Municipal Broadband Restrictions & COVID-19 Labor Supply

Jessica Van Parys
Hunter College & NBER

Saket Hegde
Philadelphia Fed

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The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Motivation 1: Low Adoption & State Bans

- BB still far from universal (Pew 2021)
  - $>$ 25% of Americans lack home BB
  - **Price**, **availability** & **speed** cited as top reasons
- As of 2020, 17 states banned Municipal and/or Co-op BB (BroadbandNow 2021)
  - 60% of U.S. Counties with these providers
  - Case Studies: Muni/Co-ops offer stable prices, up to 50% lower (Talbot, Hessekiel and Kehl 2018)
  - Bans reduced (state) BB *access* by **4.5%** between 2012-18 (Whitacre and Gallardo 2020)

Did State Restrictions on Muni/Co-op BB affect COVID-era adoption?

Little is known about **why** adoption is lower in restriction states, especially after COVID

First to examine adoption, plan choice, affordability outside of case studies

Motivation 2: Moms have High Demand for BB

- Sustained shift in BB demand for Work Infrastructure
  - 28% of paid days still WFH in mid-2023 (Barrero, Bloom & Davis 2023)
- Moms responsive to time-saving technology; helps balance caregiving (Greenwood et al. 2005; Nieto 2023)
- BB use drives maternal labor supply
  - Substantial **4.1pp LFP** effect pre-COVID (Dettling 2017)
  - **Moms** drove the **post-COVID LFP rebound**; **value WFH the most** (Bauer & Wang 2023)

Did Restrictions hinder Moms' Labor Market Recovery?

Little is known about how marginally attached workers adjust supply due to a lack of BB competition

Motivation 3: Marginal Mom is Price Constrained

- Low willingness to pay (WTP) for BB:
  - Out of labor force with no own income
  - (Potential) Childcare costs
  - LF entry requires **buying/upgrading** (speed, caps, equipment)
- Non-adopters would pay $16 vs. $89 average monthly charge (NTIA 2023; FCC URS 2023)
- 53% of women find it **difficult to afford** utilities including **internet** (Politico 2025)
- 33% of non-adopters previously had BB: "cutting the cord" is common (Pew 2019)

Did Restrictions hinder Moms' Labor Market Recovery?

Budgets strained by caregiving create a wedge between the socioeconomic value of connectivity & private WTP

Challenges in Estimating Effects of State Restrictions

What are the effects of Restrictions on COVID-era BB Adoption, Labor Supply?

- Fixed, time-varying differences between States:
  - States with incumbent advantages → regulatory capture, pre-existing differences in BB use
  - Asymmetric macro trends may bias labor supply estimates upward
    Texas (restriction state) may be entering a localized tech boom while Oklahoma may be stagnating
  - Regional differences in gender norms
    South may have more support for stay-at-home moms, but normalizes children being in adult spaces
- Pandemic effects varied by public health policies, school closures
  - Market tightness may have expanded demand for workers/moms
  - Remote schooling may have reduced maternal labor supply

This Paper: Restrictions & 2018–22 BB Adoption, Labor Supply

- Exploit exogenous increase in COVID demand for at-home BB (simple DD)
  - Restrictions proxy for incumbent-friendly environment
  - County FE's $\rightarrow$ differences in initial BB adoption*
- Rich controls from individual (CPS) or county (ACS5) data
  - Focus on moms - responsive to BB
  - Comparison groups (dads, women without children) - lower labor supply elasticity
- Control for time-varying labor demand
  - Region-by-Time FE's (also account for time-varying differences in norms)
    e.g. Compare Alabama (restriction state) with Mississippi in same quarter
  - Bartik: state differences in labor demand/pre-existing teleworkable share
- Control for COVID cases, deaths and school closures (county)
  - Highly correlated with stay-at-home orders
  - Better than stay-at-home dummies (non-compliance & differences in duration)

*Some of this captures the effect of restrictions – our estimates are likely a floor

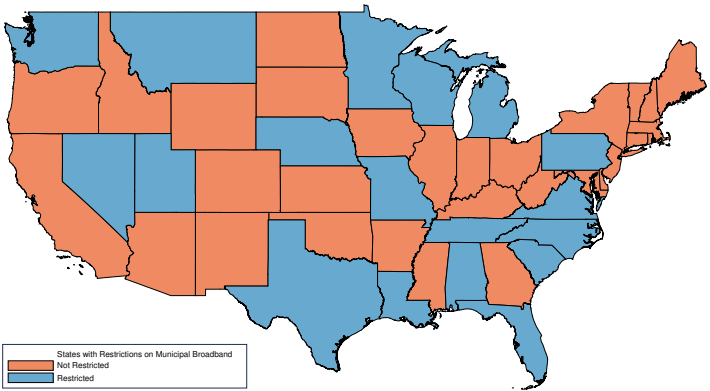
Preview - Effect of BB Restrictions on Pandemic Labor Supply

- Subscribership grew **4–8% slower** post-2020 in Restriction States
  - Driven by counties with **lower ISP competition**, **more expensive plans**
- Employment recovers **4.7% slower** for moms in Restriction States
  - Almost entire effect from dropping out of labor force and shift to caregiving
  - Large time shifts: **49% lower WFH**, **26% higher commute** among moms continuing to work

Contributions

1. **State broadband policy → Adoption**
   - Builds on Whitacre & Gallardo (2020) (restrictions reduce pre-COVID access)
     Carvalho, Hagerman & Whitacre (2022) (low adoption slowed post-COVID job recovery in SE U.S.)
   - First to show *why* adoption is lower
2. **Broadband → Maternal Labor supply in the Telework Era**
   - Impact of School Closures/Reopenings on maternal labor supply: Garcia & Cowan (2022); Hansen, Sabia & Schaller (2024)
   - First to show restriction states see relative losses in moms' LFP

Restrictions geographically dispersed & long-standing



Source: BroadbandNow. Map shows 2018 status; AR, CA, WA are excluded from the analysis.

- Pre-emption laws enacted 1991–2011; most 1997–2005
- Rarely repealed: only AR, CA, WA changed 2018–22 & are dropped
- Treatment fixed well before COVID

Data

Source	Use
BroadbandNow	State Municipal Restrictions
FCC Form 477 (County, Biannual)	**Subscribership*** (connections/1,000 households), 2018–22
FCC Area Tables	**Competition**: % of county with 0, 1, 2+ wireline ISPs (2018–21)
FCC Urban Rate Survey	**Plans**, prices, **data caps** (state)
BroadbandNow	Lowest 25/3 price (county, 2020)
CPS Internet Supplement	Home internet, video calls, job search (Nov 2017/19 vs. 2021/23)
CPS monthly, Prime-Age	LFP, Emp, Hours, Caregiving (2018–2022)
ATUS	Minutes worked from home, commuting (2017-2022, smaller sample)
CDC; Parolin & Lee (2022)	County COVID cases/deaths; school closures (SafeGraph)

*FCC releases subscribership only in tiers (0, 1–200, ..., 800+ per 1,000 HH); we collapse to <40%, 40–60%, >60%.

Data Choices

Pre-COVID: Lower adoption, Less Competition in Restriction States

County averages, Jun 2018–Dec 2019	Non-restriction	Restriction	Difference
Subscribership: % of counties with 60%+ of households connected			
100 Mbps+	3.72	2.67	**-1.05****
10 Mbps+	25.19	23.91	-1.27
Availability: % of county population with …			
0 providers, 100/10 Mbps	30.83	35.15	**+4.32*****
0 providers, 25/3 Mbps	22.48	26.45	**+3.97*****
2+ providers, 25/3 Mbps	28.72	27.06	**-1.66****
2+ providers, 10/1 Mbps	45.10	42.07	**-3.03*****
Counties × periods	5,828	5,616	

No pre-COVID differences in the share of prime-age workers in **teleworkable** occupations (12.3% vs. 12.2%; Dingel & Neiman 2020).

Availability uses wireline technologies only (ADSL, cable, fiber, other for 10/1; cable, fiber, other for 25/3+). Satellite and fixed wireless excluded.

Empirical Specification: FCC Broadband Adoption

$$y_{ist} = \beta \left(\text{Muni}_s \times \text{Post}_t \right) + \Omega X_{it} + \delta_i + \lambda_t + \epsilon_{ist}$$

- County i, state s, half-year t (Jun 2018–Dec 2022)
- **Pre**:2018–19; **Post**:2020-22
- y_{ist}: **indicator** for subscribership $\geq$20% (100 Mbps+) or $\geq$60% (25 Mbps+, 10 Mbps+) — LPM
- Also **ologit** on the 3-tier outcome, with Dec 2017 adoption in place of county FE
- X_{it}: population, density, % college+, lagged employment, median income, % poverty (ACS 5-yr)
- SEs clustered by county

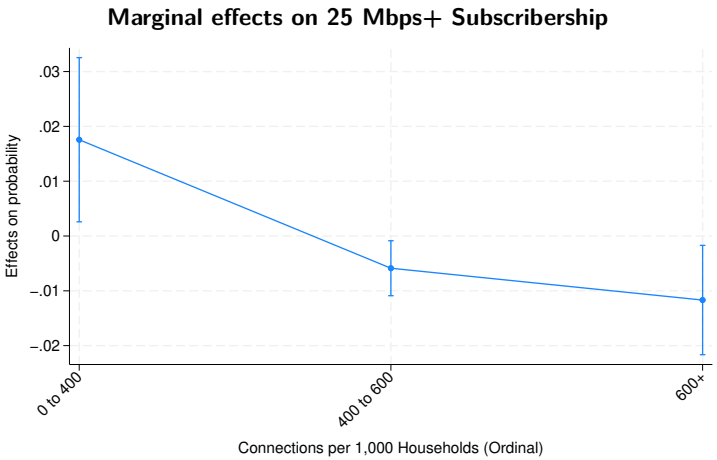
Empirical Specification: CPS/ATUS Internet Use, Labor Supply

$$y_{isrt} = \beta\,(\text{Muni}_s \times \text{Post}_t) + X'_{it}\Omega + C'_{ct}\Phi + \delta_s + \lambda_{t\times r} + \zeta B_{st} + \epsilon_{isrt}$$

- **Prime-age** (25–54) individual i, state s, census division r, quarter t
- Married women with kids 0–17; hereafter **moms**
  comparisons: women without kids, married fathers
- **Pre**:2018–19; **Post**:2020-22
- X_{it} includes individual controls on age, race, educ, metro area residency, MSA size, num kids, dummy=1 if kid under 13
- C_{ct}: county school closures, cumulative COVID cases & deaths
- $\lambda_{t\times r}$: division-by-quarter FE (e.g. AL, TN vs. KY, MS)
- B_{st}: Bartik industry shift-share labor demand
- SEs clustered by state; CPS weights

Identifying assumption: Absent restrictions, mothers' outcomes would have evolved in parallel

Restrictions Reduce Probability of Higher BB Adoption



- Effects comparable with unconditional probability ($\sim$ 25% of counties have $\geq$ 60% 25Mbps+ adoption)
- Similar effects for 100 Mbps+

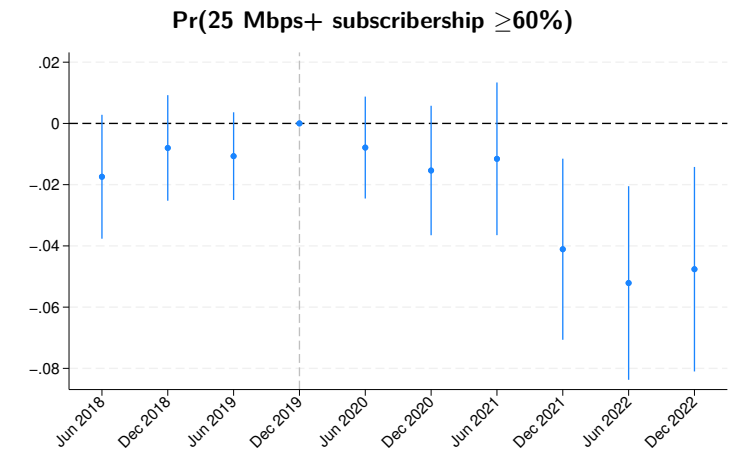
Restrictions Lowered Probability of Adequate Subscribership

	100 Mbps+		25 Mbps+		10 Mbps+	
	Ologit	LPM: $\geq$20%	Ologit	LPM: $\geq$60%	Ologit	LPM: $\geq$60%
Restrictions $\times$ Post	-0.455^{***}	-0.027^{**}	-0.207^{**}	-0.021^{*}	-0.023	-0.025^{**}
	(0.102)	(0.012)	(0.086)	(0.012)	(0.083)	(0.012)
Mean of dep. var.		0.611		0.254		0.408
Effect relative to mean		**-4.4%**		**-8.3%**		**-6.1%**

- Every speed tier affected

N = 28,592 county-periods. Controls listed on previous slides; LPMs include county FE. SEs clustered by county.

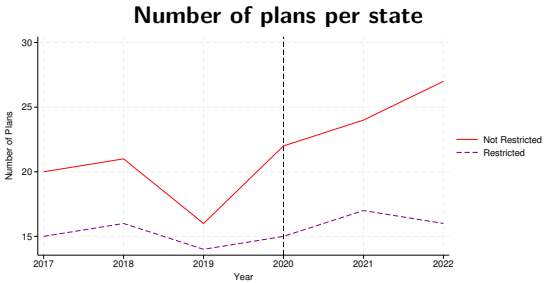
Event Study: BB Subscribership

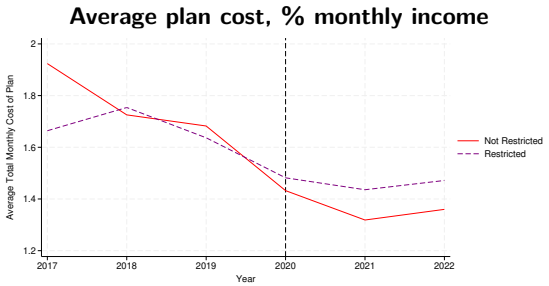


100Mbps and 10Mbps

- Flat in 2018–19
- Significant from Dec 2021
- −4.8 pp by Dec 2022
- 100 Mbps+: gap widening through Dec 2022 (−7.6 pp)
- 10 Mbps+: gap narrows by 2022 (→ convergence at low speeds)

Mechanisms: Fewer Plans that are Less Affordable





Source: FCC Urban Rate Survey, Fiber or Cable/DSL plans with at least 25/3 Mbps, unlimited usage

- Plan choice diverges sharply after 2020 (27 vs. 16 by 2022)
- Affordability converged pre-COVID, then reversed: 1.36% vs. 1.47% of income by 2022
  - Lowest cost matters more esp. for price-constrained HHs
- Restriction-state plans 11 pp more likely to have a **data cap**; caps **106 GB/month lower**

Mechanisms: Fewer Plans that are Less Affordable

Competition (% of county with 2+ ISPs, 2018–21)

	100Mbps	25Mbps	10Mbps
Restr. × Post	0.012	-0.093^{***}	-0.048^{***}
× % 2+ ISPs	-0.0007^{***}	$\mathbf{0.0026}^{***}$	0.0006^{**}

Counties with 0–1 ISPs are 9.3 pp less likely to be covered (row 1)
10pp increase in Competition closes 2.6 pp of that gap (row 2)

Affordability (lowest 25/3 price >2% of HH income)

	100Mbps	25Mbps	10Mbps
Restr. × Post	-0.022^{*}	-0.014	-0.016
× Unaffordable	-0.035^{**}	$\mathbf{-0.051}^{***}$	$\mathbf{-0.062}^{***}$

Effects operate almost entirely via restriction-state counties where cheapest plans exceed FCC's 2% benchmark (row 2)

Takeaway

Post-COVID adoption gaps are largest in restriction-state counties with **non-competitive** markets and **less affordable** plans.

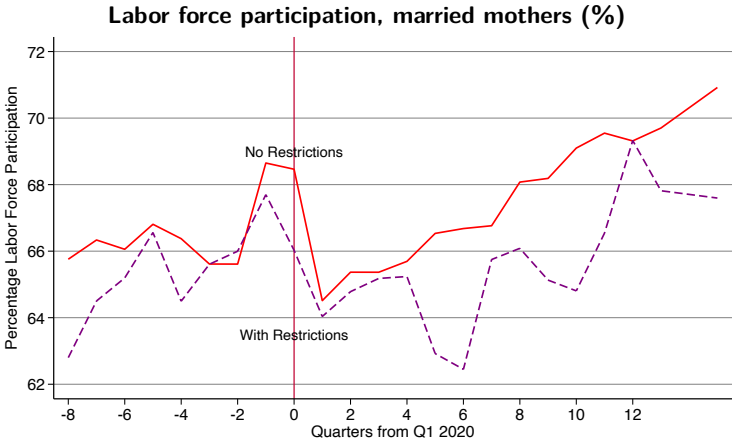
Corroboration: CPS Internet Use Supplement

Restrictions × Post	Home internet	Outside home	Email	Video/voice calls	Job search
All prime-age	−0.020*	−0.017**	−0.012*	0.015	−0.009
Married mothers	−0.008	0.003	0.009	**−0.034***	0.020
Women, no children	−0.024**	−0.023*	−0.001	0.029	−0.003
Married fathers	−0.012	−0.008	−0.019	0.010	−0.022

Scaled Estimates:

- Small samples; $<$ 10% of CPS Monthly (Nov 2017/19 vs. 2021/23); suggestive
- Prime-age adults 2.5% less likely to have internet home internet, or use email
- Moms **5.1% less likely to make video calls** — the bandwidth-heavy margin of telework (∼4 Mbps upload)

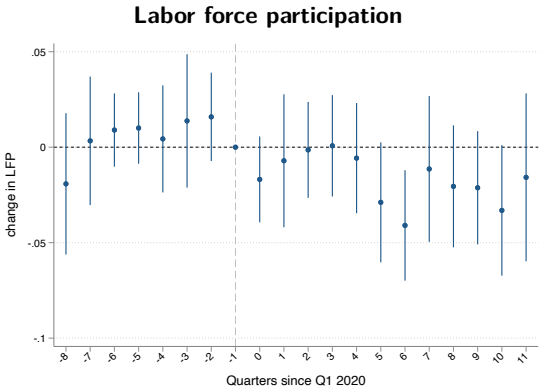
Raw Trends: Moms' LFP Slower to Recover in Restriction States

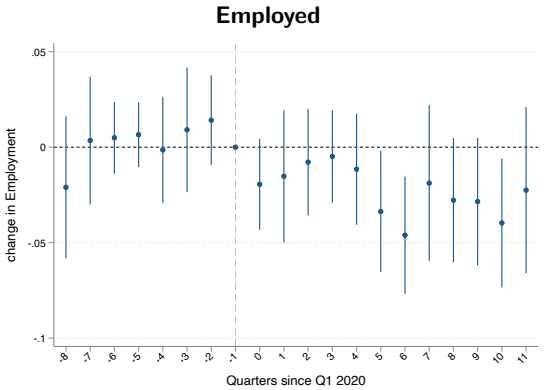


- Similar trends and similar COVID drop
- Divergence opens around **Q3 2021**, as enhanced UI expires
- Non-restriction states reach record-high maternal LFP

Weighted CPS means. Solid red = no restrictions; dashed purple = restrictions.

Event Study: Moms





- No differential pre-trends (8 pre-quarters; Q4 2019 omitted)
- Coefficients turn negative from 2021:Q2, peak in 2021:Q3, and stay negative through 2022

Main Result: Only Moms' Labor Supply Responds

Restrictions × Post	LFP	Employed, at work	Employed, any	Hours (cond.)
Married women with children	−0.0268**	−0.0310**	−0.0305**	0.179
	(0.0121)	(0.0132)	(0.0125)	(0.207)
% of mean	**−4.0%**	**−4.9%**	**−4.7%**	
Women without children	0.0041	0.0036	0.0041	−0.134
	(0.0062)	(0.0063)	(0.0064)	(0.208)
Married men with children	−0.0028	−0.0082	−0.0093*	−0.207
	(0.0041)	(0.0050)	(0.0046)	(0.156)

- 2.7 pp LFP is over **half the effect of PFL** on maternal detachment in the birth year (∼5 pp; Jones & Wilcher 2024)
- Extensive margin only: no change in hours among working mothers
- Groups with lower labor supply elasticity do not respond: argues against a general state-level shock

N = 222,009 / 309,196 / 224,011. SEs clustered by state (46 clusters).

Channels: Moms shift to Caregiving with Less WFH

Caregiving (CPS, moms)

	Coef.	% mean
PT or **not working**, family reasons	0.023**	**+7.4%**
NILF, caring for house/family	0.025**	**+8.5%**
PT due to childcare problems	−0.001	—
Part-time, any reason	−0.009	—

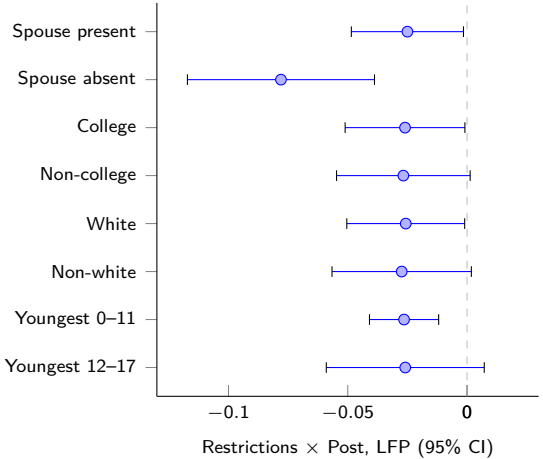
Telework (ATUS, employed moms only)

	Coef.	% mean
Minutes WFH per workday	−45.9**	−64%
Share of work time at home	−0.112**	**−49%**
Commute minutes per workday	+6.7*	**+26%**

≈**191 fewer WFH hours** per year
Pre: 2017-19; Post:Aug 2021-Dec 2022

- No significant caregiving or time-use effects for women without children or fathers
- ∼ 80% of moms are FT
  - PT less likely to have paid leave, WFH, & advance schedule notice (Landivar, Woods, and Livingston 2022)
  - 20% penalty after controlling for occupation, demographics (Golden 2020)
- No change in part-time work generally or due to *childcare problems*
  - Consistent with lack of LF entry rather than disrupted care arrangements

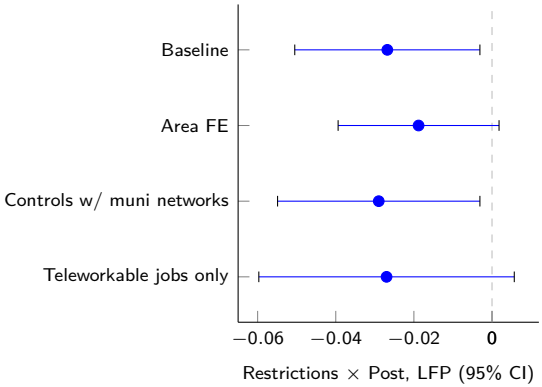
Heterogeneity: Married Moms' LFP



- **Spouse absent**: effect ≈3× larger
- Similar for college and non-college mothers (many non-college jobs teleworkable; local spending spillovers)
- Similar by race
- Most precise for moms of kids<12yo

Point estimates and 95% CIs from Appendix Tables A9–A12. Differences across education, race, and child age not significant.

Robustness: Moms' LFP



- **Area FE:** -1.9 pp*; employment -2.2 pp**
- **Controls = states with municipal networks:** larger effects on adoption and LFP
- **Teleworkable jobs:** not statistically different; women w/o children respond too (-2.4 pp***)
- **Muni-only vs. muni + co-op bans:** similar adoption effects
- No differential compositional shifts

Conclusion

- After COVID, BB adoption grew slower in restriction states — driven by markets with lower **competition** and fewer, **less affordable** plans
- Moms in those states were $\sim 5\%$ less likely to be employed $\rightarrow$ dropping out of labor force, shift towards caregiving
- Among moms continuing to work, WFH lower, commute time higher
- No effects for comparison groups, unless in teleworkable jobs
- Limitation:
  - Without the menu of BB plans/prices in CPS, we cannot prove our channels directly
  - Suggestive– fewer choices/costlier plans $\rightarrow$ lower adoption $\rightarrow$ decreased LFP

Policy

High Infrastructure Monopolies $\rightarrow$ High BB/Utility Prices
Stimulate competition via Community BB $\rightarrow$ Adoption, Labor Supply

Thank You!

Questions and comments welcome

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saket.hegde@phil.frb.org

jessica.vanparys@hunter.cuny.edu

Appendix

Data Choices

Back

- Why not FCC Broadband Availability?
  - Adoption, *not* access drives economic growth (Whitacre, Gallardo, and Strover 2014)
  - Carvalho, Hagerman, and Whitacre 2022; lower adoption counties had slower post-COVID recovery
  - Availability data are inconsistent and overstate access (Rosenworcel 2023)
  - New FCC Maps received millions of challenges during initial years (FCC 2024; ILSR 2023)

  > *if the cost of broadband service is higher than millions of people can afford, service cannot be said to be available.....low adoption rates in areas where broadband is technically deployed and available,... may evidence.... factors are in play that make it effectively unavailable for some portion of the population.* (FCC, *Section 706 Report for 2024*)

- Why not ACS5 Internet Measures?
  - No BB effects when we use ACS5
  - Averaging over 5-years, COVID disruption
  - no data on speeds - prone to errors from changing standards, speeds matter for telework!
- FCC and BLS measures are high-frequency, consistently coded
- Identify short, sharp changes in post-COVID BB adoption

Event studies for Adoption at 100 and 10 Mbps

Back

