The Minimum Wage, Turnover, and the Shape of the Wage Distribution

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January 6 2018

Introduction

- In recent years, the minimum policy has played an increasingly important policy role in the low-wage labor market
- Although the U.S. federal minimum wage is "stalled" at \$7.25, most states now have a higher minimum.
- "Fight for 15" movement in the U.S. and Canada, with the minimum wage in the process of going up to \$15:
  - Alberta (Oct 2018), Ontario (Jan 2019)
  - California (2022), D.C. (2020), Seattle, San Francisco, NYC, etc.
- New minimum wage in Germany (2015)

Introduction

- These policy innovations and better data have helped spur a new wave of research looking at various minimum wage impacts including
  - Employment (of course...) and labor turnover
  - Firm profitability and stock price
  - Other forms of adjustments to higher labor costs: price pass-through, capital and higher skill labor substitution, technological change, etc.

- Our focus here is on the wage distribution, and in particular spillover effects above the minimum that can have an important effect on wage inequality

Introduction

- There is a sizeable literature examining the impact of minimum wage changes on the wage distribution, mostly for the U.S. and U.K.:
  - U.S.: Grossman(1983), Meyer and Wise(1983), DiNardo, Fortin and Lemieux(1996), Lee(1999), Neumark, Schweitzer and Wascher(2004), Autor, Manning and Smith(2016))
  - U.K.: Manning(2003), Machin, Rahman and Manning(2003), Dickens and Manning (2004a,b), Butcher, Dickens and Manning(2012), Stewart(2012)

- But no consensus yet on the magnitude of spillover effects
  - Using variation in the relative value of the federal minimum wage in low- and high-wage labor markets, Lee (1999) finds large spillover effects that help account for most of the growth in wage inequality in the bottom half of the distribution during the 1980s
  - Using more recent data and variation in state minimum wages, Autor, Manning and Smith (2016) find much smaller spillover effects, and argue this may just reflect measurement error in wages

Introduction

- Most of these studies focus on how the minimum wage affects different wage quantiles, and rely on country-level variation in the minimum wage (U.K. and pre-1987 U.S.)
- We revisit this issue using a difference-in-differences (and triple-differences) strategy that exploits regional variation in the minimum wage
  - 10 provinces and 20 years of data (1997-2016) for Canada
  - 30 years of data (1987-2016) for the United States. Fraction of workers under a higher state minimum wage under 5 percent prior to 1987, but above 50 percent in 2016.
- We use an econometric approach that has the following features:
  1. Model probability (of being in small wage bins) instead of wage quantiles
  2. Control for possible employment effects that could confound the impact of the minimum wage on the wage distribution
  3. Model the effect of the minimum wage as a proportional function of the probability of being affected by the minimum wage (e.g. how "binding" is the minimum wage)

Introduction

We implement this approach using a proportional hazard model (PHM) as in Donald, Green, and Paarsch (2000)

- The hazard rate $h(y|x)$ is closely connected to the density $f(y|x)$:

$$h(y|x) = f(y|x)/(1 - F(y|x)) \tag{1}$$

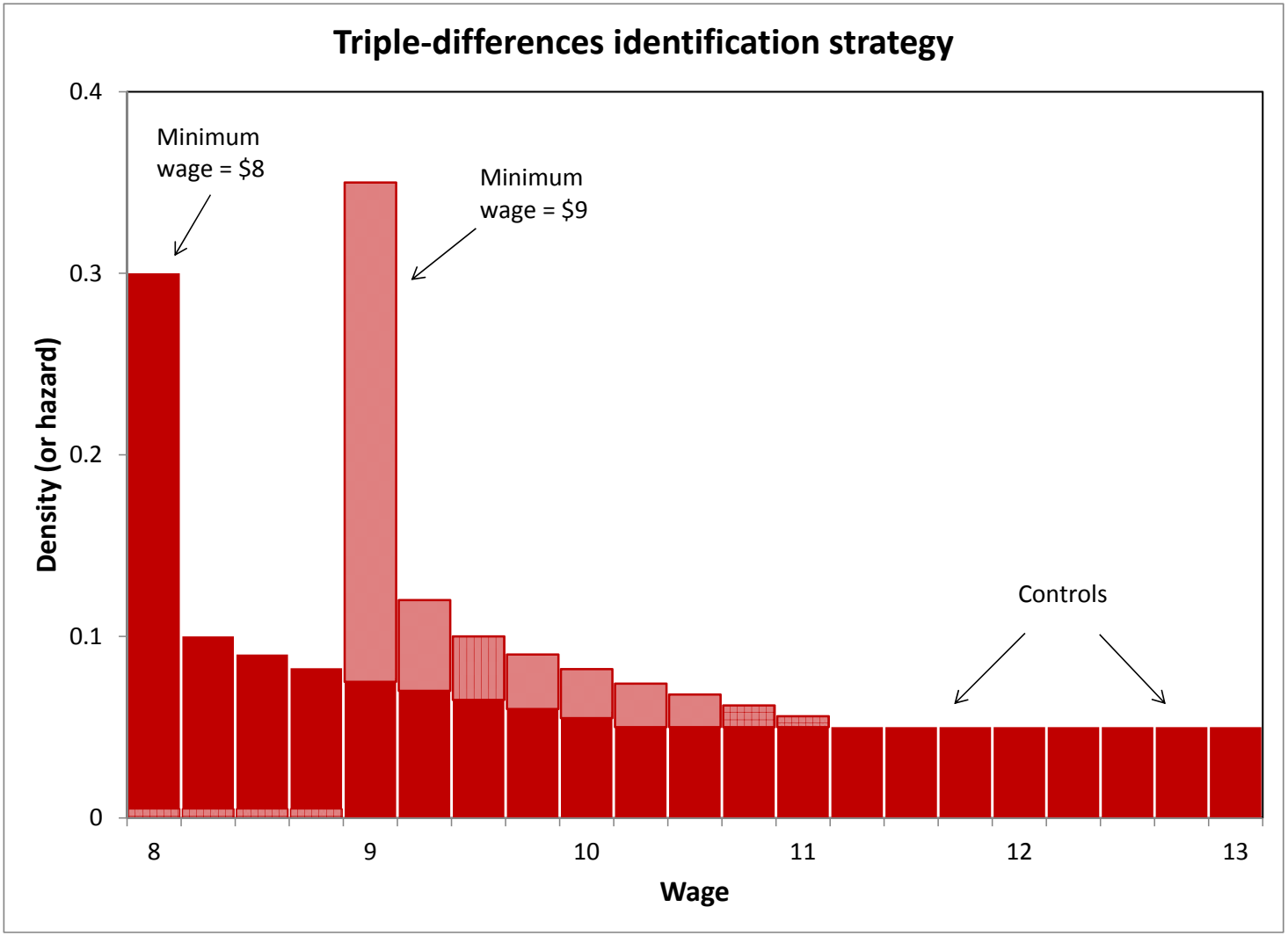
- Potential employment effects at or below the minimum wage are controlled for by conditioning on being at or above y $(1 - F(y|x))$
- Proportionality comes from the usual PHM specification:

$$h(y|x) = exp(x\alpha)h_0(y) \tag{2}$$

Provides a convenient way of modelling the underlying distribution in a flexible way

- Different effect of x (including the minimum wage) in different segments of the wage distribution
- Correct for measurement error by modelling the probability of heaping (concentration at integer values of nominal wages)
- Use higher segments of the wage distribution as control (and triple-differences)

Triple-differences strategy



Introduction

- We also use the Canadian data to connect the effect of the minimum wage on turnover and the wage distribution
- Labour Force Survey (LFS) is a 6-month panel that asks about job tenure (can identify "joiners")
- This allows us to look at questions such as:
  - Do spillover effects represent wage growth among job stayers, or the hiring of new (more skilled) workers at wages slightly above the minimum?
  - Does the selective exit of workers just below an upcoming new minimum wage contirbutes in shaping changes in the wage distribution?

- Results still tentative at this point

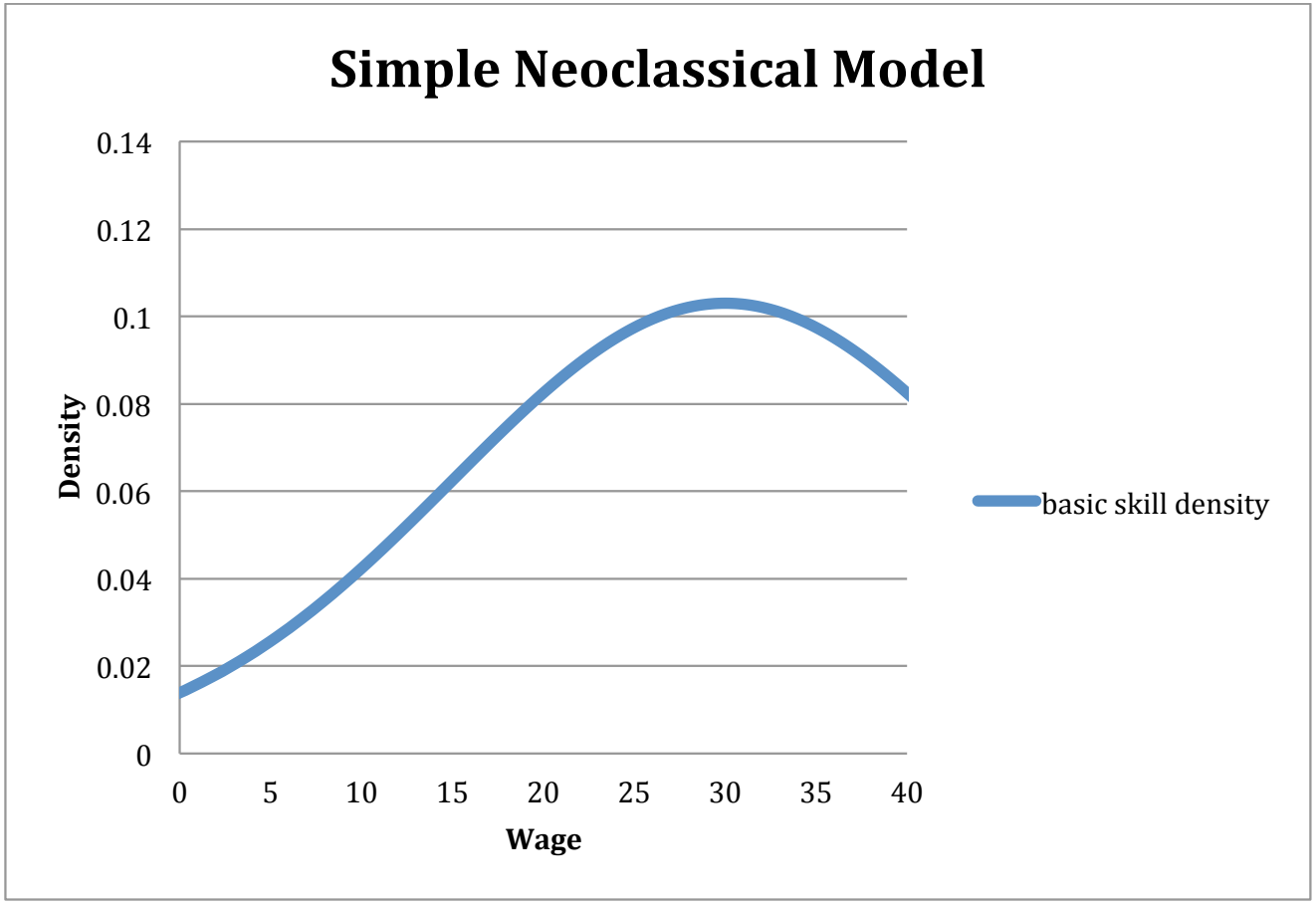
Main findings

- Evidence of spillover effects up to \$2-\$2.5 above the minimum wage in both Canada and the United States
  - On average, less than 5 percent of men are at or below the minimum wage, but spillover effects reach out to the 10^{th}-15^{th} percentile of the wage distribution
  - On average, slightly more than 5 percent of women are at or below the minimum wage, and spillover effects reach out to about the 20^{th} percentile of the wage distribution.
- Introducing dummy variables for integer wage values greatly improves the fit of the model
- The model captures well the proportional effect of the minimum wage: estimates for men and women similar despite the large minimum wage "byte" for women.
- Standard difference-in-differences model appears to be mispecified, but estimates with province/state-specific quadratic trends are similar to those with a full set of province/state-year dummies.

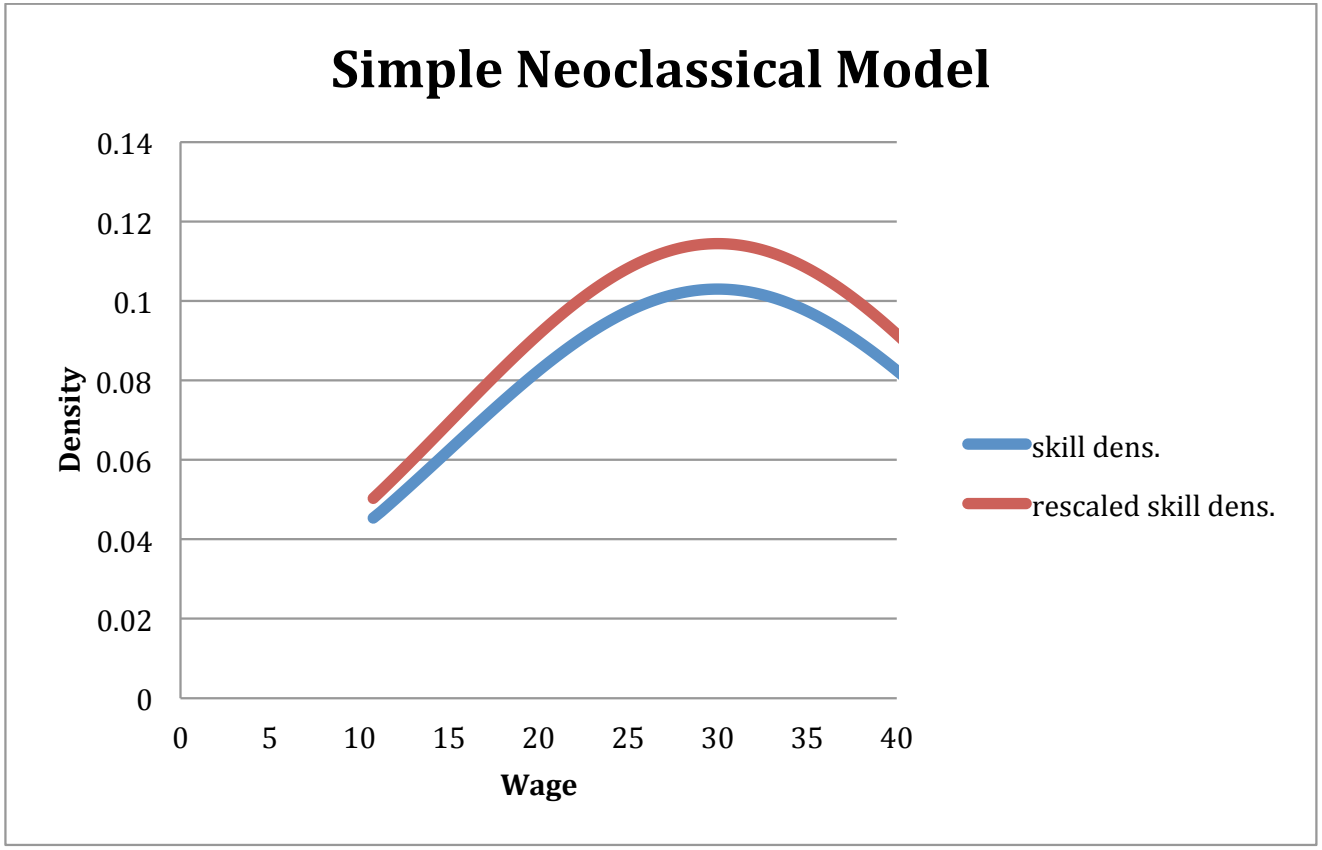
Roadmap

- Quick overview of the predicted effect of the minimum wage on the shape of the wage distribution for different models (competitive, monoposony, search)
- Econometric approach
- Wage data and minimum wages in Canada and the United States.
- Empirical results

Economic Models: Simple Competitive



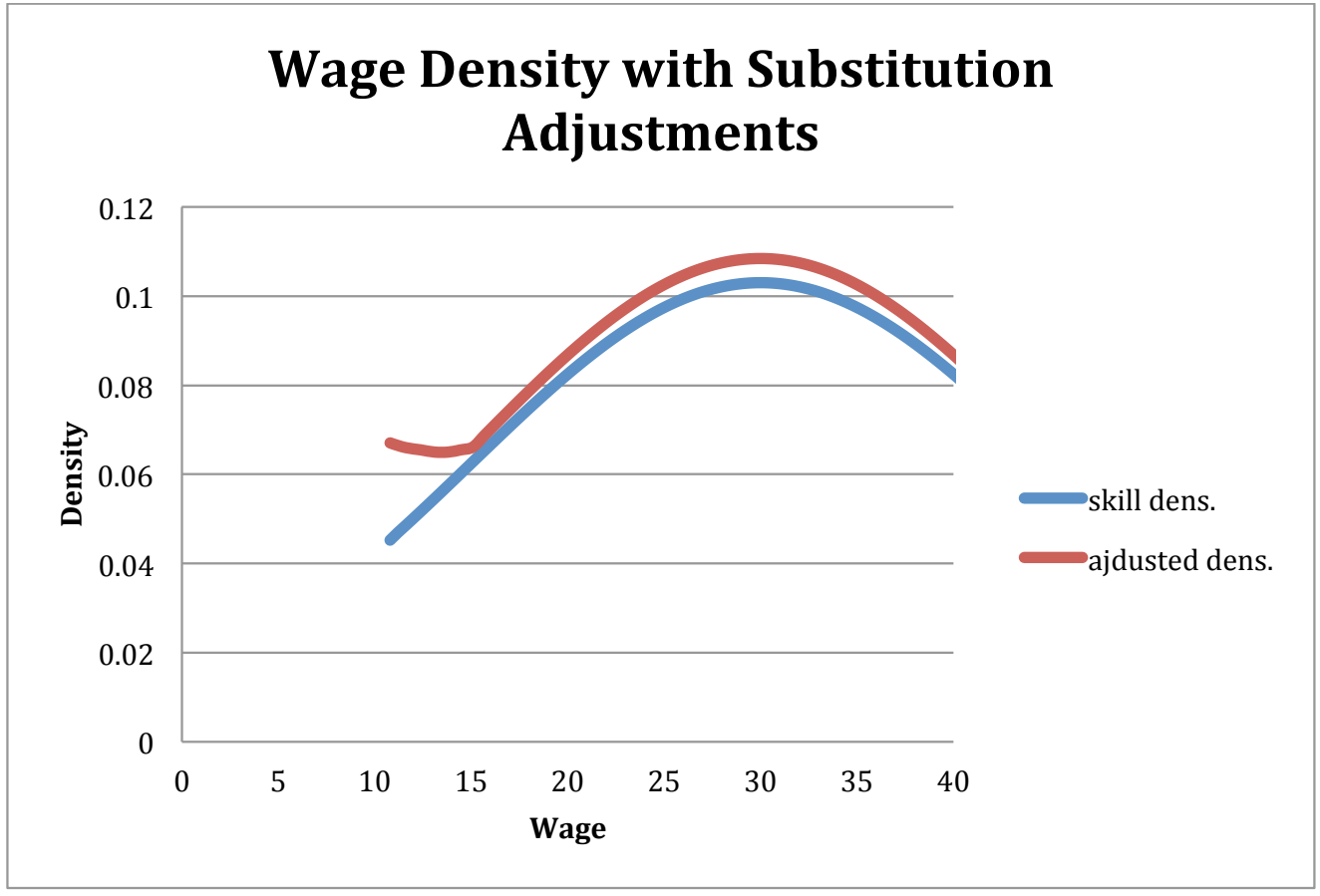
Economic Models: Simple Competitive



Economic Models: Simple Competitive

- Truncation of underlying skill distribution
- Re-scaling of above-minimum density gives "illusion" of spillover effects
- Hazard rates above minimum would show no effect

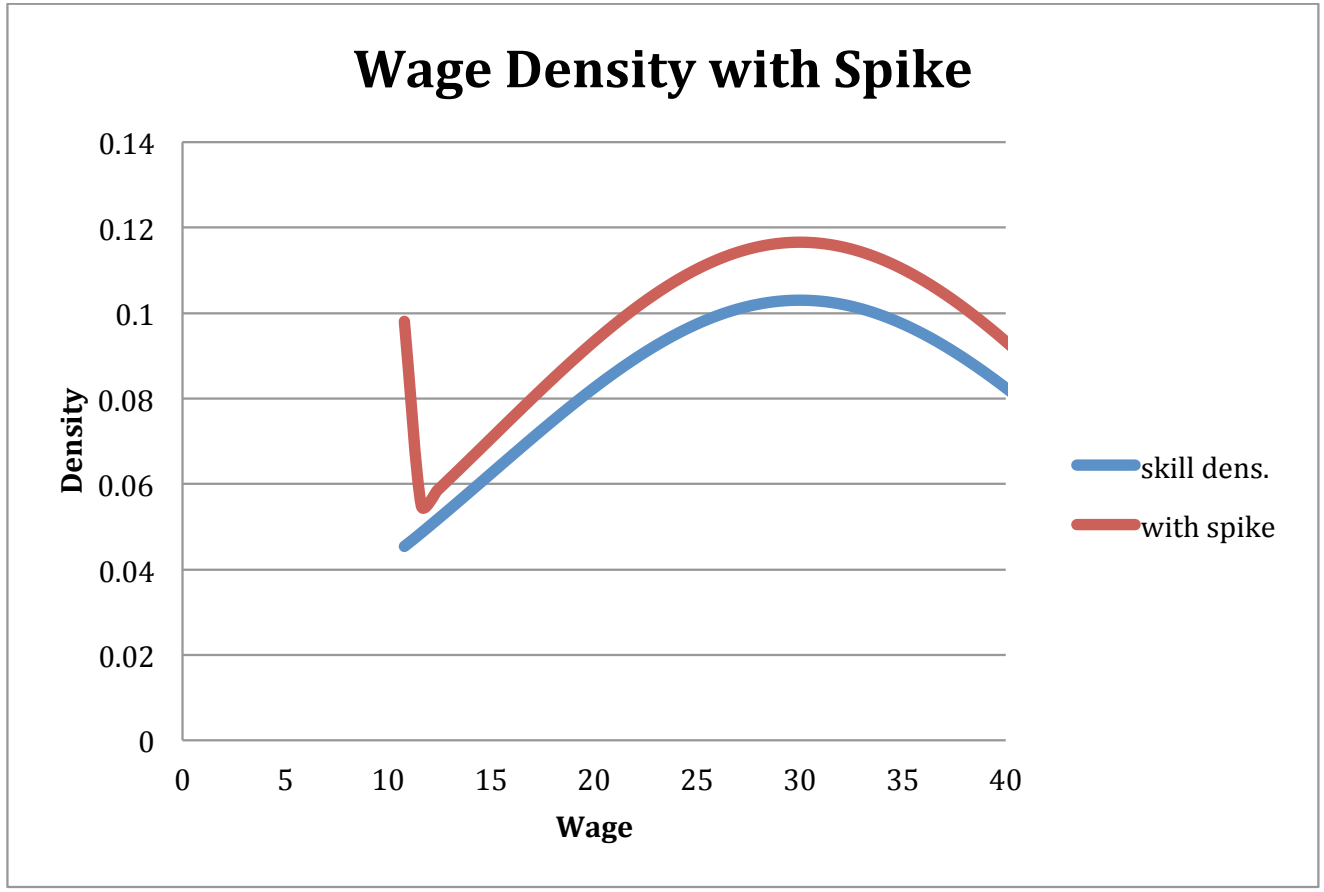
Economic Models: Competitive with Substitution (Teulings)



Economic Models: Competitive with Substitution (Teulings)

- Truncation of underlying skill distribution
- Spillovers:
  1. Truncation Spillover: Re-scaling related to truncation
  2. Shape Spillover: Change in shape due to skill price changes
- Hazard rates increase relative to base until about \$15 then no effect

Economic Models: Frictional, Butcher et al(2012)



Economic Models: Frictional, Butcher et al(2012)

- Heterogeneous firms, homogeneous workers.
- Firms face own inelastic labour supply and pay a wage below productivity
- Firms with productivity below m stop hiring. Those with productivity above m but below a* (where would pay m) all pay m $\Longrightarrow$ spike
- Firms paying above m, pay the same wage but employ more workers in proportion to numbers not taken up by m firms
- As in simple competitive model, only truncation spillover but here it corresponds to people moving up. i.e., no effect on hazard above minimum wage but also no effect on employment rate.
- With worker heterogeneity, would see a positive effect on hazard just above m, declining as move further up, combined with no employment effect.

Estimator

Donald, Green and Paarsch(2000), Green and Paarsch(1996)

- Write wage density as:

$$f(y|x) = h(y|x)S(y|x) \tag{3}$$

- We directly estimate $h(y|x)$, the conditional hazard
- Divide wage range into bins indexed by p
-

$$\int_{y_{p-1}}^{y_p} exp(x\alpha_p)h_0(u)du = exp(x\alpha_p)\gamma_p \tag{4}$$

- where:
  - $h_0(u)$ is baseline hazard
  - proportional hazard model with effect of x vector constant within a segment

Estimator

- We use 164 wage bins (10 cents wide from \$3 up to \$20)
- Top-code data at \$20 (right censoring)
- Restrict α_p's to be the same in 5"covariate segments"
- Allows for:
  1. Considerable flexibility in covariate effects
  2. Proportional effect of the minimum wage
  3. Integrates back to consistent estimates of CDF and density
  4. Control for changes in the shape of the distribution due to truncation at the low-end of the distribution (possible minimum wage employment effects)

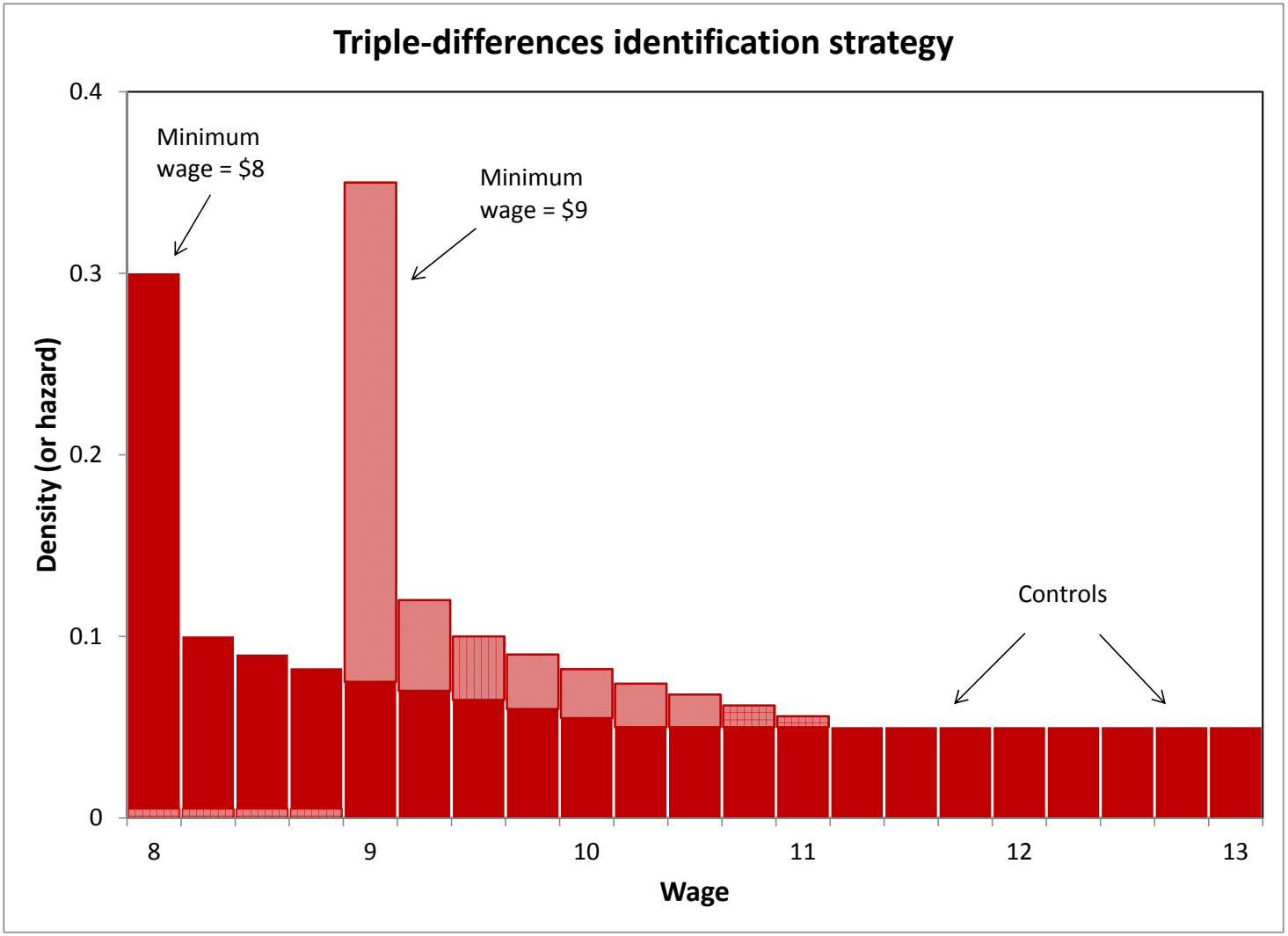
Estimator: Minimum Wage Effects

- Create a dummy variable that equals 1 in wage bin that contains minimum wage and 0 otherwise
- Minimum wage variables is equivalent of a time varying covariate (e.g. UI benefits exhaustion)
- Also create a set of related dummies corresponding to: 50 cents or more below the minimum wage (m); 30 to 50 cents below m; 10 to 30 cents below m; 10 to 30 cents above; 30 cents to 50 cents above m; 50 cents to 1$ above m; additional 50 cents segments up to $2 or $5 above m depending on specifications
- Now, $h = exp(D_{mp}\beta)exp(x\alpha_{s(p)})\gamma_p$
- where D_{mp} is vector of minimum wage related dummy variables in wage bin p

Estimator: Identification

- Triple-differences estimator: Include a complete set of province/state-year effects
- Assume minimum wage does not affect hazard at a point "high enough" in the distribution ($2 in graphical example, but testable in practice)
- Get identification, in part, by sliding down the distribution: with m_0= 8 and m_1=9, difference in hazard between $10.5 and $11 identifies the "$1.5 to $2" effect. Then use that to get baseline between $10 and $10.5, ...
- Stewart(2012): some concerns about using higher percentiles as controls. We allow for flexible differences across percentiles by year and province/state.

Triple-differences strategy



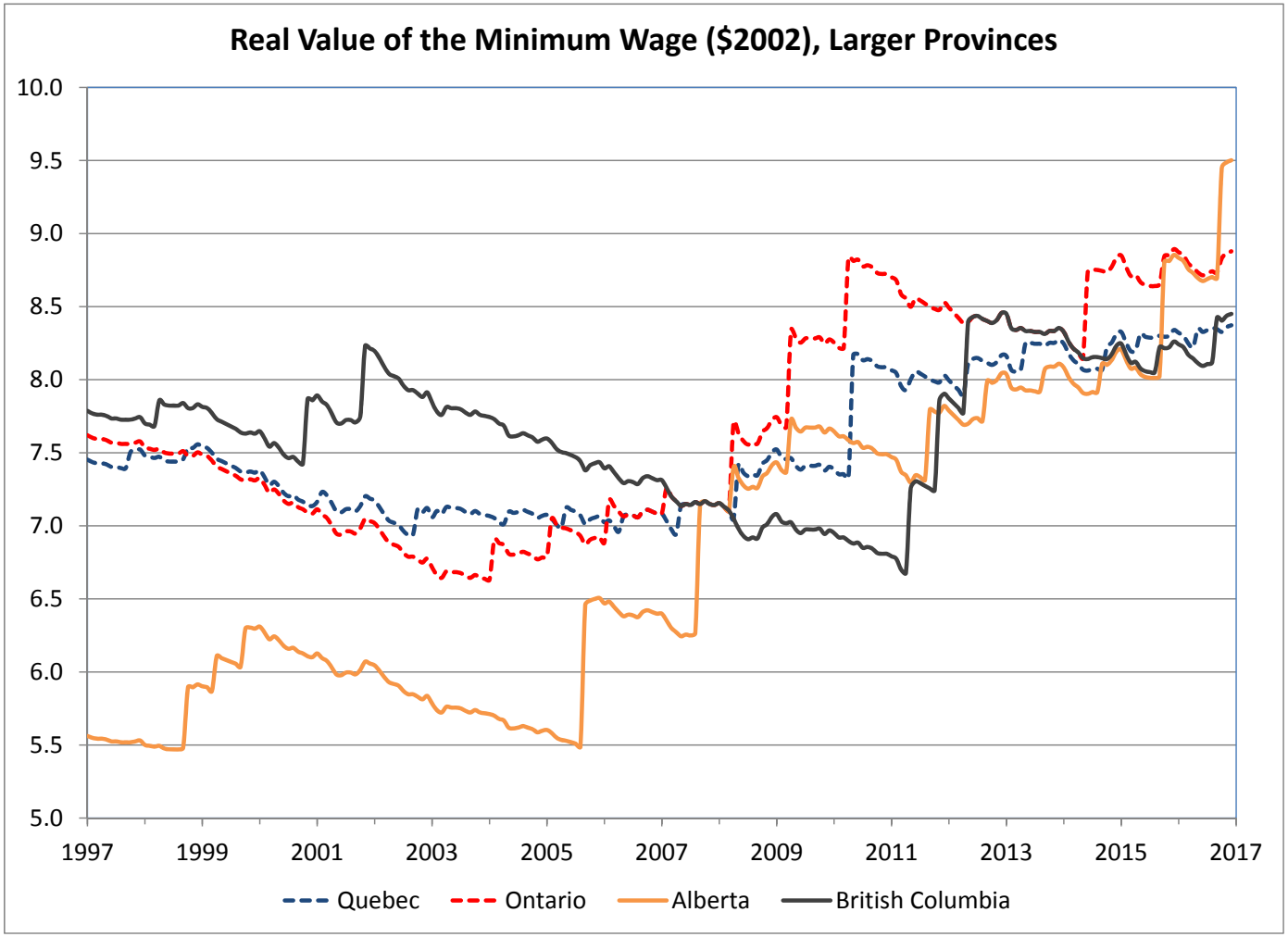
Minimum wage in Canada

Minimum Wages

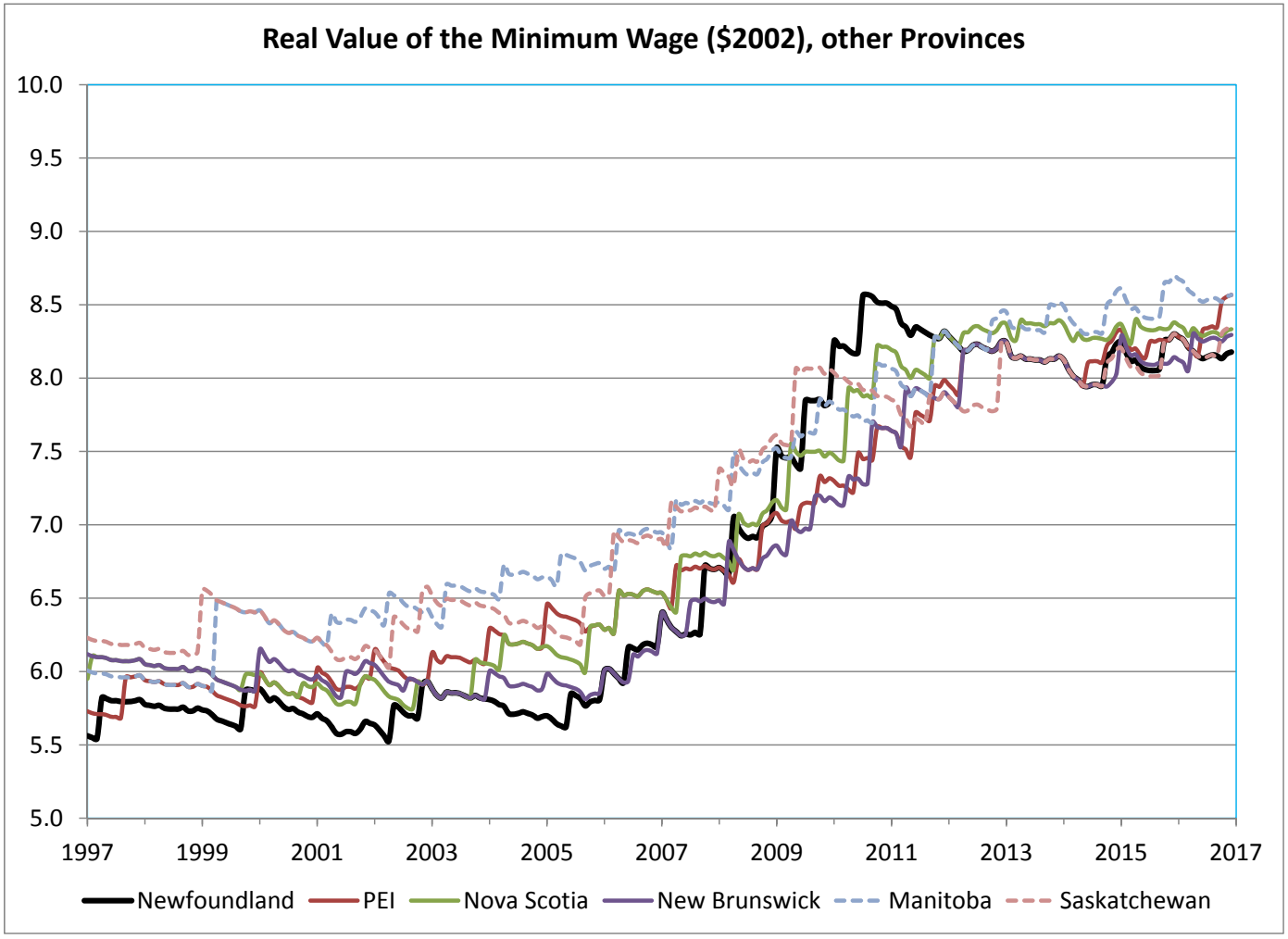
- Span period 1997-2016
- 157 nominal changes in this period
  - Many of these changes are small (median of 3.8 percent, mean of 4.3 percent)
  - 47 changes are 5 percent or more, the largest is 18 percent
- Focus on adult minimum wage
- Minimum wage in force on 15th of each month
- Deflated using CPI (2002 = 100)

Minimum wage in Canada

Minimum wage in Canada



Minimum wage in Canada



Canadian Wage Data

Labour Force Survey, monthly

- Approximately 50,000 households per month
- Consistent job tenure question since 1976:
  - "When did ... start working for his current employer?"
- Focus on wage and salary workers aged 15 to 59
- Pool data at the quarterly level from January 1997 to December 2016
- Main sample: hourly wage workers who do not receive tips or commissions

Canadian Wage Data

Labour Force Survey

- Respondents are in sample for 6 consecutive months
- Wages are only "fresh" in entry month to sample or after a job change, but month-in-sample is not identified in the public use files
- Focus on the effect of the minimum wage 6 months after a change to deal with this problem (add interactions between minimum wage dummies and the minimum wage having increased less than 6 months ago)
- Month-in-sample available in the master files (not used in this draft), so we can use the incoming sample each month.

Canadian Data: covariates

- Year and province dummies, quarter dummies, province-specific quadratic trends, and full set of province-year dummies in some models (triple-differences)
- Education dummies: high school drop outs; high school graduates; post-secondary diploma or certificate; university degree.
- Age group dummies: 15-19; 20-24; 25-34; 35-54; and 55-59.
- Dummy for integer dollar value in the wage bin (special dummies at \$10 in some specifications).
- Run everything separately by gender.
- Get number with wages in each cell defined by: wage bins, province, quarter, age group, and education group. i.e., not estimating the models at the individual level
- Estimate as a GLM on the grouped data. Maximum likelihood approach because many cells have zeros.

U.S. Data

- MORG CPS from 1987 to 2016
- Unallocated wages only
- Minimum wage is either the federal minimum or the state minimum wage (when higher)
- Specifications are otherwise similar to those for Canada.
- Some of the models are estimated at the state-quarter level (instead of state-quarter-age-education) to reduce the computational burden, but this has very little impact on the results.

Minimum wages in the United States

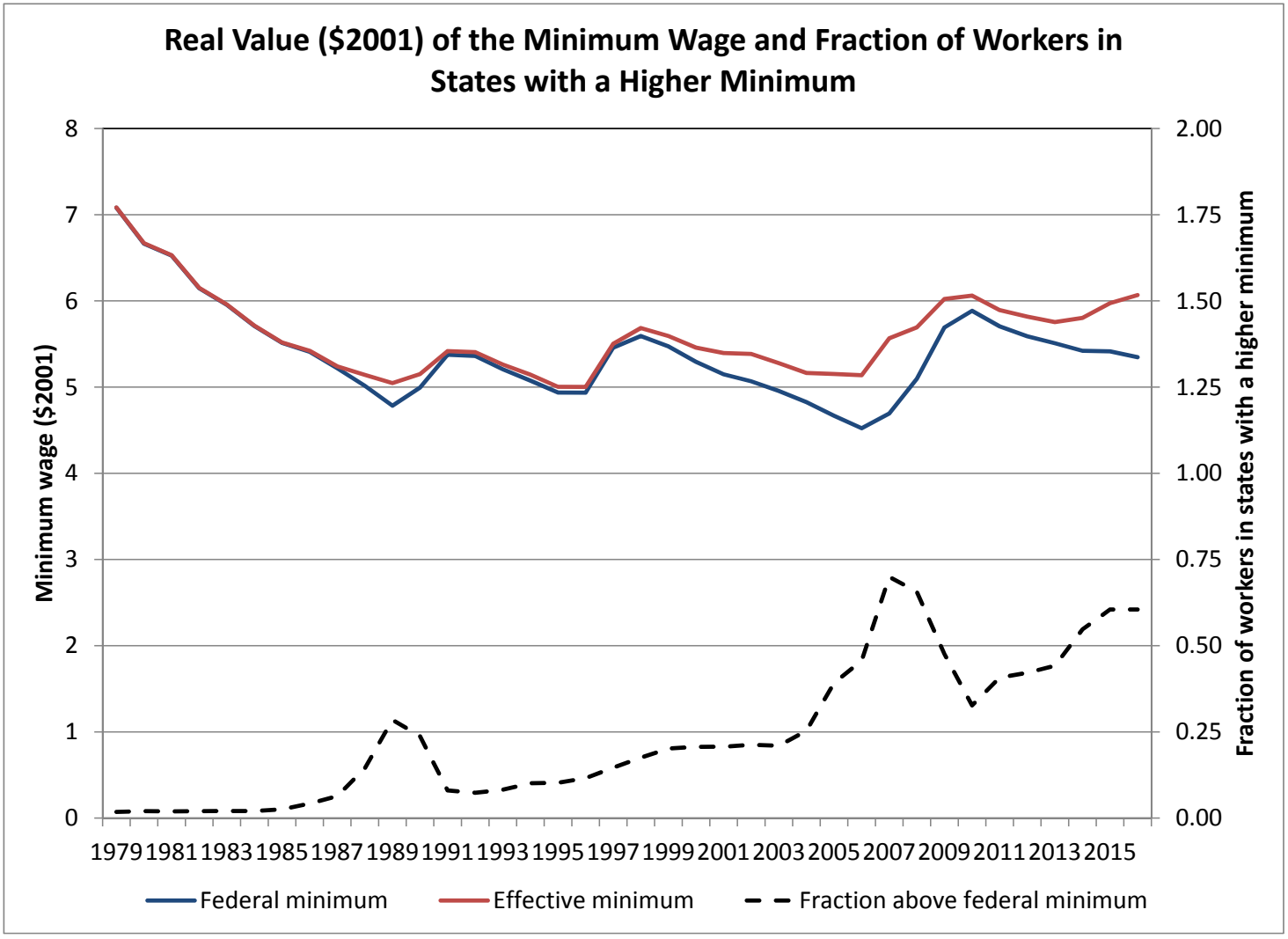


Table 1a: Estimated minimum wage effects for women, LFS public use files 1997-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Minimum wage effects:								
More than 50¢ below	-2.123	-1.702	-1.711	-1.590	-1.713	-1.717	-1.601	-1.717
	(0.413)	(0.283)	(0.317)	(0.405)	(0.373)	(0.345)	(0.278)	(0.376)
30¢ to 50¢ below	-1.133	-0.824	-0.832	-0.590	-0.918	-0.971	-0.864	-0.922
	(0.341)	(0.233)	(0.256)	(0.371)	(0.465)	(0.427)	(0.372)	(0.467)
10¢ to 30¢ below	-0.442	-0.164	-0.173	-0.192	-0.761	-0.823	-0.719	-0.765
	(0.235)	(0.118)	(0.137)	(0.164)	(0.171)	(0.126)	(0.069)	(0.174)
At minimum wage	1.697	1.966	1.959	1.837	1.849	1.816	1.917	1.846
	(0.238)	(0.129)	(0.144)	(0.304)	(0.350)	(0.287)	(0.215)	(0.352)
10¢ to 30¢ above	0.539	0.799	0.793	0.790	0.776	0.689	0.787	0.773
	(0.260)	(0.147)	(0.167)	(0.200)	(0.221)	(0.181)	(0.124)	(0.225)
30¢ to 50¢ above	0.200	0.429	0.425	0.599	0.616	0.550	0.643	0.613
	(0.165)	(0.106)	(0.103)	(0.126)	(0.133)	(0.149)	(0.144)	(0.136)
50¢ to $1 above	0.125	0.316	0.312	0.393	0.364	0.294	0.379	0.361
	(0.117)	(0.074)	(0.073)	(0.075)	(0.079)	(0.078)	(0.089)	(0.082)
$1 to $1.50 above	0.107	0.256	0.255	0.215	0.195	0.138	0.213	0.193
	(0.078)	(0.025)	(0.026)	(0.026)	(0.031)	(0.073)	(0.114)	(0.033)
$1.50 to $2.00 above	-0.055	0.047	0.049	0.203	0.233	0.196	0.257	0.233
	(0.113)	(0.130)	(0.126)	(0.057)	(0.076)	(0.096)	(0.119)	(0.076)
$2.00 to $2.50 above							0.064	
							(0.062)	
$2.50 to $3.00 above							-0.008	
							(0.035)	
Integer wage in bin				1.816	1.818	1.824	1.824	1.818
				(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Log pseudolikelihood (/1000)	-370900	-368615	-368398	-249299	-247923	-246243	-246228	-247867
Province trends	no	yes	yes	yes	yes	yes	yes	yes
Segments w/ prov-year dummies			1	1	1	1	1	1&2
Interaction w/ first 6 months	no	no	no	no	yes	yes	yes	yes
Prov-wage & year-wage effects	no	no	no	no	no	yes	yes	no

Table 1b: Estimated minimum wage effects for men, LFS public use files 1997-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Minimum wage effects:								
More than 50¢ below	-1.755	-1.426	-1.473	-1.323	-1.369	-1.295	-1.335	-1.378
	(0.440)	(0.295)	(0.300)	(0.417)	(0.389)	(0.361)	(0.284)	(0.392)
30¢ to 50¢ below	-0.753	-0.523	-0.562	-0.265	-0.360	-0.317	-0.356	-0.367
	(0.380)	(0.270)	(0.272)	(0.427)	(0.519)	(0.494)	(0.415)	(0.522)
10¢ to 30¢ below	-0.145	0.060	0.023	-0.021	-0.481	-0.452	-0.491	-0.488
	(0.245)	(0.121)	(0.130)	(0.155)	(0.159)	(0.127)	(0.078)	(0.161)
At minimum wage	1.845	2.046	2.012	1.898	1.945	1.996	1.957	1.938
	(0.232)	(0.120)	(0.128)	(0.308)	(0.368)	(0.322)	(0.217)	(0.370)
10¢ to 30¢ above	0.557	0.753	0.722	0.718	0.713	0.710	0.672	0.706
	(0.212)	(0.096)	(0.102)	(0.145)	(0.154)	(0.138)	(0.133)	(0.157)
30¢ to 50¢ above	0.247	0.424	0.397	0.614	0.657	0.674	0.637	0.651
	(0.157)	(0.103)	(0.110)	(0.137)	(0.142)	(0.147)	(0.153)	(0.144)
50¢ to $1 above	0.155	0.305	0.283	0.384	0.389	0.398	0.363	0.384
	(0.112)	(0.080)	(0.085)	(0.078)	(0.079)	(0.076)	(0.103)	(0.081)
$1 to $1.50 above	0.122	0.243	0.228	0.178	0.182	0.189	0.156	0.178
	(0.086)	(0.035)	(0.039)	(0.040)	(0.045)	(0.075)	(0.133)	(0.046)
$1.50 to $2.00 above	-0.101	-0.014	-0.021	0.172	0.229	0.240	0.209	0.227
	(0.127)	(0.144)	(0.145)	(0.067)	(0.084)	(0.101)	(0.138)	(0.084)
$2.00 to $2.50 above							-0.025	
							(0.080)	
$2.50 to $3.00 above							-0.066	
							(0.043)	
Integer wage in bin				2.081	2.084	2.089	2.088	2.084
				(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Log pseudolikelihood (/1000)	-375599	-373603	-373360	-236036	-235391	-234173	-234161	-235317
Province trends	no	yes	yes	yes	yes	yes	yes	yes
Segments w/ prov-year dummies			1	1	1	1	1	1&2
Interaction w/ first 6 months	no	no	no	no	yes	yes	yes	yes
Prov-wage & year-wage effects	no	no	no	no	no	yes	yes	no

Figure 1a: Effect of the minimum wage on wage bin probabilities for women (logs)

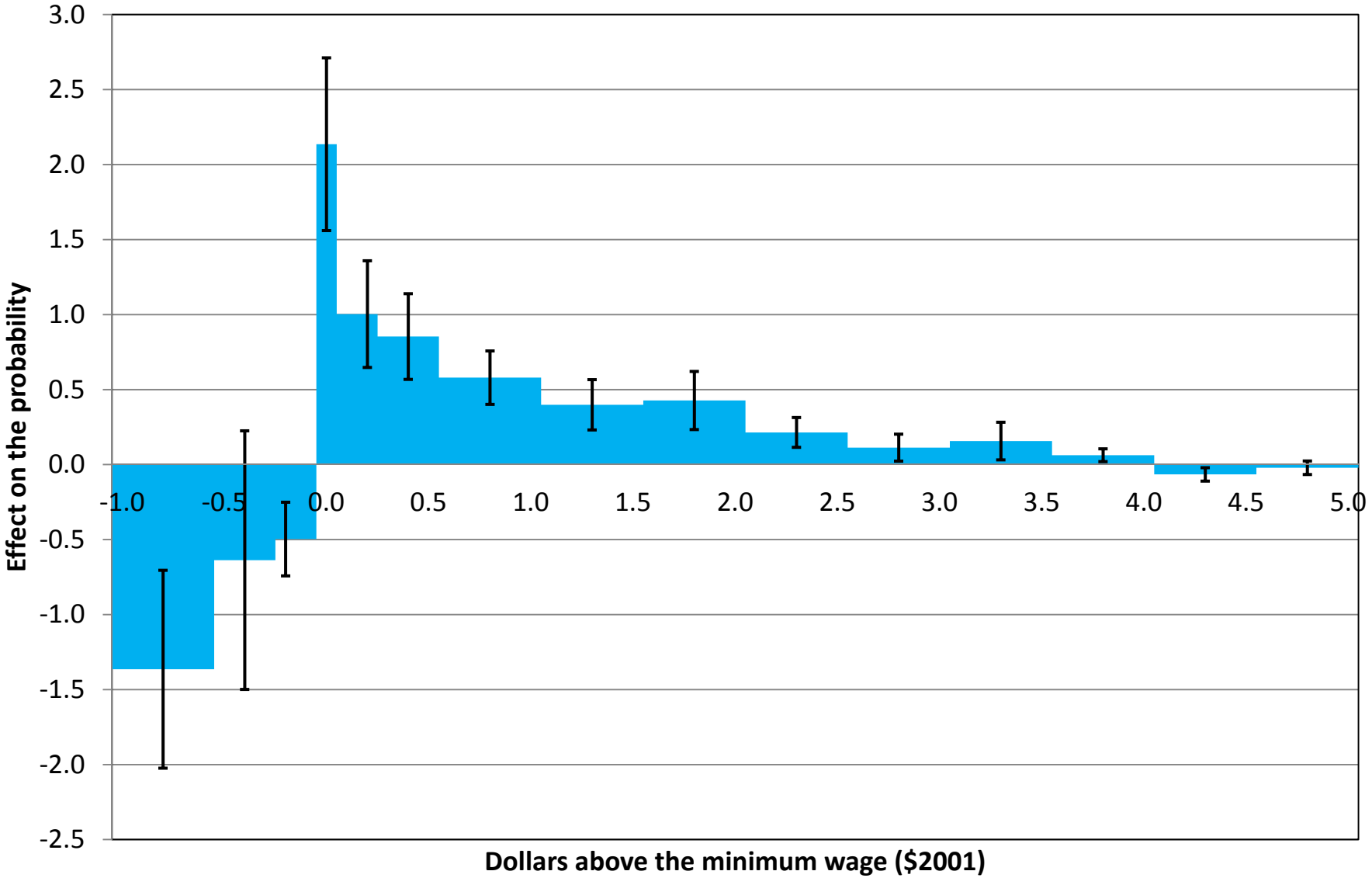


Figure 1b: Effect of the minimum wage on wage bin probabilities for men (logs)

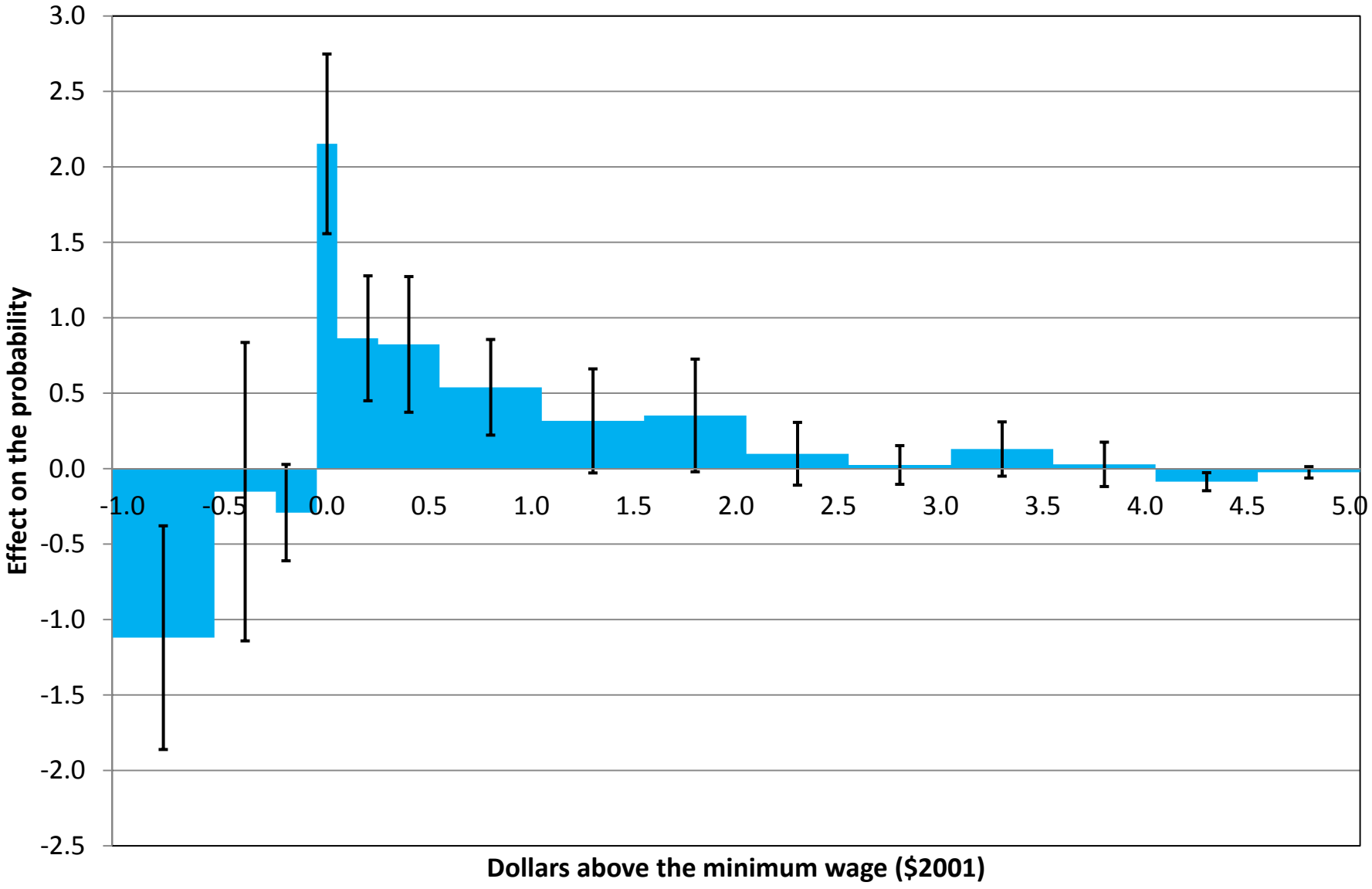


Figure 2a: Effect of the minimum wage on wage bin probabilities for women (% terms)

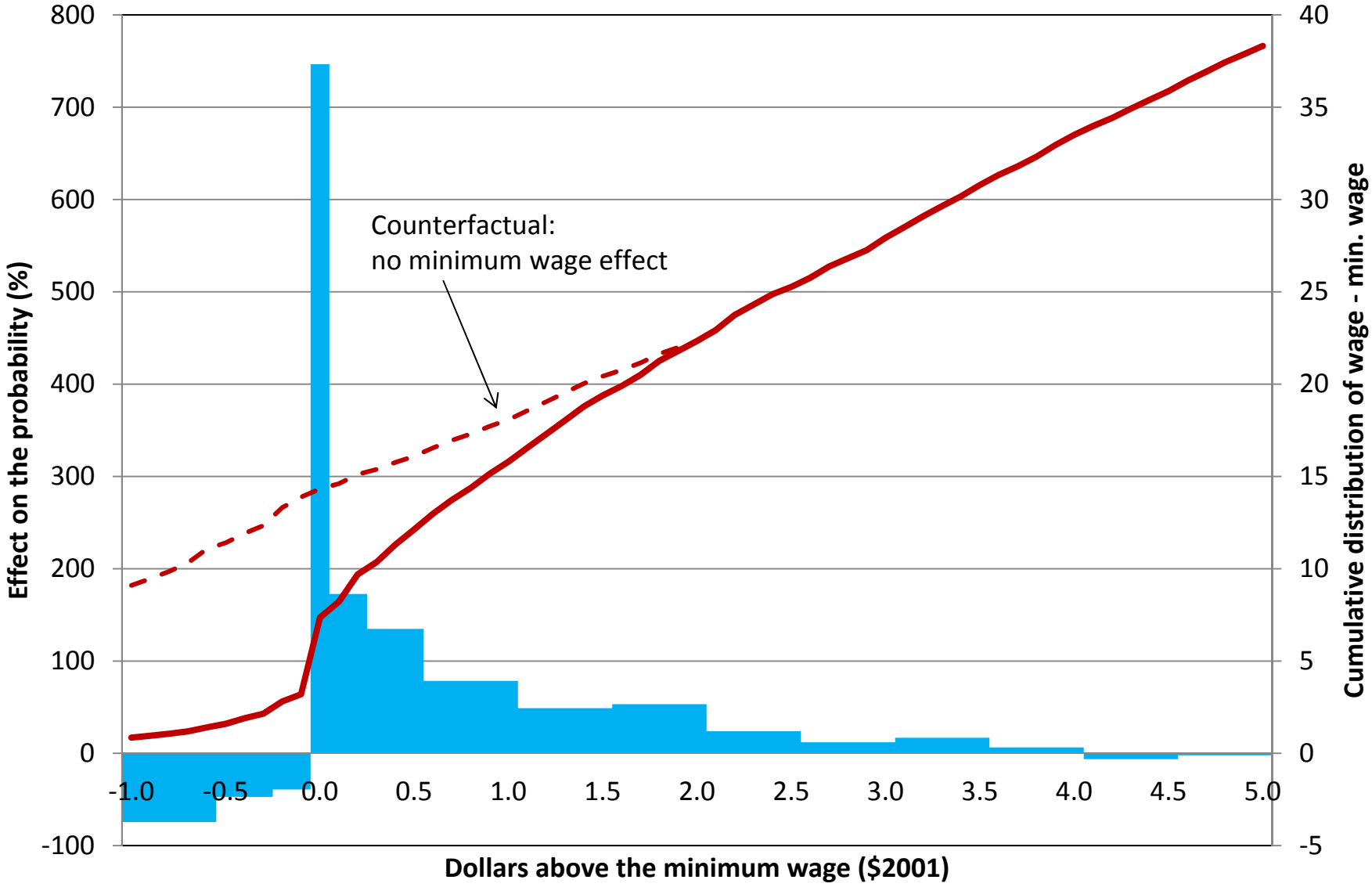


Figure 2b: Effect of the minimum wage on wage bin probabilities for men (% terms)

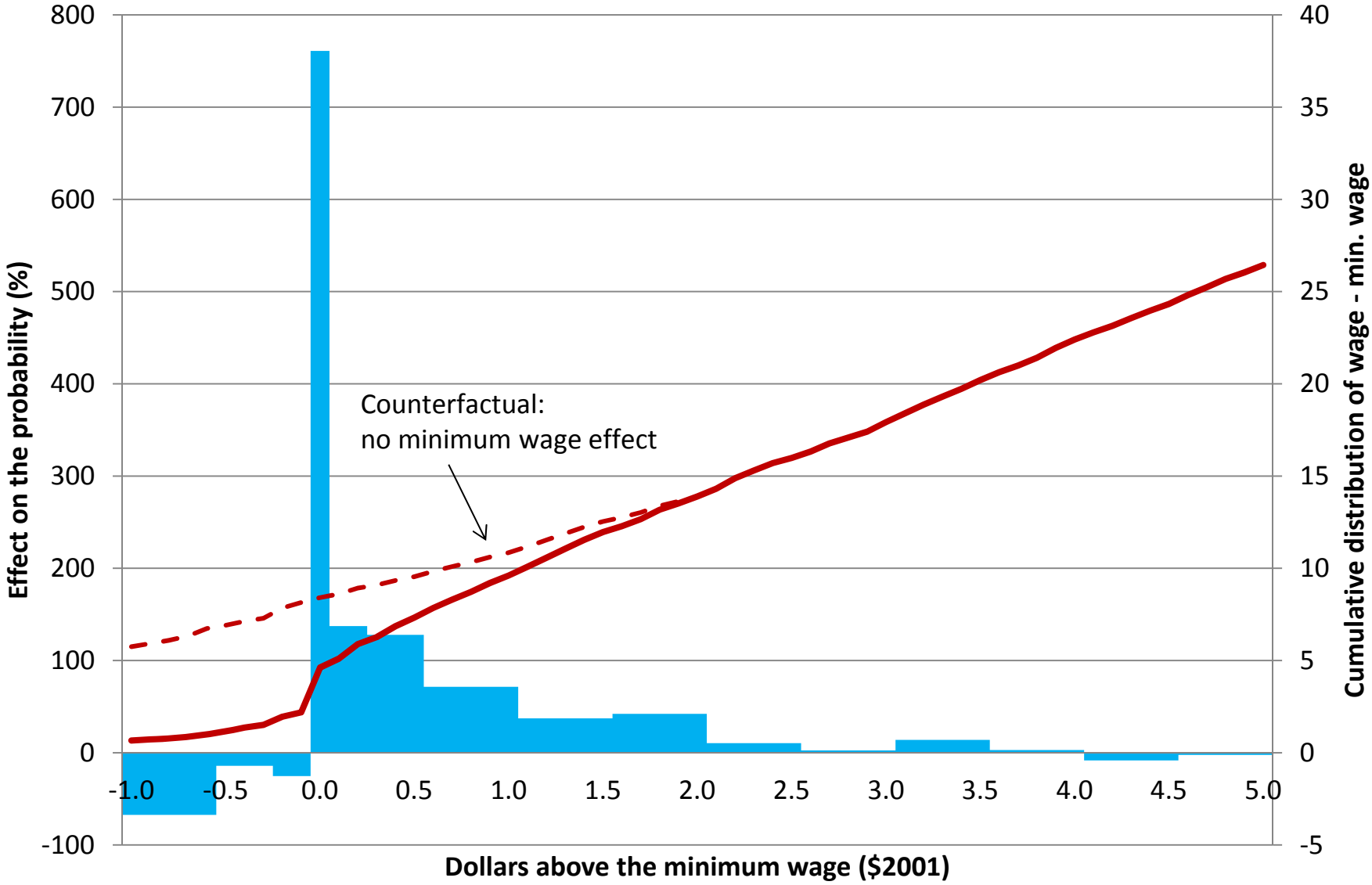


Table 2: Estimates effects of the minimum wage by job tenure, LFS public use files 1997-2016

	Women		Men	
	Tenure<=1 yr	Tenure>1 yr	Tenure<=1 yr	Tenure>1 yr
	(1)	(2)	(3)	(4)
Minimum wage effects:				
More than 50¢ below	-1.835	-1.565	-1.464	-1.101
	(0.416)	(0.304)	(0.442)	(0.284)
30¢ to 50¢ below	-0.871	-1.012	-0.213	-0.404
	(0.533)	(0.343)	(0.601)	(0.381)
10¢ to 30¢ below	-0.804	-0.846	-0.473	-0.465
	(0.174)	(0.118)	(0.133)	(0.128)
At minimum wage	2.125	1.517	2.203	1.744
	(0.326)	(0.291)	(0.360)	(0.315)
10¢ to 30¢ above	0.862	0.531	0.778	0.610
	(0.226)	(0.179)	(0.159)	(0.127)
30¢ to 50¢ above	0.710	0.445	0.763	0.598
	(0.215)	(0.116)	(0.169)	(0.137)
50¢ to $1 above	0.404	0.224	0.453	0.353
	(0.122)	(0.059)	(0.080)	(0.077)
$1 to $1.50 above	0.214	0.094	0.208	0.172
	(0.113)	(0.049)	(0.083)	(0.066)
$1.50 to $2.00 above	0.264	0.164	0.284	0.216
	(0.122)	(0.078)	(0.102)	(0.098)

Table 3: Estimates effects of the minimum wage in the United States

	Women				Men			
	1987-2002	2003-2016	1987-2002		1987-2002	2003-2016	1987-2002	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Minimum wage effects:								
More than 50¢ below	-0.880	-0.913	-0.800	-1.021	-0.823	-0.626	-0.678	-0.917
	(0.170)	(0.088)	(0.075)	(0.046)	(0.131)	(0.060)	(0.048)	(0.054)
30¢ to 50¢ below	-0.976	-0.665	-0.708	-0.939	-0.920	-0.334	-0.541	-0.787
	(0.197)	(0.114)	(0.122)	(0.091)	(0.193)	(0.097)	(0.100)	(0.078)
10¢ to 30¢ below	-0.822	-0.526	-0.551	-0.769	-0.756	-0.369	-0.480	-0.704
	(0.127)	(0.102)	(0.082)	(0.068)	(0.136)	(0.070)	(0.060)	(0.055)
At minimum wage	2.113	1.983	2.164	1.995	2.232	2.146	2.278	2.098
	(0.194)	(0.145)	(0.144)	(0.112)	(0.200)	(0.154)	(0.143)	(0.114)
10¢ to 30¢ above	0.679	0.770	0.814	0.685	0.690	0.854	0.833	0.692
	(0.095)	(0.071)	(0.057)	(0.039)	(0.075)	(0.057)	(0.034)	(0.040)
30¢ to 50¢ above	0.478	0.353	0.501	0.406	0.546	0.412	0.539	0.431
	(0.097)	(0.112)	(0.088)	(0.065)	(0.106)	(0.108)	(0.084)	(0.062)
50¢ to $1 above	0.177	0.290	0.275	0.207	0.138	0.313	0.254	0.175
	(0.042)	(0.067)	(0.051)	(0.035)	(0.048)	(0.063)	(0.047)	(0.034)
$1 to $1.50 above	0.212	0.026	0.118	0.096	0.173	0.043	0.094	0.059
	(0.019)	(0.055)	(0.036)	(0.025)	(0.020)	(0.067)	(0.042)	(0.029)
$1.50 to $2.00 above	0.113	0.044	0.068	0.052	0.102	0.024	0.045	0.020
	(0.017)	(0.031)	(0.020)	(0.015)	(0.024)	(0.044)	(0.029)	(0.021)
State-year dummies (seg. 1)	yes	yes	yes	no	yes	yes	yes	no
Covariates	no	no	no	yes	no	no	no	yes

Figure 3a: Effect of the minimum wage on wage bin probabilities for U.S. women (logs)

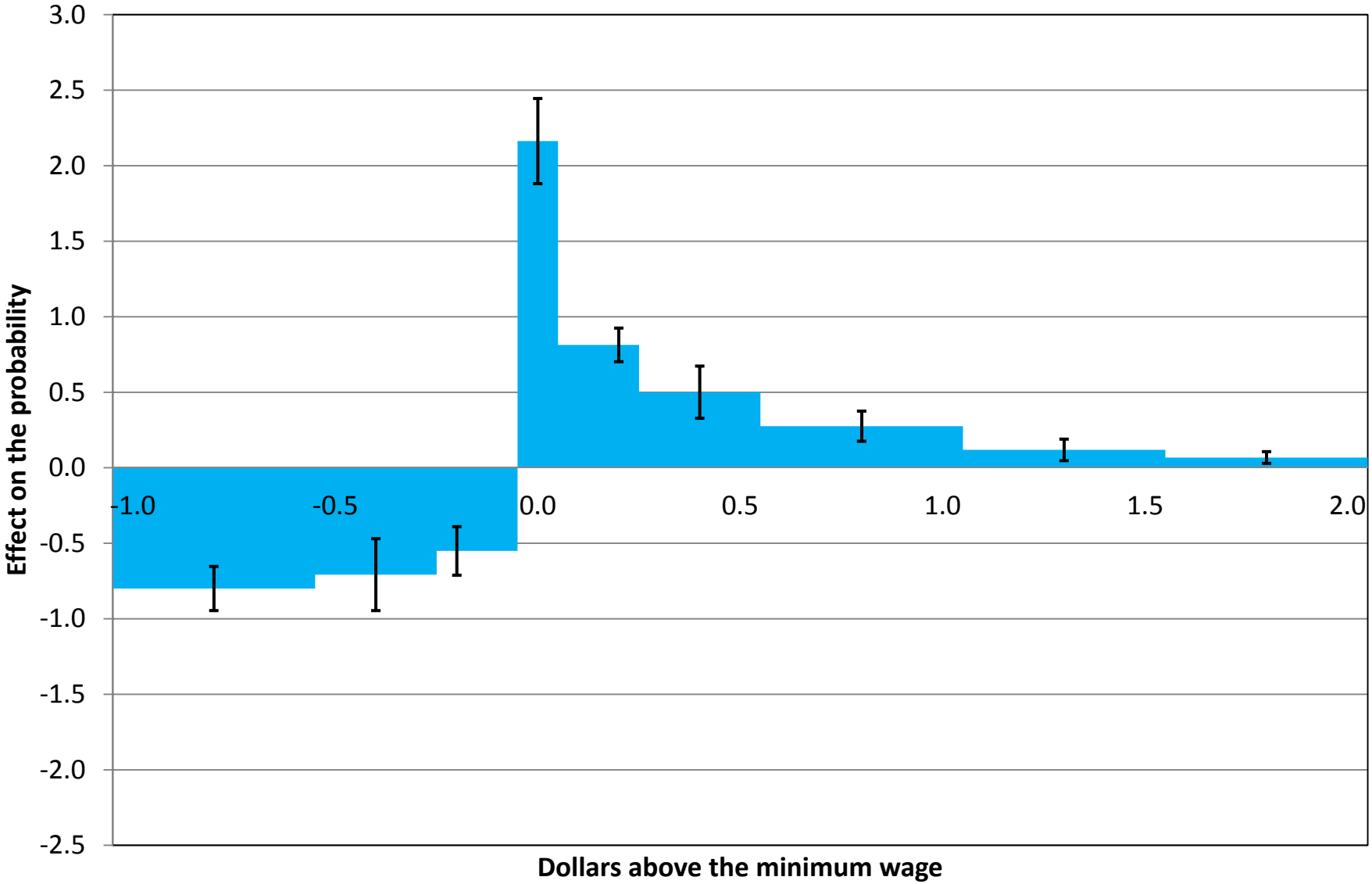


Figure 3a: Effect of the minimum wage on wage bin probabilities for U.S. men (logs)

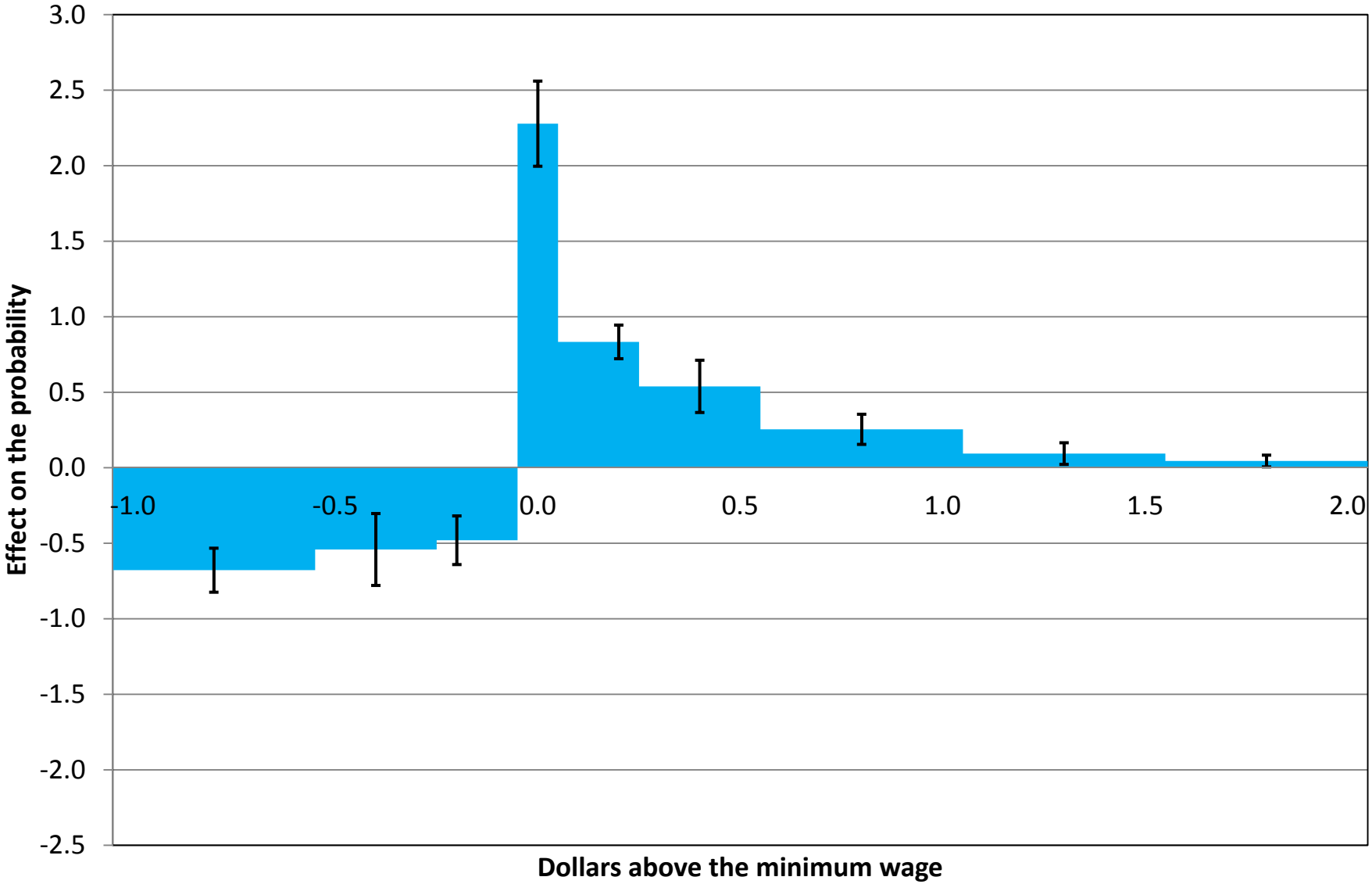


Figure 4a: Effect of the minimum wage on wage bin probabilities for U.S. women (% terms), 1987-2016

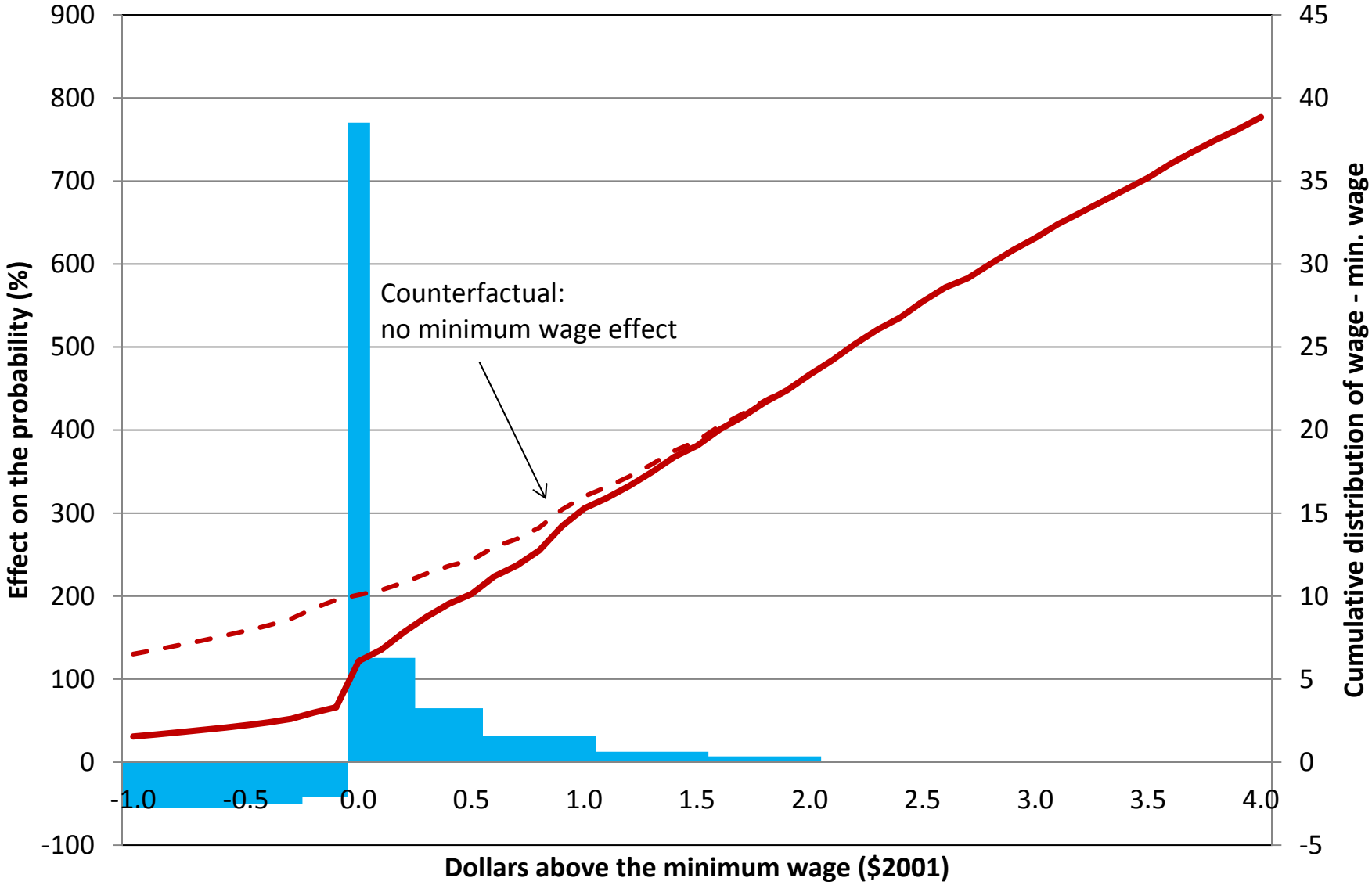
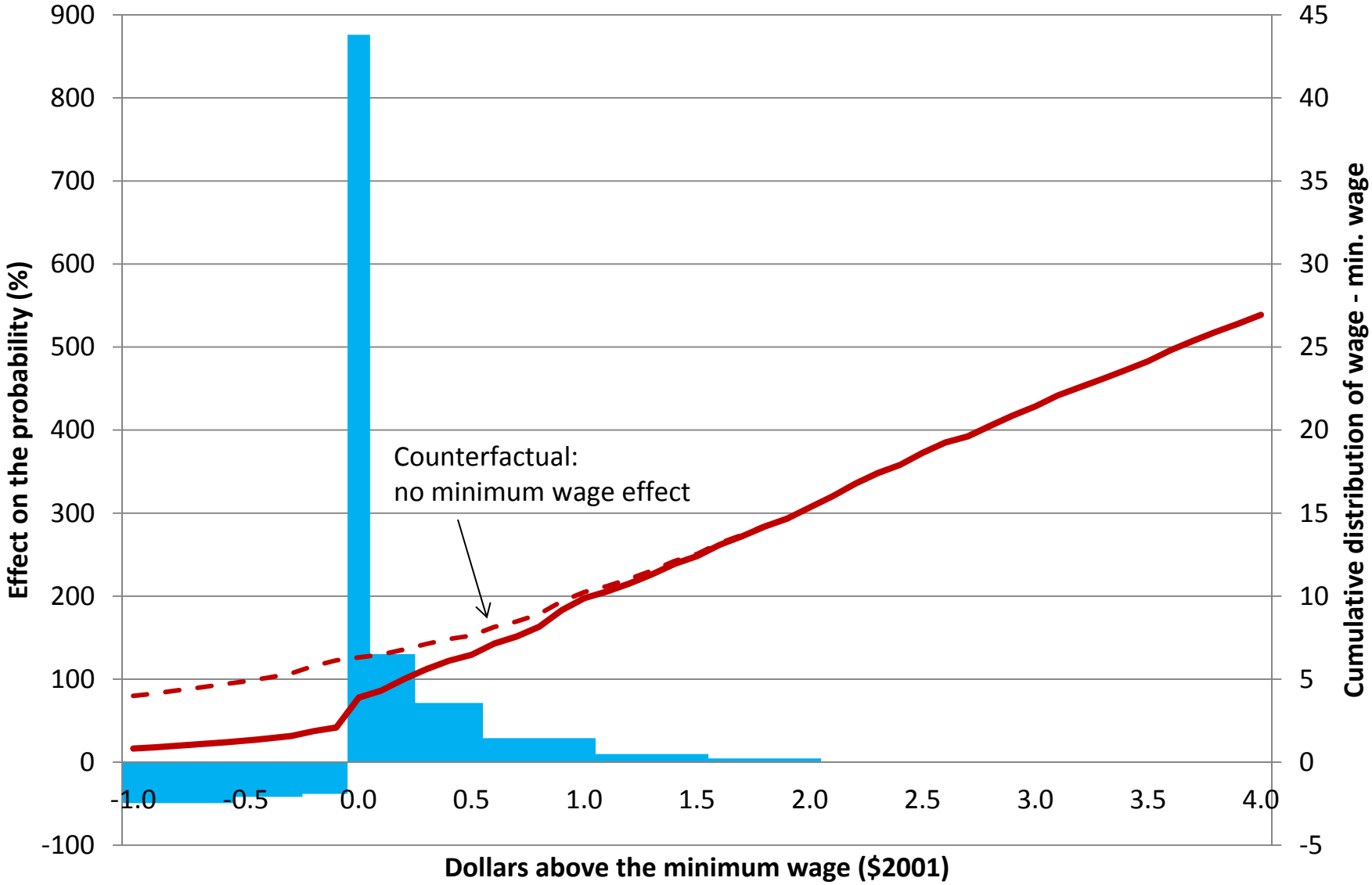
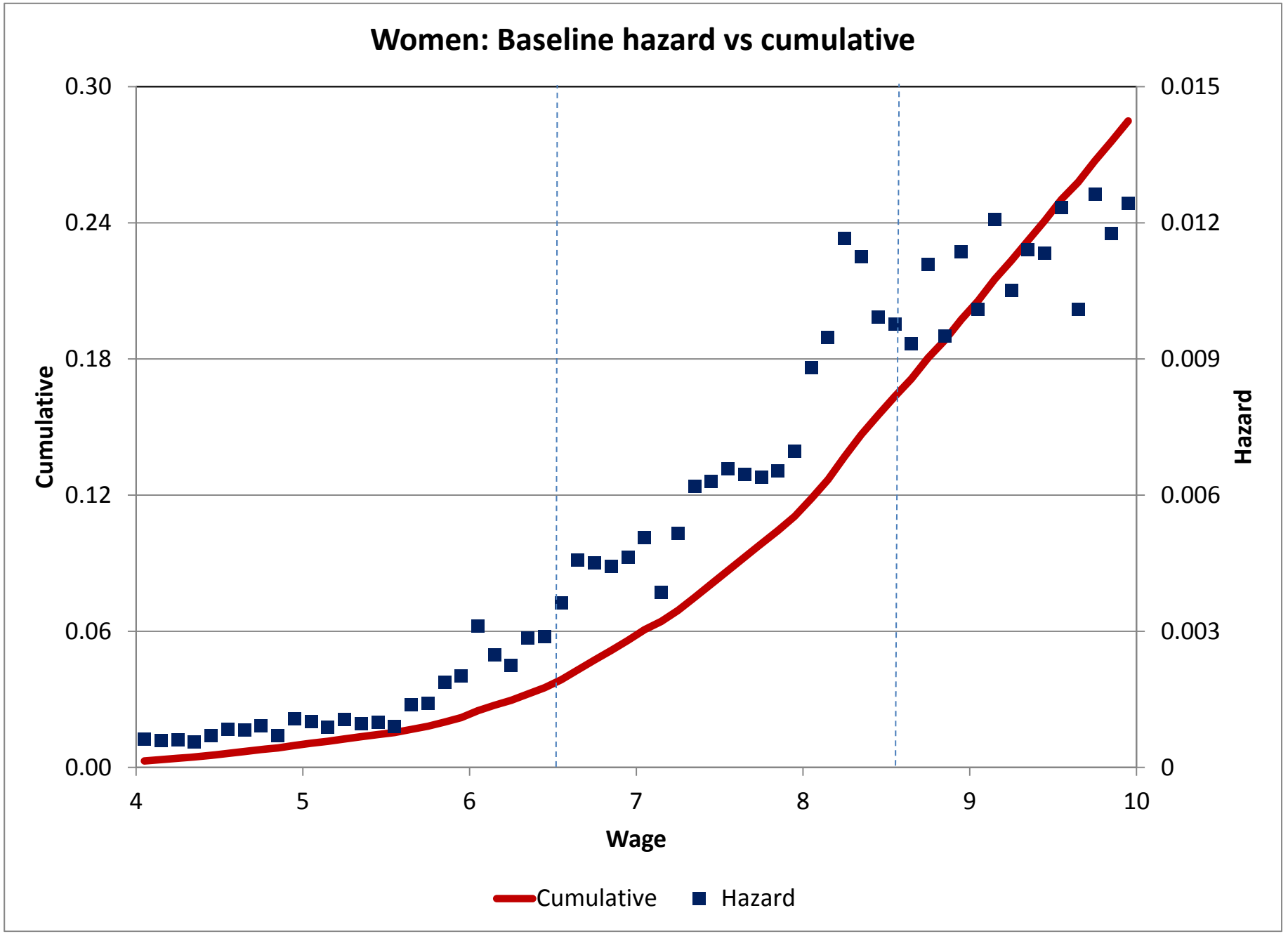


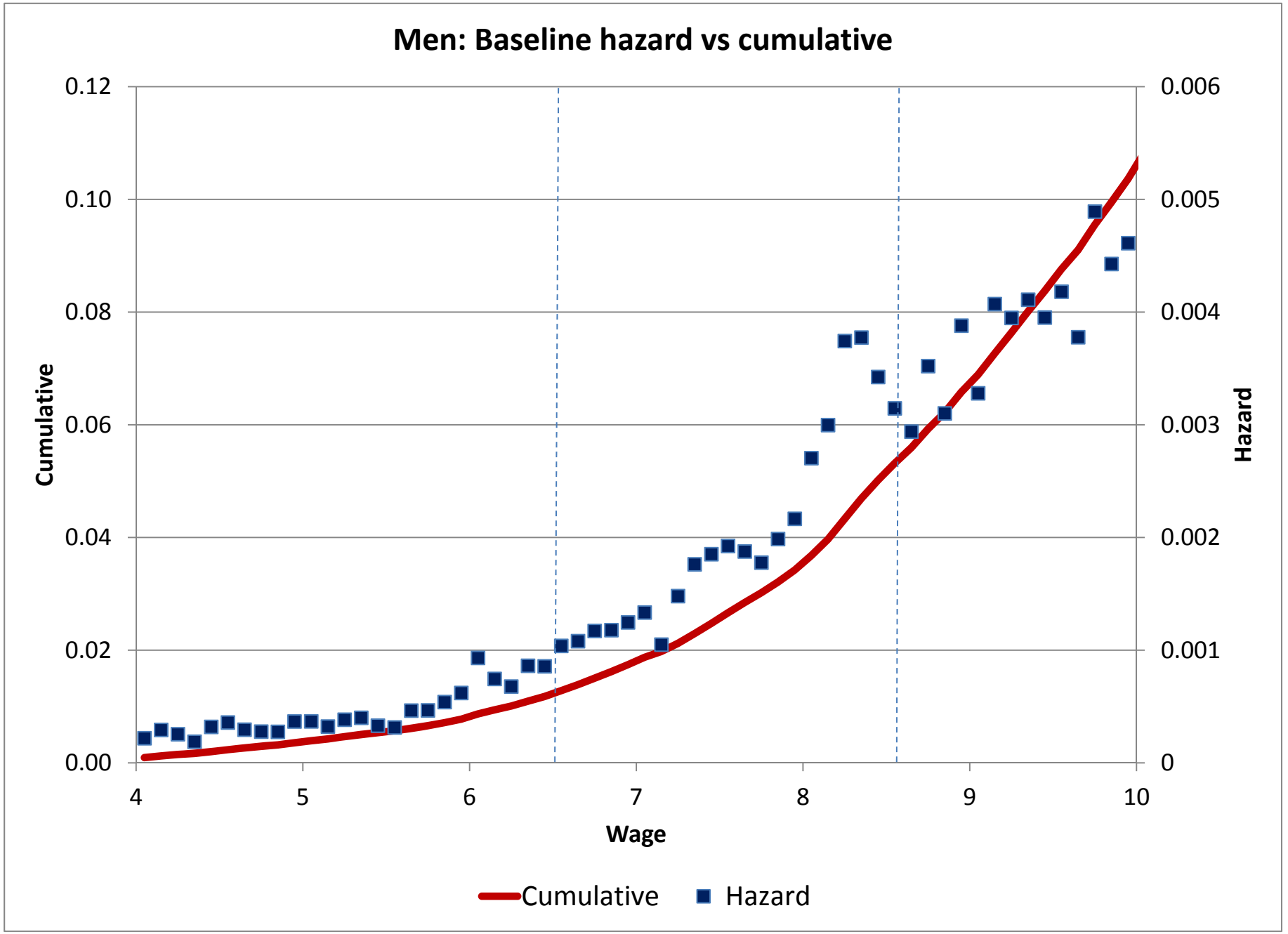
Figure 4b: Effect of the minimum wage on wage bin probabilities for U.S. men (% terms), 1987-2016



Conclusions

- Evidence of spillover effects up to \$2-\$2.5 above the minimum wage in both Canada and the United States
  - On average, less than 5 percent of men are at or below the minimum wage, but spillover effects reach out to the 10^{th}-15^{th} percentile of the wage distribution
  - On average, slightly more than 5 percent of women are at or below the minimum wage, and spillover effects reach out to about the 20^{th} percentile of the wage distribution.
- Introducing dummy variables for integer wage values greatly improves the fit of the model
- The model captures well the proportional effect of the minimum wage: estimates for men and women similar despite the large minimum wage "byte" for women.
- Standard difference-in-differences model appears to be mispecified, but estimates with province/state-specific quadratic trends are similar to those with a full set of province/state-year dummies.


Women: Baseline hazard vs cumulative
0.30
0.24
0.18
0.12
0.06
0.00
Cumulative
0.015
0.012
0.009
0.006
0.003
0
Hazard
4
5
6
7
8
9
10
Wage
Cumulative
Hazard


Men: Baseline hazard vs cumulative
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Cumulative
0.006
0.005
0.004
0.003
0.002
0.001
0
Hazard
4
5
6
7
8
9
10
Wage
Cumulative
Hazard