Education Quality, Income Inequality, and Female Labor Force Participation in Brazil

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PURPOSE:
Study the effect of education quality on

- Income inequality

- Female labor force participation (FLFP)

METHODS

1. Theory:

- Assume labor markets are gendered.
- **men**
- -work for a wage
- **women**
- -produce home good,
- -can choose to supply labor for a wage.

2. Develop Education Quality Data

3. Econometric Strategies to get around invisible domestic labor

Brazilian DATA:

- 65 years of Brazilian Local school spending data (1941 to 2004)
  - Provides much more granularity than years of schooling alone

- PNAD household surveys for 1976, 1985, 1995, 2005, & 2015

MAIN FINDINGS:

- Public investment in education
  - grew tremendously over the past 1/2 century
  - accelerated after the end of military dictatorship

- The quality of schools attended contributes significantly to income inequality among adult men.

- The quality of schools attended contributes significantly to the labor force participation decisions of women worked.

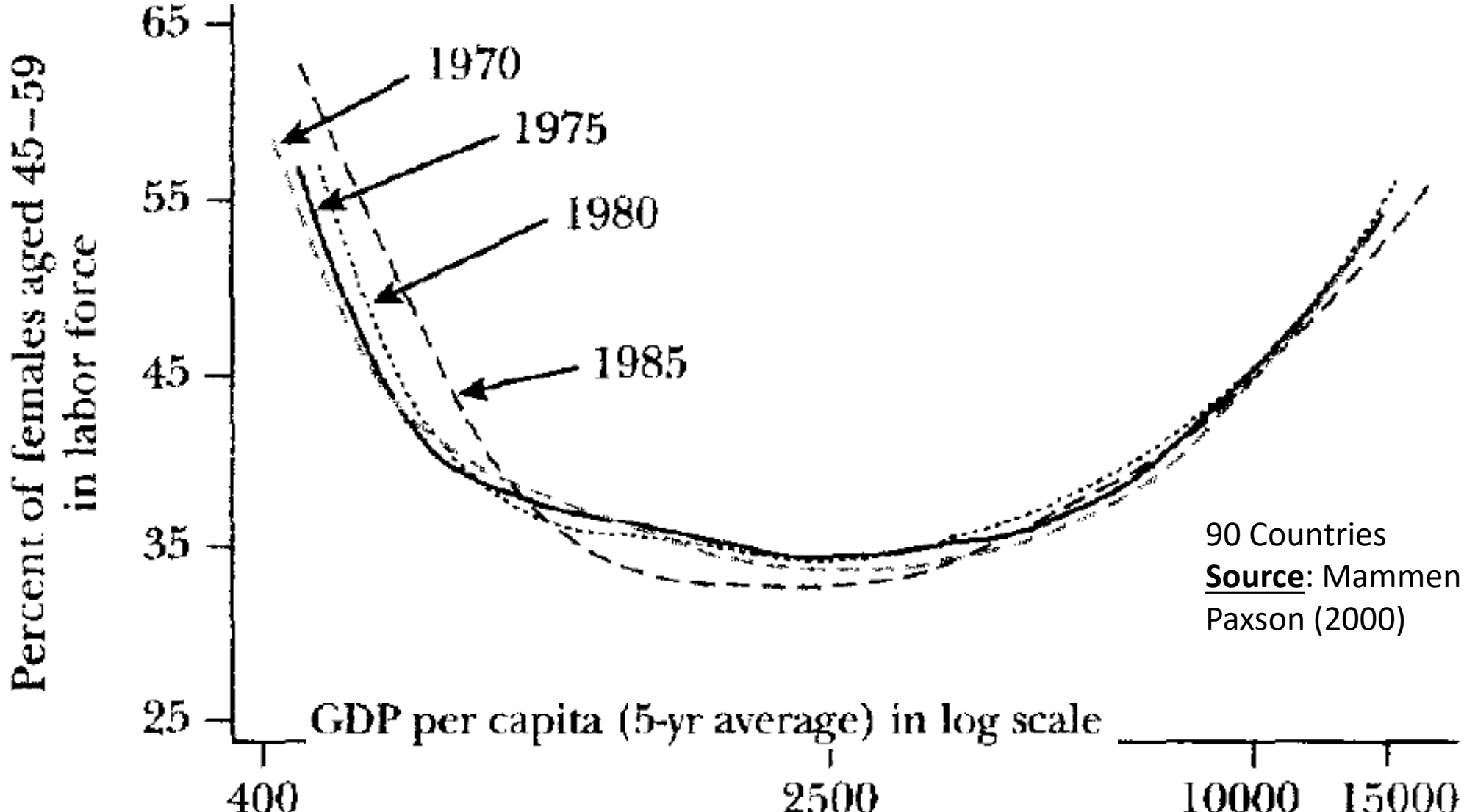
Economic Development is an Inequality-Inducing Process

- Technological change favors industry & service sectors
- As incomes grow, Engel curves lead higher share to industry & service outputs (Kuznets, 1955, 1966)
- Labor reallocates from rural to urban areas (Lewis, 1954, Ranis Fei, 1961),

Development & FLFP

- Development involves monetization of economic activity,
  - but necessarily the monetization of goods and labor that are destined for use outside of the home.
- Traditional gender division of productive activity places activities outside the home in men's camp and women's activities inside the home,
  - ➔the monetization that accompanies development favors men's activities over women's

Development and U-shaped FLFP



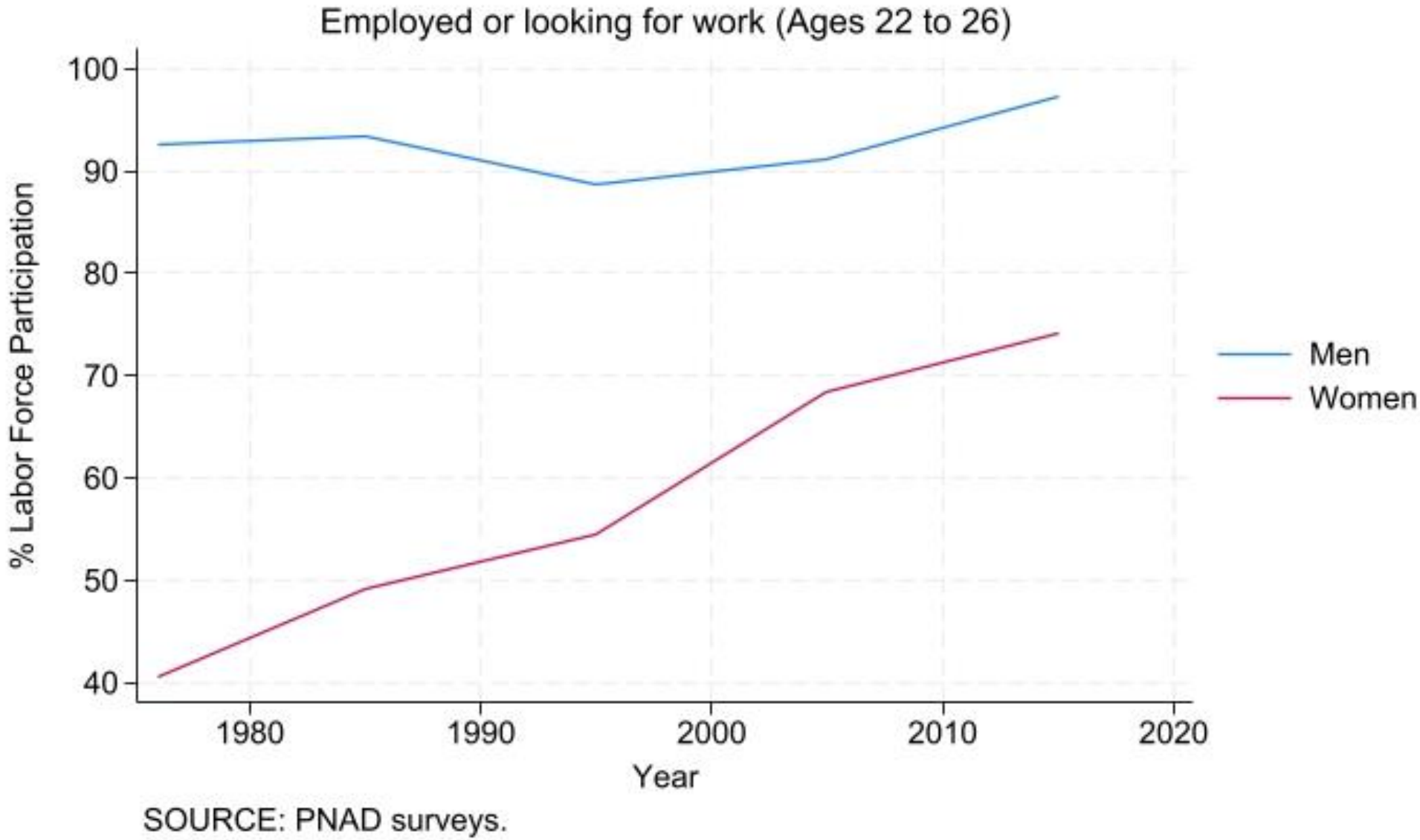
90 Countries

Source: Mammen & Paxson (2000)

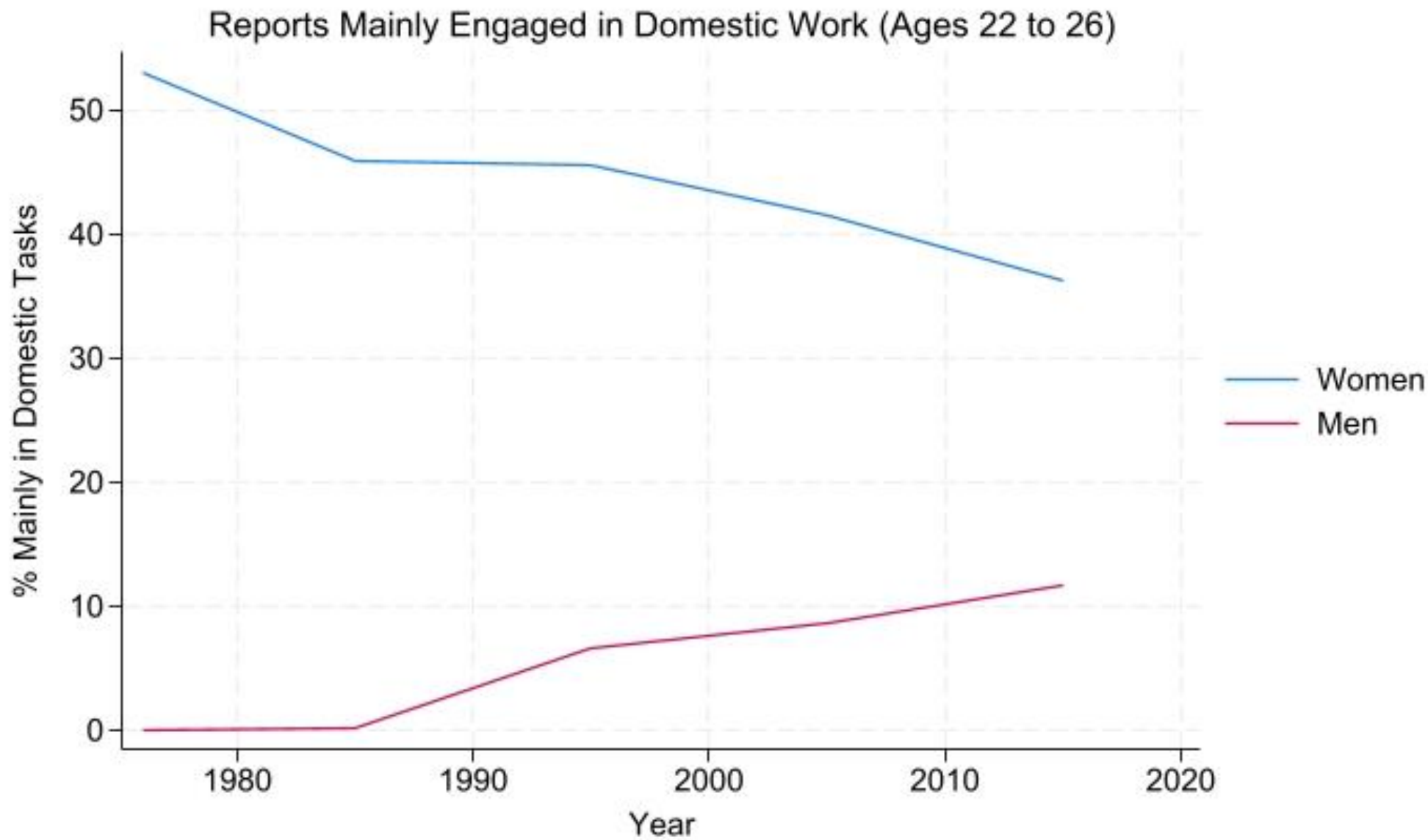
Why Brazil?

- Classic development pattern
  - 1960: 45% urban
  - 2015: 85% urban (PNAD surveys)
- one of the most unequal countries in the world:
  - Gini coefficient of 0.63
  - ”almost a historical and worldwide record” (Lopez-Calva et al., 2012, Ray and Genicot, 2023)
- differences in education long recognized as a major cause of inequality (Yap, 1976, Almeida dos Reis & Paes de Barros, 1991, Lam & Levinson, 1991, Dureya et al., 2023).
- Recent explanations focus on education quality.
  - quality deficiencies in entire Latin American region (Hanushek and Woessman, 2012)
  - enormous differences in pre-college education quality within Brazil (Brotherhood et al., 2019)
  - unequal access to high-quality public universities (Dureya et al., 2023)

Labor Force Participation in Brazil



Brazil: Domestic Chores by Gender



This Contribution

- Relation between education *quality* (1941 to 2004) and
  - Income inequality among men
  - Labor force participation among women

Framework

- Men work for a wage
- Women
  - *Must* produce home good *"g"*
  - *May* choose to also work for a wage.

  - Max: $u(g_i, q_i) = g_i^{\beta} q_i^{(1-\beta)}$, s.t. $g_i = 1 - z_i$ and $q_i = y_i + w h_i z_i$
    - g_i: home-produced good
    - q_i: market good
    - z_i: market labor
    - h_i: woman's human capital
    - y_i: spouse income
- ➔Women's market labor supply: $$z_i^{\sup} = 1 - \beta\left(1 + \frac{y_i}{wh_i}\right)$$

Implications $z_i^{\text{sup}} = 1 - \beta\left(1 + \frac{y_i}{wh_i}\right)$

1. FLFP is a function of the earnings potential of woman relative to spouse

2. For any h_i $\exists$ y_i^* such that z_i^{sup}=0

$$y_i^* = \left(\frac{1-\beta}{\beta}\right) wh_i$$

3. Women with husband's income $y_i > y^*$ withdraw from the market.

4. Labor supply can be "negative" (shadow demand for home production (Heckman, 1976))

3 Econometric Issues

1. Cannot observe human capital
2. Women's work is only observed if $y<y^*$
    1. ➔Many with zero hours worked
    2. ➔Cannot use earnings of workers to predict earnings of non-workers (selection bias)
3. Correlation between spousal incomes (Becker, 1973, Bratsberg et al. 2023)

Estimation Techniques

1. Estimate men's human capital equation using school years, school quality, & experience.
2. Women's human capital index developed by predicting what their earnings would be if they were prime-aged men
3. 3 Econometric models for censorship using school quality data:
    1. Maximum likelihood estimation of reduced form Correlated Spousal Earnings Model (CSE)
    2. Heckman selection model
    3. Tobit model

(1) Correlated Spousal Earnings Model (CSE)

- Women have potential earnings of ψ_i , with empirical implementation

$$\text{Log}\,(\psi_i) = \text{Log}\left(\frac{w}{\delta}\right) + \gamma_e e_i + \gamma_v v_i + \gamma_{v2} v_i^2 + \gamma_s S_i + \gamma_m q_{m_i} S_i$$

- They draw a husband from a lognormal earnings distribution with median income μ_{xi} that depends their own potential earnings ψ_i:
  - $\mu_{xi}(\psi_i) = {\psi_i}^{\alpha+1},\ with\ \alpha > 0$
- She knows the (lognormal) distribution of her husband's income x_i at the time of marriage, including μ_{xi}, but his actual income is only revealed to her after marriage.

$$\text{let } y_i := \ln(x_i)\,, then\ y_i \sim N({\psi_i}^{\alpha+1}, \sigma_x^2)$$

- From the definition of the lognormal density, we have that the mean of y_i, $\mu_{yi} = \mu_{xi}$
- So, given the CDF of x, $F_x(x)$, the cumulative density function of hours worked in domestic tasks *d* is given by

$$F_d(d) = F_x\left(\frac{(d_i-\beta)}{\beta}\psi_i\right) = \Phi\left(\frac{\ln\left(\frac{(d_i-\beta)}{\beta}\psi_i\right)-\mu_y}{\sigma_y}\right) = \Phi\left(\frac{\ln\left(\frac{(d_i-\beta)}{\beta}\right)+\ln(\psi_i)-(1+\alpha)\ln(\psi)}{\sigma_y}\right) = \Phi\left(\frac{\ln\left(\frac{(d_i-\beta)}{\beta}\right)-\alpha\ln(\psi)}{\sigma_y}\right).$$

(1) Correlated Spousal Earnings Model (*cont.*)

- Substituting for $ln(\psi_i)$, the CDF of *d* is

$$F_d(d) = \Phi\left(\frac{\ln\left(\frac{(d_i-\beta)}{\beta}\right) - \sum_{j=1}^{n}\omega_j v_j}{\sigma_y}\right)$$

- and the pdf is $$f_d(d) = \frac{\partial F_d(d)}{\partial d} = \frac{1}{(d-\beta)}\phi\left(\frac{\ln\left(\frac{(d_i-\beta)}{\beta}\right) - \sum_{j=1}^{n}\omega_j v_j}{\sigma_y}\right).$$
- Letting c_i indicate censorship of observation *i*, the likelihood function of observation *i is* $$l_i = f_d\left(d_i\right)^{(1-c_i)}\left(1 - F_d\left(d_i\right)\right)^{c_i}.$$
- The log-likelihood estimated by Max. Likelihood then becomes

$$\ell_i = (1-c_i)\ln\left(\frac{\phi\left(\ln\left(\frac{d_i-\beta}{\beta}\right) - \sum_{j=1}^{n}\omega_j v_j\right)}{(d-\beta)}\right) + c_i \ln\Phi\left(\frac{\ln\left(\frac{d_i-\beta}{\beta}\right) - \sum_{j=0}^{n}\omega_j v_j}{\sigma_y}\right),$$

(2) Heckman Selection

- The Heckman (1976) 2-step approach :

1. predict the instantaneous “hazard function”, defined as the ratio of the pdf to the survival function (“inverse of the Mills ratio”).
2. Insert predicted hazard as an ancillary variable in an hours worked equation.

(3) Tobit

- Large number of zero hours worked for women,
- estimate hours worked equations using Tobin's (1956) limited dependent variable model.
- two-part decision:
  - (i) work for a wage: yes, or no? Then if "yes",
  - (ii) work for how many hours?
- Observe

$$z_i^+ = 0 \qquad \text{if } z_i^{sup} \leq 0, \text{ and}$$

$$z_i^+ = z_i^{sup} \qquad \text{if } z_i^{sup} > 0.$$

Or, equivalently

$$z_i^+ = 0 \text{ if } h_i \leq \left(\frac{\beta}{1-\beta}\right)\frac{y_i^*}{\psi_i}, \text{ and}$$

$$z_i^+ = 1 - \beta\left(1 + \frac{y_i}{\psi_i}\right) \text{ if } h_i > \left(\frac{\beta}{1-\beta}\right)\frac{y_i^*}{\psi_i}.$$

2 Data Sources

1. Five decades pf Brazil's PNAD household surveys:
   1976, 1985, 1995, 2005, 2015.
2. *New dataset*: 64 years of data on municipal government education spending, 1941-2004.

Table 1: School Attainment by Gender, 1975 to 2015

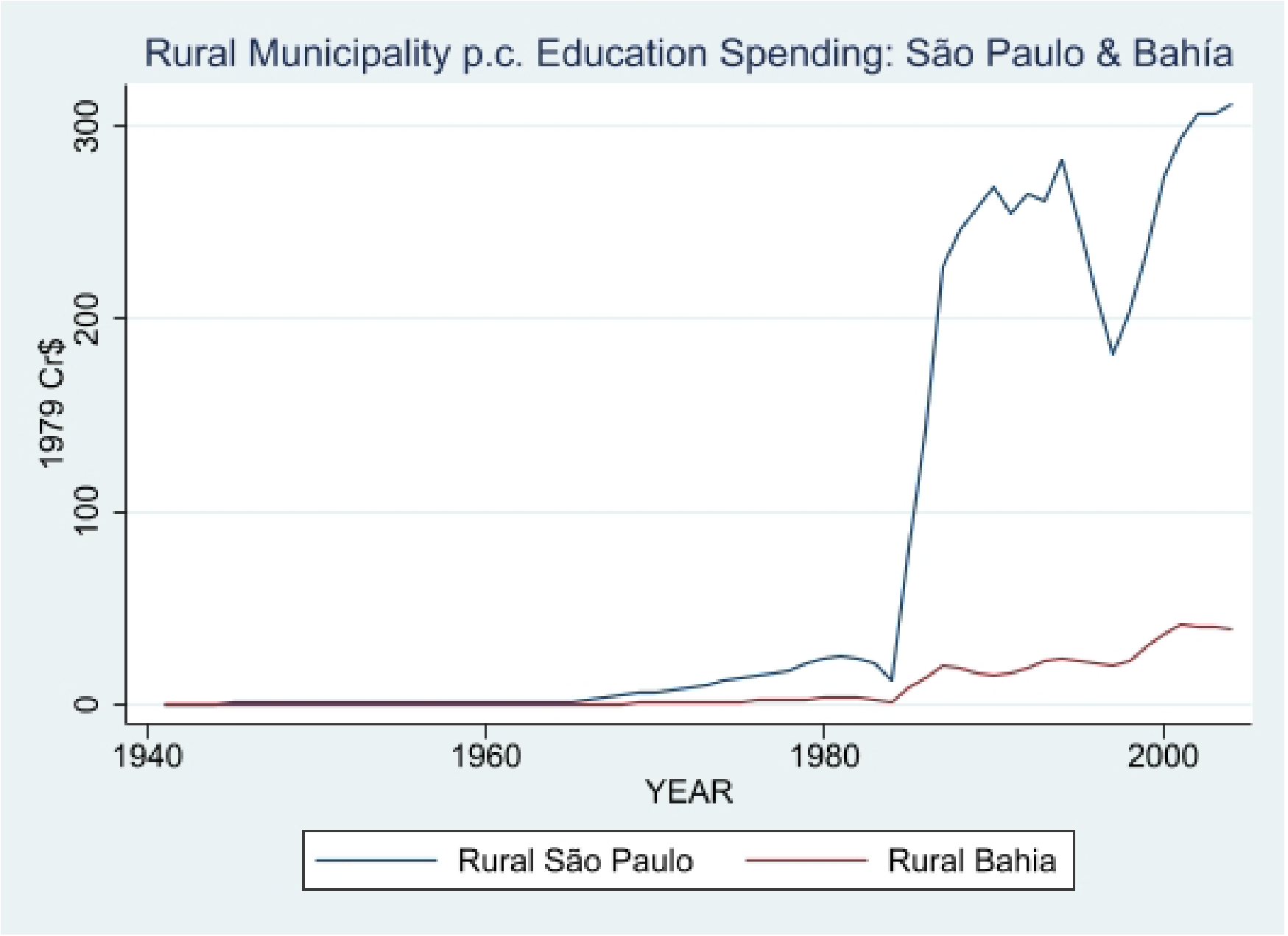
	1976		1985		1995		2005		2015	
A. Ages 16 to 65	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
# Obs.	104,370	112,057	144,699	154,898	97,595	104,846	128,324	137,527	117,362	125,996
Age	33.48	33.19	33.64	33.73	34.40	34.89	35.21	35.84	37.43	38.37
(St. Dev.)	(13.37)	(13.47)	(13.23)	(13.24)	(13.18)	(13.27)	(13.36)	(13.41)	(13.79)	(13.82)
Schooling (Yrs.)	4.05	3.84	5.01	4.98	5.67	5.91	7.13	7.55	9.31	9.85
(St. Dev.)	(3.81)	(3.67)	(4.22)	(4.17)	(4.27)	(4.30)	(4.37)	(4.44)	(4.13)	(4.10)
Zero Schooling	28.3	32.18	21.61	22.63	17.27	16.1	11.63	10.35	7.32	6.08
4+ Schooling	43.9	41.82	41.05	39.53	41.24	39.26	31.5	28.61	85.39	87.57
8+ Schooling	13.57	13.1	17.96	17.77	18.07	18.13	21.38	20.63	64.73	69.48
11+ Schooling	14.24	12.9	19.37	20.08	23.42	26.51	35.5	40.41	45.66	52.45
B. Ages 22 to 26										
# Obs.	16,569	18,372	22,795	24,983	13,804	14,627	19,066	19,421	13,276	13,208
Age	23.91	23.92	23.93	23.94	23.96	23.99	23.95	23.97	23.95	23.99
(St. Dev.)	(1.42)	(1.41)	(1.41)	(1.41)	(1.41)	(1.41)	(1.41)	(1.40)	(1.43)	(1.42)
Years of Schooling	4.86	4.93	6.03	6.36	6.36	7.03	8.44	9.16	10.70	11.44
(St. Dev.)	(4.0)	(4.1)	(4.2)	(4.2)	(3.97)	(4.02)	(3.97)	(3.85)	(3.17)	(2.93)
Zero Schooling	19.46	20.19	12.66	10.48	10.93	7.14	5.84	3.86	2.69	1.78
4+ Schooling	43.82	42.45	39.47	38.26	40.99	38.63	24.76	21.57	95.07	96.79
8+ Schooling	16.05	15.00	22.34	21.92	22.34	21.07	21.01	18.74	80.45	86.99
11+ Schooling	20.66	22.36	25.53	29.35	25.73	33.15	48.39	55.83	59.94	70.86

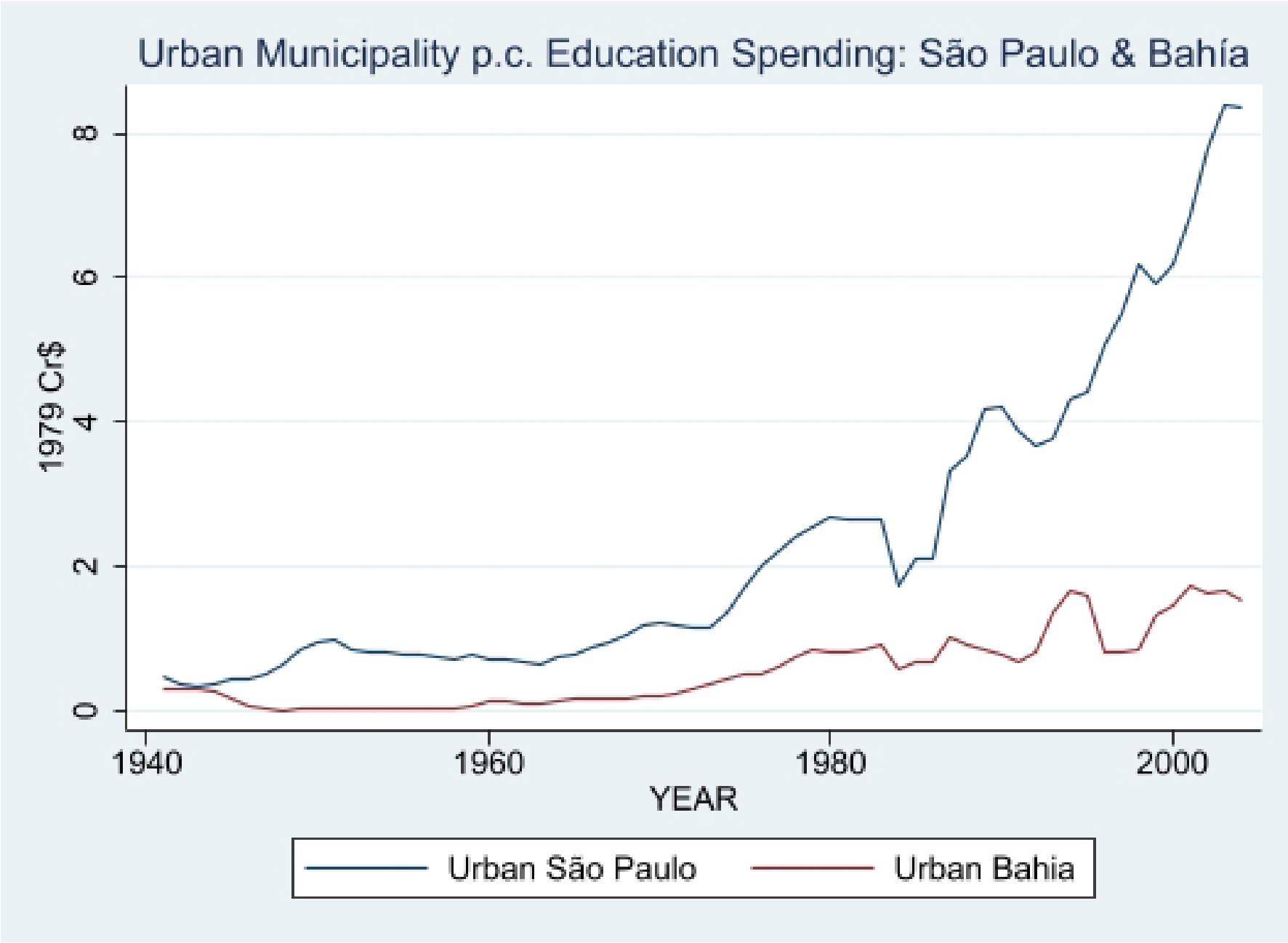
PNAD School Attainment Data 1976-2015

- Educational attainment more than doubled, from about 4 years of schooling to more than nine.
- The proportion of the labor force that is functionally illiterate –with fewer than 4 years of schooling– declined from nearly 60% in 1976 to less than 15% in 2015.
- The proportion with at least a high school degree increased from 13.5% to nearly half of the labor force.
- Gender change was enormous

Table 3: Mean, 1941-2004 Municipal School Spending Per Capita
(*Constant 1979 Cr$'000*)

	Rural Municipalities				Urban Municipalities			
State	**1941**	**1961**	**1981**	**2001**	**1941**	**1961**	**1981**	**2001**
Acre	0.31	0.03	0.92	31.61	0.10	0.10	2.12	8.96
Amazonas	0.10	0.03	2.35	34.90	0.35	0.00	0.85	9.93
Pará	0.20	0.07	1.68	33.71	0.12	0.19	0.73	3.19
Amapa	0.03	0.00	0.59	36.71		1.02	1.87	6.88
Rondônia			2.66	33.43		0.01	0.71	3.94
Roraima		0.09	0.06	11.81		0.17	2.43	12.58
Maranhão	0.04	0.03	1.13	25.36	0.11	0.10	0.95	3.07
Piauí	0.04	0.07	0.57	29.35	0.06	0.04	0.52	4.52
Ceará	0.03	0.07	1.77	40.38	0.13	0.13	1.77	4.95
Rio Grande do Norte	0.02	0.11	3.34	49.17	0.01	0.11	1.21	4.32
Paraíba	0.05	0.16	0.92	43.87	0.03	0.05	0.63	3.22
Pernambuco	0.11	0.27	2.67	45.19	0.25	0.17	0.92	3.63
Alagoas	0.05	0.14	1.91	36.83	0.01	0.09	1.53	3.85
Sergipe	0.05	0.10	3.33	45.14	0.07	0.16	1.79	4.69
Bahía	0.12	0.12	2.48	41.60	0.34	0.11	0.85	1.66
Mato Grosso	0.31	0.58	2.56	74.27	0.06	0.04	0.99	4.56
Mato Grosso do Sul	0.31	0.58	4.50	74.86	0.06	0.04	2.03	6.66
Goias	0.12	0.18	25.45	102.34	0.08	0.12	1.08	4.87
Minas Gerais	0.13	0.21	3.70	78.81	0.03	0.13	0.87	3.40
Espirito Santo	0.05	0.11	4.45	80.41	0.02	0.00	1.09	5.32
Rio de Janeiro	0.20	0.93	17.74	257.40	0.01	0.00	6.95	13.48
São Paulo	0.29	1.27	20.28	312.25	0.43	0.66	2.63	7.91
Paraná	0.06	0.27	5.25	72.06	0.09	0.08	1.18	3.90
Santa Catalina	0.21	0.35	4.56	82.07	0.07	0.03	0.27	1.82
Rio Grande do Sul	0.23	1.03	8.04	89.57	0.03	0.20	0.67	3.96


Rural Municipality p.c. Education Spending: São Paulo & Bahía
1979 Cr$
0
100
200
300
1940
1960
1980
2000
YEAR
Rural São Paulo
Rural Bahia


Urban Municipality p.c. Education Spending: São Paulo & Bahía
1979 Cr$
0
2
4
6
8
1940
1960
1980
2000
YEAR
Urban São Paulo
Urban Bahia

Quality inequality and income inequality

- Mincer equation expanded to account for quality:

$$y_i = \mu_0 + \mu_v v_i + \mu_{v2} v_i^2 + \mu_s S_i + \mu_{m_i} q_{m_i} S_i + \epsilon_i,$$

- Implies variance decomposition into quality and quantity of schooling:

$$\mathrm{Var}(y) = \beta^2 \mathrm{Var}(S) + \gamma^2 \mathrm{Var}(qS) + 2\beta\gamma \mathrm{Cov}(S, qS) + \Theta.$$

- Estimation results show that school quality accounts for a significant share the variation men's income.

Age Cohort	(1) N	(2) Var(y)	(3) β	(4) γ	(5) $\beta^2 Var(S)$	(6) $\gamma^2 Var(Sq)$	(7) $2\beta\gamma Cov(S, Sq)$	(8) R^2	% of R^2 from Quality
				1976	**Sample**				
25-27	6,504	0.83	0.14	0.034	0.33	0.007	0.042	0.46	10.5%
28-30	6,538	0.98	0.16	0.031	0.43	0.005	0.046	0.50	10.2%
31-33	5,450	1.05	0.16	0.031	0.50	0.006	0.053	0.53	11.1%
34-36	5,574	1.02	0.16	0.038	0.43	0.006	0.050	0.48	11.7%
37-39	5,081	1.02	0.16	0.037	0.42	0.002	0.032	0.45	7.7%
40-42	6,483	1.05	0.17	0.062	0.44	0.004	0.050	0.47	11.6%
43-45	4,210	1.10	0.18	0.031	0.49	0.001	0.025	0.47	5.4%
				1995	**Sample**				
25-27	5,780	0.66	0.11	0.002	0.18	0.007	0.032	0.33	11.8%
28-30	5,789	0.83	0.13	0.003	0.28	0.008	0.040	0.39	12.3%
31-33	5,950	0.88	0.13	0.005	0.30	0.007	0.039	0.39	11.8%
34-36	5,528	0.92	0.14	0.005	0.35	0.004	0.028	0.42	7.6%
37-39	5,107	0.98	0.13	0.015	0.36	0.007	0.048	0.42	13.1%
40-42	4,778	1.09	0.14	0.026	0.42	0.009	0.065	0.46	16.1%
43-45	4,137	1.17	0.15	0.031	0.46	0.011	0.079	0.47	19.1%
				2005	**Sample**				
25-27	7,133	0.54	0.09	0.0006	0.13	0.005	0.017	0.29	7.9%
28-30	6,742	0.62	0.10	0.0010	0.18	0.005	0.021	0.34	7.6%
31-33	6,524	0.66	0.10	0.0015	0.19	0.007	0.031	0.35	10.8%
34-36	6,254	0.75	0.11	0.002	0.23	0.013	0.050	0.40	15.8%
37-39	6,047	0.78	0.11	0.003	0.23	0.013	0.049	0.38	16.5%
40-42	6,045	0.85	0.12	0.004	0.28	0.009	0.044	0.40	13.5%
43-45	5,423	0.91	0.12	0.005	0.32	0.007	0.039	0.40	11.4%
				2015	**Sample**				
25-27	4,868	0.36	0.08	0.00009	0.07	0.0017	0.004	0.22	2.8%
28-30	5,392	0.45	0.09	0.00019	0.11	0.0043	0.010	0.28	5.2%
31-33	5,644	0.51	0.09	0.00032	0.13	0.0054	0.015	0.29	6.9%
34-36	5,677	0.56	0.09	0.00060	0.14	0.0092	0.023	0.30	10.7%
37-39	5,452	0.56	0.09	0.0011	0.14	0.0089	0.027	0.32	11.3%
40-42	5,147	0.58	0.09	0.0012	0.15	0.0056	0.022	0.31	9.2%
43-45	4,899	0.62	0.08	0.0016	0.14	0.0081	0.027	0.28	12.8%

Summary of Results on FLFP

- All 3 methods show significant impact of education quality on FLFP.
- Some evidence that impact falls over time.

Maximum Likelihood CSE Estimates

Table 7: CSE Model Maximum Likelihood Estimates Estimates of of Domestic Labor Supply
Human Capital Index, Fertility & Marital Status

YEAR	**1976**		**1995**		**2005**		**2015**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Human Capital	-0.207***	-0.229***	-0.129***	-0.131***	-0.179***	-0.176***	-0.234***	-0.233***
	(-36.02)	(-42.41)	(-47.55)	(-48.12)	(-69.04)	(-67.17)	(-69.03)	(-68.40)
# Children		0.0277***		0.0157***		0.0204***		0.0186***
		(8.60)		(6.82)		(8.29)		(6.05)
Married		0.511***		0.113***		0.0253***		0.0323***
		(70.38)		(32.03)		(8.32)		(10.55)
Constant	1.029***	0.765***	0.699***	0.626***	0.536***	0.512***	1.166***	1.138***
	(80.43)	(63.43)	(125.05)	(106.12)	(163.50)	(135.96)	(94.68)	(91.19)
σ_y	0.765***	0.682***	0.463***	0.459***	0.462***	0.461***	0.431***	0.431***
	(184.97)	(186.20)	(280.70)	(280.87)	(326.58)	(326.57)	(300.42)	(300.44)
N	66693	66693	90396	90396	118157	118157	99696	99696
β	0.410	0.400	0.370	0.370	0.390	0.390	0.390	0.390
Loglikelihood	-24509.6	-20921.9	-18691.0	-18049.4	-20024.7	-19935.4	-13403.7	-13314.1

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: CSE Model Maximum Likelihood Estimates of Domestic Labor Supply
Using 'Raw' Human Capital Inputs Directly, with and without School Quality

YEAR	**1976**		**1995**		**2005**		**2015**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Sch. Yrs.	-0.0210***	-0.0165***	-0.0110***	-0.0108***	-0.0166***	-0.0165***	-0.0213***	-0.0211***
	(-24.84)	(-18.48)	(-28.06)	(-26.52)	(-49.23)	(-48.37)	(-61.91)	(-61.03)
Sch. Quality		-0.0165***		-0.000154**		-0.284e-4*		-0.189e-4***
		(-14.32)		(-2.88)		(-2.48)		(-4.62)
Age	-0.0938***	-0.100***	-0.0308***	-0.0312***	-0.0314***	-0.0316***	-0.0286***	-0.0291***
	(-25.91)	(-27.47)	(-62.95)	(-61.20)	(-82.15)	(-80.42)	(-68.30)	(-67.23)
Age^2	0.00134***	0.00143***	0.668e-5***	0.674e-5***	0.638e-5***	0.641e-5***	0.567e-5***	0.573e-5***
	(21.50)	(22.84)	(61.95)	(61.32)	(83.77)	(83.11)	(74.14)	(73.78)
# Children	0.0390***	0.0388***	0.0322***	0.0320***	0.0433***	0.0432***	0.0595***	0.0594***
	(12.08)	(12.04)	(13.61)	(13.52)	(17.38)	(17.32)	(19.16)	(19.10)
Married	0.606***	0.605***	0.157***	0.157***	0.0637***	0.0637***	0.0529***	0.0532***
	(73.08)	(73.18)	(41.46)	(41.51)	(20.16)	(20.17)	(17.04)	(17.14)
constant	1.819***	1.922***	1.090***	1.101***	1.126***	1.133***	1.144***	1.159***
	(38.03)	(39.73)	(97.75)	(93.14)	(116.85)	(113.08)	(100.46)	(97.64)
σ_y	0.677***	0.675***	0.450***	0.450***	0.448***	0.448***	0.416***	0.416***
	(186.30)	(186.34)	(281.51)	(281.52)	(327.74)	(327.74)	(301.71)	(301.72)
N	66693	66693	90396	90396	118157	118157	99696	99696
β	0.400	0.400	0.370	0.370	0.390	0.390	0.390	0.390
Loglikelihood	-20645.0	-20543.4	-16478.3	-16474.2	-16776.6	-16773.5	-10027.2	-10016.5

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Heckman Model shows a sign-flip for both Schooling and husband's income.

Table 9: Basic Heckman 2-step Model of Women's Hours Worked

	(1) 1976	(2) 1995	(3) 2005	(4) 2015
% Hours in Formal Market Work				
School	-0.692***	-0.129***	0.0510*	0.116***
	(-24.08)	(-3.54)	(2.03)	(5.35)
Experience	-0.0803**	-0.395***	-0.269***	-0.161***
	(-3.11)	(-8.82)	(-9.13)	(-6.28)
Experience^2	0.000892*	0.00658***	0.00472***	0.00302***
	(2.37)	(8.88)	(8.93)	(6.07)
_cons	52.53***	58.74***	51.76***	45.07***
	(77.31)	(41.36)	(55.39)	(57.86)
Selection				
School	0.0621***	0.0232***	0.0169***	0.0227***
	(38.64)	(17.90)	(15.69)	(21.25)
Experience	0.0270***	0.0369***	0.0271***	0.0280***
	(20.00)	(29.97)	(27.36)	(27.28)
Experience^2	-0.000606***	-0.000784***	-0.000705***	-0.000794***
	(-31.70)	(-47.06)	(-52.57)	(-55.01)
Married	-0.793***	-0.293***	-0.230***	-0.253***
	(-38.43)	(-18.73)	(-18.73)	(-22.83)
Husband's Income	-0.0195***	-0.0111***	0.00367*	0.0105***
	(-7.70)	(-4.78)	(2.19)	(7.81)
# Children	-0.0689***	-0.112***	-0.218***	-0.277***
	(-13.13)	(-17.08)	(-32.12)	(-32.13)
_cons	-0.217***	0.0265	0.260***	0.200***
	(-7.55)	(0.94)	(11.01)	(8.33)
/mills lambda	-6.180***	-26.60***	-22.41***	-14.87***
	(-19.55)	(-23.59)	(-26.41)	(-21.72)
N	79374	78660	105098	104011

Table 10: Heckman 2-step Model of Women's Hours Worked with Human Capital Index

	(1) 1976	(2) 1995	(3) 2005	(4) 2015
% Hours in Formal Market Work				
Human Capital	-4.532***	-0.844**	-0.460	0.393
	(-22.61)	(-3.16)	(-1.31)	(0.96)
_cons	57.60***	52.97***	51.94***	43.76***
	(80.87)	(39.58)	(34.98)	(19.23)
Selection				
Human Capital	0.539***	0.262***	0.284***	0.476***
	(43.86)	(30.34)	(35.67)	(45.57)
Married	-0.718***	-0.345***	-0.266***	-0.247***
	(-19.40)	(-18.67)	(-19.32)	(-19.63)
# Children	-0.0745***	-0.0320***	-0.0704***	-0.0609***
	(-12.40)	(-5.12)	(-10.68)	(-7.05)
Husband's Income	-0.0696***	-0.00716**	0.0206***	0.0252***
	(-16.13)	(-2.85)	(11.62)	(17.22)
_cons	-0.505***	-0.0572**	0.0515***	-1.394***
	(-15.72)	(-2.66)	(3.89)	(-36.07)
/mills				
lambda	-6.399***	-24.11***	-25.42***	-15.42***
	(-18.35)	(-19.48)	(-15.11)	(-12.18)
N	44348	63893	84143	76334

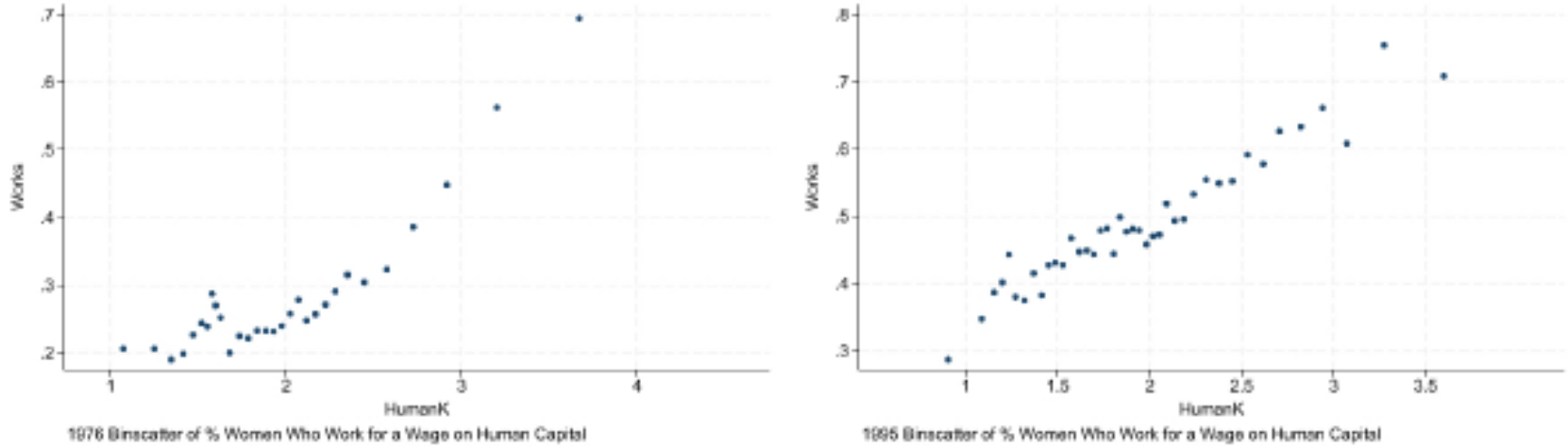
Table 11: Heckman 2-step Model of Women's Hours Worked with 'Raw' School Quality Measures

	(1) 1976	(2) 1995	(3) 2005	(4) 2015
% Hours in Formal Market Work				
School	-0.816***	-0.192***	0.0132	0.138***
	(-20.88)	(-5.17)	(0.49)	(6.34)
Sch. Quality	3.124***	0.210***	0.0672***	0.0156***
	(8.00)	(4.65)	(5.42)	(4.59)
Experience	0.00500	-0.357***	-0.267***	-0.123***
	(0.07)	(-7.20)	(-7.93)	(-4.66)
Experience2	-0.00171	0.00573***	0.00488***	0.00260***
	(-1.03)	(6.89)	(8.21)	(5.13)
_cons	52.05***	56.07***	51.94***	43.98***
	(53.38)	(42.47)	(52.63)	(56.65)
select				
School	0.108***	0.0343***	0.0192***	0.0205***
	(47.34)	(23.97)	(16.98)	(18.64)
Sch. Quality	0.0817***	-0.0129***	-0.00337***	-0.000923***
	(3.95)	(-6.80)	(-5.99)	(-4.55)
Experience	0.0432***	0.0427***	0.0307***	0.0248***
	(10.60)	(22.90)	(25.15)	(21.37)
Experience2	-0.000534***	-0.000867***	-0.000777***	-0.000772***
	(-5.51)	(-28.45)	(-43.38)	(-47.92)
Married	-0.717***	-0.331***	-0.251***	-0.252***
	(-19.72)	(-18.27)	(-19.50)	(-22.38)
Husband's Income	-0.0699***	-0.0219***	0.00270	0.0109***
	(-16.35)	(-8.69)	(1.56)	(7.90)
# Children	-0.0725***	-0.0991***	-0.215***	-0.288***
	(-12.06)	(-14.68)	(-31.06)	(-32.52)
_cons	-0.501***	-0.0161	0.245***	0.300***
	(-10.43)	(-0.46)	(9.24)	(11.22)
/mills				
lambda	-6.662***	-23.44***	-22.92***	-14.66***
	(-19.41)	(-24.24)	(-26.53)	(-21.36)
N	46114	67828	97187	98983

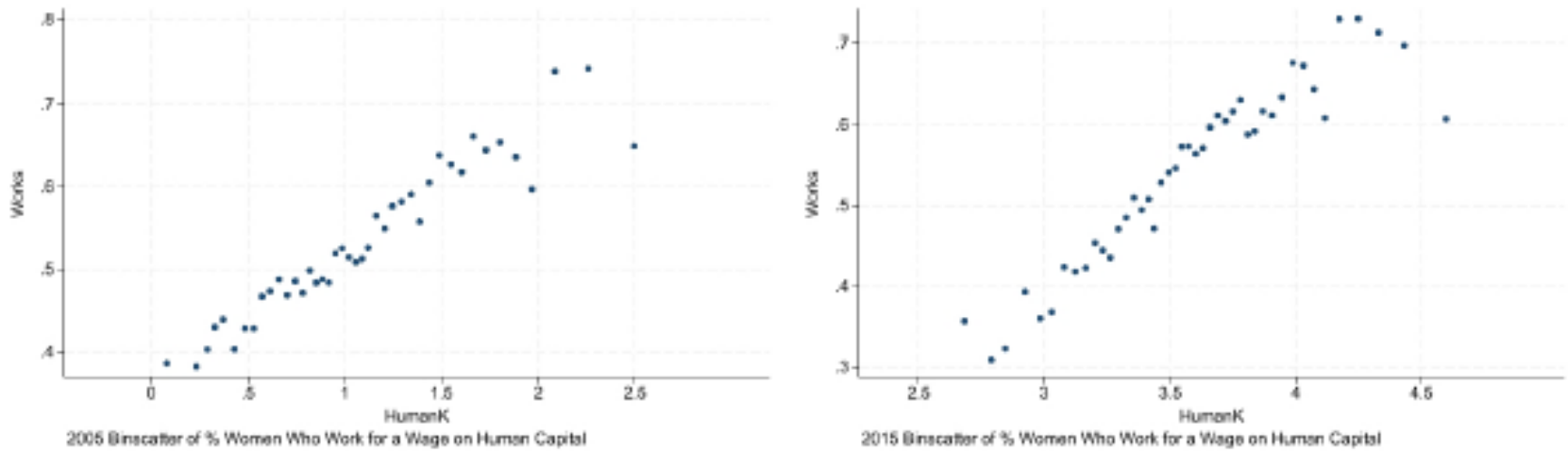
Binscatter Plots

- Using Cataneo et al. (2024) optimal bin size
- Binscatter plots suggest linearity in FLFP decdsion, but
- *non-linear* relation between women's human capital and hours worked.

% of women who work as a function of their human capital.



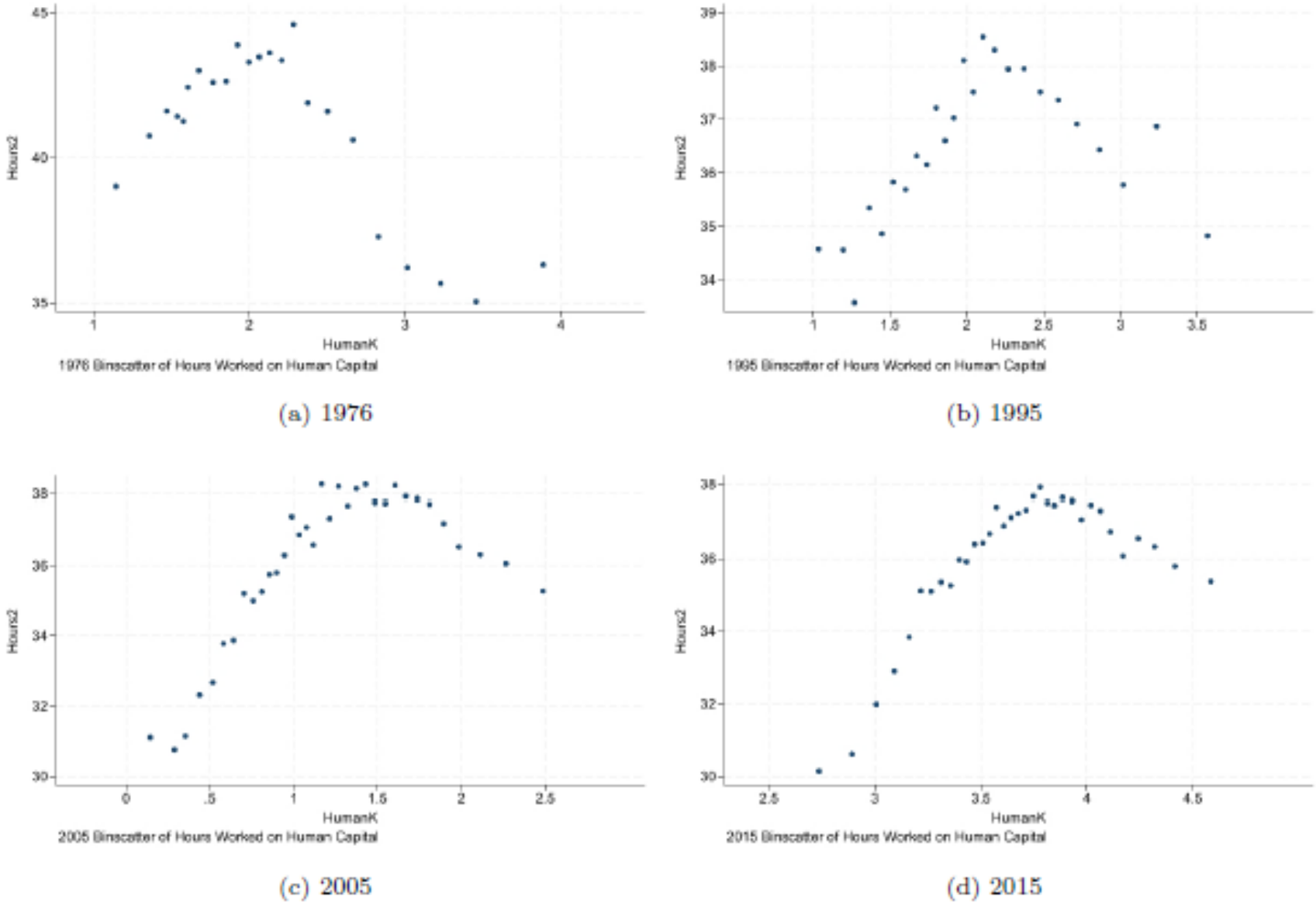
(a) 1976 (b) 1995



(c) 2005 (d) 2015

Figure 5: Binscatter plots of the percentage of women who work, by human capital level.

Weekly hours worked among working women, as a function of their human capital.



(a) 1976 (b) 1995

(c) 2005 (d) 2015

Figure 6: Binscatter plots of women's weekly work hours, as a function of their human capital level.

Conclusions

Differences in education quality are a significant factor explaining income inequality among fully employed men and an important determinant of the labor force participation of women.

Over the past ½ century Brazil invested more in education

Brazilian women attended better schools and attained more years of schooling

The participation of Brazilian women in the labor force grew substantially.

But women's market employment remains secondary to that of their spouses.

Education quality is a major factor in women's labor force participation decisions and one of the most important determinants of income inequality in Brazil.

Thank you!

Appendix (Extra Slides)

Table 2: Labor Force Participation and Labor Characteristics, 1975 to 2015

	1976		1985		1995		2005		2015	
A. Ages 16 to 65	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Worked	86.65	32.77	85.60	41.63	83.52	49.95	78.47	47.71	77.43	53.60
Looking for Work	2.82	1.28	4.01	2.43	4.75	4.27	8.36	8.02	13.62	11.76
Domestic Tasks	0.05	56.90	0.30	47.47	6.47	48.73	11.75	45.19	12.84	44.00
Studies	3.70	4.89	3.55	5.80	2.52	0.72	6.36	8.82	4.80	5.17
Pensioned	3.60	2.36	4.29	1.89	4.16	6.64	7.41	4.70	5.49	8.96
Hours worked/week	43.44	14.89	42.14	17.11	38.37	19.07	35.47	19.83	31.65	19.22
(St. Dev.)	(18.71)	(21.77)	(19.58)	(21.90)	(20.08)	(21.12)	(20.17)	(20.90)	(20.07)	(20.23)
Zero work hours (%)	11.5	65.2	13.6	57.7	15.8	46.2	19.3	43.9	23.0	45.5
Migrant (%)	49.4	49.3	..	..	50.5	52.2	47.3	49.5	41.9	43.9
Married (%)	59.1	58.1	60.7	59.9	61.1	52.2	57.7	59.0	58.7	57.8
Urban Resident (%)	65.9	68.9	73.8	76.8	79.4	52.2	82.5	85.2	84.4	86.8
Largest 10 City (%)	22.0	23.0	47.9	50.0	63.6	52.2	64.1	66.1	65.0	66.8
B. Ages 22 to 26										
Worked	89.49	38.87	90.05	45.80	86.47	52.96	82.33	55.86	77.00	54.82
Looking for Work	3.17	1.72	3.40	3.40	2.24	1.56	8.75	12.56	20.28	19.43
Domestic Tasks	0.05	53.02	0.15	45.85	6.51	45.52	8.54	41.49	11.70	36.22
Studies	4.10	4.57	2.31	4.08	3.24	5.82	4.83	7.84	6.43	10.04
Pensioned	0.20	0.16	0.23	0.10	0.38	0.14	0.26	0.43	0.25	0.23
Hours worked/week	46.64	17.2	43.63	19.02	39.59	20.74	36.41	21.7	31.57	20.74
(St. Dev.)	(15.8)	(22.3)	(17.1)	(22.3)	(18.65)	(4.17)	(19.20)	(21.17)	(19.49)	(20.57)
Zero work hours (%)	6.5	59.6	9.3	53.7	13.0	43.8	16.5	41.3	22.7	44.0
Migrant (%)	45.8	47.4	..	..	42.7	45.8	36.7	39.1	30.8	32.7
Married (%)	40.9	57.4	42.0	57.1	41.4	55.7	34.2	53.3	34.0	46.9
Urban Resident (%)	66.8	69.8	74.6	77.6	79.9	81.8	83.8	85.2	86.1	87.1
Largest 10 City (%)	21.7	23.1	48.2	50.1	63.1	64.1	64.3	64.4	65.5	64.2

Labor Force, 1976 to 2015

1. **LFP**:
    1. **Men** –either working or were looking for work –remained close to 90%.
    2. **Women**: rose from 34% to 66%
2. **Domestic tasks**
    1. **Men** –negligible (0.05%) to 13%
    2. **Women**: fell from 57% to 44%
3. **Hours Worked: Opposite change by gender**
    1. **Men:** From 43 hrs/wk in 1976 to 32 hrs/wk
    2. **Women:** Rises, from 15 to 19 hrs/wk
4. **Urbanized: Share in 10 Largest Cities**
    - 23% in 1976,
    - 67% in 2015

3 Estimates of Women's School Quality

1. Brotherhood et al. (2019) "EdQual"
   --Static school quality measure:
   --Wage differential according to place where went to school.
2. **New dataset** on municipal expenditures on education
   --Rural and urban municipalities of all Brazilian states
   --1941 to 2004
   --matched with individual PNAD data according to where person resided at age 10
3. **Women's human capital index**:
   --Regress school years, experience, & school quality ***on earnings of men***
   --Use estimated coefficients to predict ***women's earnings as if they were men***.
4. ***Huge increase when democracy returned***