peer review for verification.	Journal requires preregistration of studies and provides link and badge in article to meeting requirements.
Preregistration of analysis plans	Journal says nothing	Article states whether preregistration with analysis plan exists, and, if so, where to access it.	Article states whether preregistration with analysis plan exists, and, if so, allows journal access during peer review for verification.	Journal requires preregistration of studies with analysis plans and provides link and badge in article to meeting requirements.
Replication	Journal discourages submission of replication studies, or says nothing	Journal encourages submission of replication studies	Journal encourages submission of replication studies and conducts results blind review	Journal uses Registered Reports as a submission option for replication studies with peer review prior to observing the study outcomes.

Figure: Reproduced from: https://cos.io/our-services/top-guidelines/