Enlisting Employees in Improving Payroll-Tax Compliance: Evidence from Mexico

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  - Informal economy estimated at 40+% of GDP (Schneider and Enste, 2000).
  - Mexican social security agency (IMSS) supposed to cover all private-sector workers; in fact covers 53%.
  - Lowest tax revenue/GDP share in the OECD: 15-20% over study period.
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  ▶ Lowest tax revenue/GDP share in the OECD: 15-20\% over study period.

▶ Non-compliance of firms is a key element of general weakness of tax compliance.
Introduction (cont.)

- One well-appreciated dimension of non-compliance: failure to register.
  - Generates a variety of distortions: limited access to credit, limits on employment growth (Gordon and Li, 2009; Levy, 2008).
  - Recent papers have examined effect of policies/interventions to induce formalization (Fajnzylber, Maloney and Montes-Rojas, 2011; Bruhn, 2011; Kaplan, Piedra and Seira, forthcoming; McKenzie and Sakho, 2010; de Mel, McKenzie and Woodruff, 2012).

This paper focuses on an under-appreciated form of non-compliance: under-reporting of wages by registered firms. Arguably more relevant for larger firms, which are unlikely to be completely informal.
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- Arguably more relevant for larger firms, which are unlikely to be completely informal.
Institutional background

- *Instituto Mexicano del Seguro Social* (IMSS) is main source of social insurance for private-sector employees.
  - Public-sector workers, PEMEX workers have separate systems.

- Components:
  - Health care: free to covered employees and their families in IMSS clinics and hospitals.
  - Child care: free for children ages 7 weeks-4 years to mothers and single fathers covered in their jobs.
  - Retirement pension (more below)
  - Disability
  - Worker’s compensation
  - Housing fund

- Health care, child care, disability, worker’s compensation are available to all covered workers, spouses and dependents, *independent of wage reported*.

- Health care, child care, disability, worker’s compensation changed little over study period.
Employer contribution: 18-23% of wage, for most workers.
Fig. 1: Employer contribution schedule (low wages)

- Employer contribution: 18-23% of wage, for most workers.
Fig. 2: Employee contribution schedule

- Employee contribution: 2-5% of wage, for most workers.
Fig. 2: Employee contribution schedule (low wages)

- Employee contribution: 2-5% of wage, for most workers.
Institutional background (cont.)

- Pension benefits, pre-reform (PAYGO pension):
  - Individuals vested (and eligible for pension) after 10 years of contributions. Guaranteed at least minimum pension.

- Pension calculated based on average nominal wage in 5 years prior to retirement.

- Before 1991, not adjusted for inflation.

- Beginning in 1991, final average wage indexed to minimum wage (in Mexico City).


- Inflation rate under pressure to do something about eroding value of pensions, congress increased value of minimum pension.
  - 70% of minimum wage in 1989.
  - Gradually raised to 100% of minimum wage in 1995.

- Many retirees near minimum 10 years of contributions.

- Upshot: 80+% of retirees were getting minimum pension prior to 1997 reform.
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  - Inflation was extremely high in 1982-1988, moderately high in 1989-1992. [Inflation rate]
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Fig. 3C: Value of pension, men ages 60-65

C. Value of pension by ENEU wage percentile, ages 60–65

- Pension vs. level of final avg. wage
- Pension vs. IMSS wage percentile
- Women
Institutional background (cont.)

- In 1992, personal accounts created in parallel with PAYGO system. Plagued by administrative problems.
- Pension benefits, post-reform:
  - Individuals guaranteed minimum pension only after 25 years of contributions (although they have access to account balance if contribute fewer years.)
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▶ “Transition generation” (in system June 30, 1997) retained right to choose between pre-reform and post-reform pensions.
Fig. 4: Estado de Cuenta
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<table>
<thead>
<tr>
<th>Concepto</th>
<th>Saldo anterior</th>
<th>Aportaciones</th>
<th>Retiros</th>
<th>Rendimientos</th>
<th>Comisiones</th>
<th>Saldo final</th>
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<td></td>
<td>9,641.37</td>
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**TOTAL DE MI AHORRO**

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<td>98,339.04</td>
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* Los recursos de vivienda NO SCV administrados por las AFORES, sino por los Institutos de vivienda. Las AFORES únicamente brindan esta información a sus clientes pero no pueden resolver ninguna acción relacionada con créditos. INFONAVIT 01800-00-03-900 Lada sin costo o 9171-5260 en el D.F. / FOVISSSTE 01800-366-4763 D.F. y Lada sin costo.
### Table 1: Pension wealth simulation, by age in 1997

<table>
<thead>
<tr>
<th>Age in 1997</th>
<th>Years of Expected PRA Contributions</th>
<th>Plan</th>
<th>43</th>
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<th>200</th>
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<td>815.0</td>
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<td>PAYGO</td>
<td>398.6</td>
<td>398.6</td>
<td>603.8</td>
<td>890.2</td>
<td>1483.6</td>
<td>3200.1</td>
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<tr>
<td>30</td>
<td>30</td>
<td>PRA</td>
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<tr>
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<td>398.6</td>
<td>398.6</td>
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<td>398.6</td>
<td>603.8</td>
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<td>398.6</td>
<td>398.6</td>
<td>662.6</td>
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<td>55</td>
<td>5</td>
<td>PRA</td>
<td>398.6</td>
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<td>398.6</td>
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Notes: Values are real present discounted value of the future stream of pension benefits in thousands of 2002 pesos, for a male worker who began contributing at age 25 and expects to continue until age 60.
Data

- IMSS administrative records:
  - Full set of employers’ reports of employees’ wages, 1985-2005.
  - Variables: age, sex, daily wage, state and year of first registration with IMSS, employer id (location, industry)
  - Wages reported as spells; we draw for June 30.
  - Reports for temporary workers not captured electronically prior to 1997; we drop them.
  - “Permanent” legally defined as having written contract of indefinite duration, but employers have latitude.

- Encuesta Nacional de Empleo Urbano (ENEU)
  - CPS-like household survey, households surveyed quarterly for 5 quarters.
  - Began in 1987, some weirdness in first year.
  - Initial sample from 16 cities, expanded over time.
  - Questionnaire modified in 1994.
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- Sample selection (both sources):
  - Years: 1988-2003
  - Ages: 16-65
  - Cities: 16 cities in original ENEU sample
  - Sectors: manufacturing, construction, retail/hotel/restaurant (sectors in which IMSS is only social security agency.)
  - Main (highest-wage) job, if more than one.
  - Impose 1991 IMSS topcode (lowest real value).

- Focus on men.
  - Reasons:
    - Women’s labor-force participation changing.
    - Women often covered through husband. (Incentive to remain informal? Topic for future.)
    - Small N problem in ENEU, especially for older women by metro area.

- Summary: cross-sectional results for women similar to those for men. D-in-D noisier, no clear pattern.
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### Table 2: Comparison of IMSS and ENEU, men

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<th>IMSS baseline sample (1)</th>
<th>full ENEU sample (2)</th>
<th>ENEU w/ IMSS (3)</th>
<th>ENEU w/o IMSS (4)</th>
<th>ENEU permanent w/ IMSS (5)</th>
<th>ENEU full-time w/ IMSS (6)</th>
</tr>
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<tbody>
<tr>
<td><strong>A. 1990</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>real avg. daily post-tax wage</td>
<td>121.02 (0.07)</td>
<td>163.88 (1.58)</td>
<td>172.98 (1.94)</td>
<td>143.88 (2.62)</td>
<td>166.73 (1.85)</td>
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<tr>
<td>age</td>
<td>31.75 (0.01)</td>
<td>31.46 (0.15)</td>
<td>32.13 (0.17)</td>
<td>29.98 (0.29)</td>
<td>32.22 (0.17)</td>
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<tr>
<td>fraction employed in ests &gt;100 employees</td>
<td>0.52 (0.00)</td>
<td>0.43 (0.01)</td>
<td>0.55 (0.01)</td>
<td>0.18 (0.01)</td>
<td>0.55 (0.01)</td>
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<td>N (raw observations)</td>
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<td>16169</td>
<td>11592</td>
<td>4577</td>
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<tr>
<td>N (population, using weights)</td>
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<td>806324</td>
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<td><strong>B. 2000</strong></td>
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<tr>
<td>real avg. daily post-tax wage</td>
<td>123.60 (0.07)</td>
<td>148.20 (1.31)</td>
<td>161.15 (1.60)</td>
<td>120.78 (2.16)</td>
<td>166.42 (1.80)</td>
<td>155.80 (1.59)</td>
</tr>
<tr>
<td>age</td>
<td>32.70 (0.01)</td>
<td>32.22 (0.14)</td>
<td>32.82 (0.16)</td>
<td>30.94 (0.28)</td>
<td>33.22 (0.17)</td>
<td>32.88 (0.16)</td>
</tr>
<tr>
<td>fraction employed in ests &gt;100 employees</td>
<td>0.58 (0.00)</td>
<td>0.44 (0.01)</td>
<td>0.59 (0.01)</td>
<td>0.10 (0.01)</td>
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<td>N (raw observations)</td>
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<td>2384267</td>
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<td>2042988</td>
<td>2225318</td>
</tr>
</tbody>
</table>

---

Women
Fig. 6: Wage histograms, men, 1990

Notes: Bins are 5 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar. Vertical lines represent the three region-specific minimum wages. IMSS reported wage is pre-tax.
Fig. 7: Wage histograms, men, 1990, low wages

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar. Vertical lines represent the three region-specific minimum wages. IMSS reported wage is pre-tax.
Fig. 8: Wage histograms, men, 1990, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar. IMSS reported wage is pre-tax.
Notes: IMSS wage is post-tax. Densities estimated using 1990 Q2 data and an Epanechnikov kernel with bandwidth 3 pesos for IMSS data and 6 pesos for ENEU data. Vertical line is at 25th percentile of the ENEU wage distribution. Excess mass for 25th percentile defined as (area under red, left of vertical line) - (area under blue, left of vertical line).
### Table 4: Cross-sectional patterns of evasion, 1990, men

<table>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
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<tr>
<td>26-35 years</td>
<td>-0.054* (0.029)</td>
<td>-0.054** (0.021)</td>
<td>-0.081*** (0.024)</td>
</tr>
<tr>
<td>36-45 years</td>
<td>-0.072** (0.034)</td>
<td>-0.073*** (0.027)</td>
<td>-0.149*** (0.028)</td>
</tr>
<tr>
<td>46-55 years</td>
<td>-0.029 (0.035)</td>
<td>-0.026 (0.031)</td>
<td>-0.154*** (0.031)</td>
</tr>
<tr>
<td>56-65 years</td>
<td>-0.026 (0.044)</td>
<td>-0.034 (0.040)</td>
<td>-0.165*** (0.037)</td>
</tr>
<tr>
<td>11-50 employees</td>
<td>-0.332*** (0.026)</td>
<td>-0.333*** (0.023)</td>
<td>-0.173*** (0.025)</td>
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<tr>
<td>51-100 employees</td>
<td>-0.480*** (0.033)</td>
<td>-0.478*** (0.031)</td>
<td>-0.281*** (0.030)</td>
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<tr>
<td>101-250 employees</td>
<td>-0.393*** (0.039)</td>
<td>-0.374*** (0.037)</td>
<td>-0.242*** (0.035)</td>
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<tr>
<td>&gt; 250 employees</td>
<td>-0.499*** (0.035)</td>
<td>-0.465*** (0.034)</td>
<td>-0.231*** (0.030)</td>
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<tr>
<td>Construction</td>
<td>0.128*** (0.029)</td>
<td></td>
<td>0.122*** (0.025)</td>
</tr>
<tr>
<td>Retail/Services</td>
<td>-0.073*** (0.024)</td>
<td></td>
<td>-0.108*** (0.021)</td>
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<tr>
<td>Constant</td>
<td>0.559*** (0.017)</td>
<td>0.854*** (0.018)</td>
<td>0.639*** (0.047)</td>
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<tr>
<td>Metro Area Effects</td>
<td>N</td>
<td>N</td>
<td>Y</td>
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<tr>
<td>R-squared</td>
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<td>0.20</td>
<td>0.31</td>
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<tr>
<td>N</td>
<td>1068</td>
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</table>

Notes: Data are from IMSS and ENEU baseline samples, collapsed to metro area/age group/firm-size category/sector level for 1990. The omitted category for age is 16-25, for firm size is 1-10 employees, and for sector is manufacturing. The wage gap (medians) is log median real daily take-home wage from the ENEU minus log median real daily post-tax reported wage from IMSS, calculated. Wage gap (means) is analogous, using mean in place of median.
Fig. 12: Wage densities by age group, men

Women
Fig. 13: Wage gaps (medians) by age group, men

Notes: Wage gap (medians) = log median net wage (ENEU) - log median post-tax reported wage (IMSS). ENEU data pooled across quarters within year.
Fig. 14: Wage gaps (medians) by age group, men, deviated from metro-year means

Notes: Wage gap (medians) = log median net wage (ENEU) - log median post-tax reported wage (IMSS), calculated at age-group/metro area/year level. Shown are average residuals from regressions of wage gaps on metro-year dummies. ENEU data pooled across quarters within year.
Table 5: Differential effects on evasion, men

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<tr>
<th></th>
<th>wage gap (medians)</th>
<th></th>
<th>wage gap (means)</th>
<th></th>
<th>excess mass (25th perc.)</th>
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<td>(3)</td>
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<tr>
<td>1(age &gt; 55)*1988</td>
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<td>0.056</td>
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<td>0.040</td>
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<td>1(age &gt; 55)*1989</td>
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<td>0.076*</td>
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<td>0.048</td>
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<td>(0.042)</td>
<td>(0.039)</td>
<td>(0.032)</td>
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<tr>
<td>1(age &gt; 55)*1990</td>
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<td>0.067*</td>
<td>0.060</td>
<td>0.060*</td>
<td>0.027</td>
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<td>(0.039)</td>
<td>(0.041)</td>
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<td>(0.022)</td>
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<tr>
<td>1(age &gt; 55)*1991</td>
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<td>0.058</td>
<td>0.040</td>
<td>0.040</td>
<td>0.042**</td>
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<td>(0.038)</td>
<td>(0.036)</td>
<td>(0.037)</td>
<td>(0.019)</td>
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<tr>
<td>1(age &gt; 55)*1992</td>
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<td>0.037</td>
<td>-0.013</td>
<td>-0.013</td>
<td>0.029</td>
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<tr>
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<td>(0.042)</td>
<td>(0.043)</td>
<td>(0.042)</td>
<td>(0.038)</td>
<td>(0.021)</td>
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<tr>
<td>1(age &gt; 55)*1993</td>
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<td>0.039</td>
<td>0.002</td>
<td>0.002</td>
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<td>1(age &gt; 55)*1994</td>
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<td>0.033</td>
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<tr>
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<td>0.124***</td>
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<td>0.106**</td>
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<td>-0.029</td>
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<td>1(age &gt; 55)*1998</td>
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<td>(0.040)</td>
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<td>(0.018)</td>
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<tr>
<td>1(age &gt; 55)*1999</td>
<td>0.154***</td>
<td>0.154***</td>
<td>0.100***</td>
<td>0.100***</td>
<td>0.062***</td>
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<td>(0.041)</td>
<td>(0.032)</td>
<td>(0.033)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>1(age &gt; 55)*2000</td>
<td>0.146***</td>
<td>0.146***</td>
<td>0.104***</td>
<td>0.104***</td>
<td>0.053**</td>
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<td>(0.039)</td>
<td>(0.030)</td>
<td>(0.024)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>1(age &gt; 55)*2001</td>
<td>0.201***</td>
<td>0.201***</td>
<td>0.151***</td>
<td>0.151***</td>
<td>0.074***</td>
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<td>(0.047)</td>
<td>(0.041)</td>
<td>(0.035)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>1(age &gt; 55)*2002</td>
<td>0.243***</td>
<td>0.243***</td>
<td>0.188***</td>
<td>0.188***</td>
<td>0.071***</td>
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<td>(0.039)</td>
<td>(0.033)</td>
<td>(0.030)</td>
<td>(0.018)</td>
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<tr>
<td>1(age &gt; 55)*2003</td>
<td>0.192***</td>
<td>0.192***</td>
<td>0.175***</td>
<td>0.175***</td>
<td>0.051***</td>
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<td>(0.044)</td>
<td>(0.040)</td>
<td>(0.035)</td>
<td>(0.031)</td>
<td>(0.018)</td>
</tr>
</tbody>
</table>

age group effects  | Y                   | Y               | age group-metro area effects | Y                   | N     | Y     |
metro-year effects  | Y                   | Y               | metro-year effects | Y                   | Y     | Y     |
R-squared           | 0.85                | 0.92            | N                             | 1280               | 1280  | 1280  |

Notes: Data collapsed to metro area/age group/year level. ENEU data pooled across quarters within year.
Fig. 15: Differential effect of reform on wage gap (medians), ages 55-65, men

Notes: Figure plots coefficients for 1(age>55)*year interaction term from Column 2 of Table 5. The dotted lines indicate the 95 percent confidence interval.
Fig. 16: Differential effect of reform on wage gap (means), ages 55-65, men

Notes: Figure plots coefficients for $1(\text{age}>55) \times \text{year}$ interaction term from Column 4 of Table 5. The dotted lines indicate the 95 percent confidence interval.
Conclusion

- Two basic points:
  - There is substantial under-reporting. Third-party reporting does not eliminate evasion.
  - The extent of under-reporting appears to respond to economic incentives, in particular to change in employees’ incentives to ensure accurate reporting and information about employers’ reports.

- Implication: giving employees incentives to monitor employers should be a consideration in the design of social-insurance systems.

- Theoretical model suggests that reducing payroll taxes ($\tau$) would have the same effect on compliance as an increase in benefit rate ($b$).

- But increasing sensitivity of benefits to contributions may be preferable on revenue grounds.
Conclusion

- Two basic points:
  - There is substantial under-reporting. Third-party reporting does not eliminate evasion.
  - The extent of under-reporting appears to respond to economic incentives, in particular to change in employees’ incentives to ensure accurate reporting and information about employers’ reports.

- Implication: giving employees incentives to monitor employers should be a consideration in the design of social-insurance systems.
  - Theoretical model suggests that reducing payroll taxes ($\tau \downarrow$) would have same effect on compliance as increase in benefit rate ($b \uparrow$).
  - But increasing sensitivity of benefits to contributions may be preferable on revenue grounds.
Conclusion

- Future work:
  - To what extent are workers aware of under-reporting by employers?
    - Empirically, need setting with independent variation in incentives and information.
  - Does greater compliance on intensive margin (less under-reporting by registered firms) induce lower compliance on extensive margin (fewer firms registering)?
References I


Housing account

- Employer contributes 5% of worker’s wage to housing fund (INFONAVIT), to which workers can apply for loans.
- Workers can claim unused funds at retirement.
  - Prior to 1992: nominal contributions, real value low.
  - Post-reform: Funds administered by AFORE, can be claimed by workers who choose PRA.

- Changes reinforce pension changes.
Other dimensions of tax system

- **VAT:** 15% for 1988-2003 period.
- **Corporate income taxes:**
  - 39.2% in 1988, 34% in 2003
  - Widespread evasion: e.g. in early 1990s, 70% of corporations declared no income (OECD, 1992).
- **Personal income taxes:**
  - 3-50% in 1988, 3-34% in 2003.
  - Extensive tax credits for low-income workers, to offset regressive effects of VAT.
  - In 1997, individuals making <3.2 minimum wages (70% of all employees) paid ≤0 income tax (OECD, 1999, p. 80).
- VAT, social security taxes each ∼3% of GDP; corporate + personal income taxes and PEMEX contributions each ∼4% of GDP (OECD, 1999).
- IMSS and tax authority first signed agreement to share data in June 2002. No information sharing previously.
Fig. 3A: Value of pension, men ages 60-65
Fig. 3B: Value of pension, men ages 60-65

B. Value of pension by IMSS wage percentile, ages 60–65
Inflation rate

![Inflation rate graph](image)
Table A5: Pension wealth simulation, worker entering June 30, 1997

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<th>Years of Contributions</th>
<th>Plan</th>
<th>43</th>
<th>100</th>
<th>200</th>
<th>300</th>
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<td>35</td>
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<td>398.6</td>
<td>815.0</td>
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<td>398.6</td>
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<td>965.8</td>
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</tbody>
</table>

Notes: Values are real present discounted value of the future stream of pension benefits in thousands of 2002 pesos, for a male worker who enters the system on June 30, 1997.
Theoretical framework

- Simple model of payroll-tax compliance by heterogeneous firms.
Theoretical framework

- Simple model of payroll-tax compliance by heterogeneous firms.
- Shares features with models in Yaniv (1992), Kopczuk and Slemrod (2006), Kleven et al. (2009), and Besley and Persson (2013), but these papers do not focus on heterogeneity across firms.
Theoretical framework

- Simple model of payroll-tax compliance by heterogeneous firms.
- Shares features with models in Yaniv (1992), Kopczuk and Slemrod (2006), Kleven et al. (2009), and Besley and Persson (2013), but these papers do not focus on heterogeneity across firms.
- Model is special in a number of ways. Goal is to spell out in a precise way why empirical exercise makes sense.
Theoretical framework (cont.)

- Payroll taxes:
  - $\tau_f$ on firms, $\tau_w$ on workers (statutorily).
  - Let $\tau = \tau_f + \tau_w$, assuming $0 < \tau < 1$. 

- Wages:
  - $w_r$ = pre-tax wage reported by firm to government
  - $w_u$ = unreported wage.
  - Total wage paid by firm: $w_f = w_r + w_u$.
  - Net take-home wage to worker: $w_{net} = w_u + (1 - \tau)w_r$.
  - "Effective" wage: $w_e = w_{net} + bw_r = w_u + (1 - (\tau - b))w_r$, where $b$ is "benefit rate."

- $w_r$, $w_u$, $w_{net}$ observable to econometrician in IMSS, ENEU data, respectively (at cell level).
- Can infer unreported wage from them: $w_u = w_{net} - (1 - \tau)w_r$.
- Assume $w_r$, $w_u$, $w_{net}$, $w_e$ observable to workers.
- Issue: pre-reform, do workers know $w_u$ (they collude) or not (they are uninformed)? We will return to this.
Payroll taxes:
- $\tau_f$ on firms, $\tau_w$ on workers (statutorily).
- Let $\tau = \tau_f + \tau_w$, assuming $0 < \tau < 1$.

Wages:
- $w_r =$ pre-tax wage reported by firm to government
- $w_u =$ unreported wage.
- Total wage paid by firm: $w_f = w_r + w_u$.
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- “Effective” wage: $w_e = w_{net} + bw_r = w_u + (1 - (\tau - b))w_r$,
  where $b$ is “benefit rate.”
Theoretical framework (cont.)

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  - Let $\tau = \tau_f + \tau_w$, assuming $0 < \tau < 1$.

- Wages:
  - $w_r = \text{pre-tax wage reported by firm to government}$
  - $w_u = \text{unreported wage}$.
  - Total wage paid by firm: $w_f = w_r + w_u$.
  - Net take-home wage to worker: $w_{net} = w_u + (1 - \tau)w_r$.
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Payroll taxes:
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- Let $\tau = \tau_f + \tau_w$, assuming $0 < \tau < 1$.

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- $w_r =$ pre-tax wage reported by firm to government
- $w_u =$ unreported wage.
- Total wage paid by firm: $w_f = w_r + w_u$.
- Net take-home wage to worker: $w_{net} = w_u + (1 - \tau)w_r$.
- “Effective” wage: $w_e = w_{net} + bw_r = w_u + (1 - (\tau - b))w_r$, where $b$ is “benefit rate.”

$w_r, w_{net}$ observable to econometrician in IMSS, ENEU data, respectively (at cell level).
- Can infer unreported wage from them: $w_u = w_{net} - (1 - \tau)w_r$
- Assume $w_r, w_u, w_{net}, w_e$ observable to workers.
- Issue: pre-reform, do workers know $w_u$ (they collude) or not (they are uninformed)? We will return to this.
Theoretical framework (cont.)

- Firm side based on one-country version of Melitz (2003):
  
  \[ x(\phi) = A_p(\phi) - \sigma \]

  Cost of evasion:
  
  \[ c(w_u) = \begin{cases} c(0) = 0, & c'(w_u) > 0, \\ c''(w_u) > 0 \end{cases} \]

  Labor market competitive; firms are price-takers of \( w_e \).

  Firm's problem: choose \( w_u, p \) to maximize
  
  \[ \pi(w_u, p; \phi, w_e) = \{ p - 1 \phi w_e - (\tau - b) w_u - (\tau - b) \} x - f \]
Theoretical framework (cont.)

- Firm side based on one-country version of Melitz (2003):
  - Firms heterogeneous in productivity parameter, $\varphi$, with density $g(\varphi)$.

- CES demand:
  - $x(\varphi) = A p(\varphi) - \sigma$

- Cost of evasion:
  - $x_c(w_u)$, where $c(0) = 0$, $c'(w_u) > 0$, $c''(w_u) > 0$

- Labor market competitive; firms are price-takers of $w_e$.

- Firm's problem: choose $w_u, p$ to maximize $\pi(w_u, p; \varphi, w_e) = \{p - 1\varphi w_e - (\tau - b)w_u^{1 - (\tau - b)} - c(w_u)\} x - f$.
Theoretical framework (cont.)

- Firm side based on one-country version of Melitz (2003):
  - Firms heterogeneous in productivity parameter, \( \varphi \), with density \( g(\varphi) \).
  - CES demand: \( x(\varphi) = Ap(\varphi)^{-\sigma} \)
Theoretical framework (cont.)

- Firm side based on one-country version of Melitz (2003):
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  - Cost of evasion: $xc(w_u)$, where $c(0) = 0$, $c'(w_u) > 0$, $c''(w_u) > 0$
Theoretical framework (cont.)

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Theoretical framework (cont.)

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▶ Labor market competitive; firms are price-takers of \( w_e \).
▶ Firm’s problem: choose \( w_u, p \) to maximize

\[
\pi(w_u, p; \varphi, w_e) = \left\{ p - \frac{1}{\varphi} \frac{w_e - (\tau - b)w_u}{1 - (\tau - b)} - c(w_u) \right\} x - f
\]
Theoretical framework (cont.)

- First order conditions yield:

  \[ \begin{align*}
  \text{Optimal evasion} \quad w^* \quad u(\phi) & \text{depends on neither } p \text{ nor } w_e: \\
  c'(w^*u(\phi)) &= \tau - b \phi (1 - (\tau - b)) \\
  \text{Price is fixed mark-up over costs:} \\
  p^*(w_e,\phi) &= \left\{\frac{\sigma}{\sigma - 1} \right\} w_e - (\tau - b) w^*u(\phi) \phi (1 - (\tau - b)) + c(w^*u(\phi)) \\
  \text{Aggregate labor demand:} \\
  L_{\text{agg}}(w_e) &= \int_{\phi_{\text{max}}}^{\phi_{\text{min}}} \{ p^*(w_e,\phi) - \sigma \phi g(\phi) \} d\phi \\
  \text{Assume constant elasticity of labor supply (with } \rho > 0 \text{ and } B > 0): \\
  L_{\text{agg}}(w_e) &= B w_e^\rho \\
  \text{Labor market clearing pins down } w_e: \\
  L_{\text{agg}}(w_e) &= L_{\text{Dagg}}(w_e)
  \end{align*} \]
First order conditions yield:

Optimal evasion $w_u^*(\varphi)$ depends on neither $p$ nor $w_e$:

$$c'(w_u) = \frac{\tau - b}{\varphi(1 - (\tau - b))}$$
First order conditions yield:

- Optimal evasion $w_u^*(\varphi)$ depends on neither $p$ nor $w_e$:
  \[
  c'(w_u) = \frac{\tau - b}{\varphi(1 - (\tau - b))}
  \]

- Price is fixed mark-up over costs:
  \[
  p^*(w_e, \varphi) = \left(\frac{\sigma}{\sigma - 1}\right) \left\{ \frac{w_e - (\tau - b)w_u^*(\varphi)}{\varphi(1 - (\tau - b))} + c(w_u^*(\varphi)) \right\}
  \]
Theoretical framework (cont.)

- First order conditions yield:
  - Optimal evasion $w_u^*(\varphi)$ depends on neither $p$ nor $w_e$:
    \[
    c'(w_u) = \frac{\tau - b}{\varphi(1 - (\tau - b))}
    \]
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    \[
    p^*(w_e, \varphi) = \left( \frac{\sigma}{\sigma - 1} \right) \left\{ \frac{w_e - (\tau - b)w_u^*(\varphi)}{\varphi(1 - (\tau - b))} + c(w_u^*(\varphi)) \right\}
    \]
  - Aggregate labor demand:
    \[
    L_{agg}^D(w_e) = \int_{\varphi_{min}}^{\varphi_{max}} \frac{Ap^*(w_e, \varphi)^{-\sigma}}{\varphi} g(\varphi) d\varphi
    \]
Theoretical framework (cont.)

- First order conditions yield:
  - Optimal evasion $w_u^*(\varphi)$ depends on neither $p$ nor $w_e$:
    \[ c'(w_u) = \frac{\tau - b}{\varphi(1 - (\tau - b))} \]
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- Assume constant elasticity of labor supply (with $\rho > 0$ and $B > 0$):
  \[ L_{agg}^S = Bw_e^\rho \]
Theoretical framework (cont.)

- First order conditions yield:
  - Optimal evasion $w_u^*(\varphi)$ depends on neither $p$ nor $w_e$:
    \[ c'(w_u) = \frac{\tau - b}{\varphi(1 - (\tau - b))} \]
  - Price is fixed mark-up over costs:
    \[ p^*(w_e, \varphi) = \left( \frac{\sigma}{\sigma - 1} \right) \left\{ \frac{w_e - (\tau - b)w_u^*(\varphi)}{\varphi(1 - (\tau - b))} + c(w_u^*(\varphi)) \right\} \]

- Aggregate labor demand:
  \[ L_{agg}^D(w_e) = \int_{\varphi_{min}}^{\varphi_{max}} \frac{Ap^*(w_e, \varphi)^{-\sigma}}{\varphi} g(\varphi) d\varphi \]

- Assume constant elasticity of labor supply (with $\rho > 0$ and $B > 0$):
  \[ L_{agg}^S = Bw_e^\rho \]

- Labor market clearing pins down $w_e$:
  \[ L_{agg}^S(w_e) = L_{agg}^D(w_e) \]
Theoretical punchlines:

1. Evasion declining in productivity in cross-section:

$$\frac{d{w}_u^*}{d\varphi} = -\frac{\tau - b}{\varphi^2c''(w_u)(1 - (\tau - b))} < 0$$

If employment is increasing in productivity (true if cost of evasion not too large), then evasion is also declining in employment.
Theoretical framework (cont.)

▶ Theoretical punchlines:

1. Evasion declining in productivity in cross-section:

\[
\frac{dw_u^*}{d\varphi} = - \frac{\tau - b}{\varphi^2 c''(w_u)(1 - (\tau - b))} < 0
\]

▶ If employment is increasing in productivity (true if cost of evasion not too large), then evasion is also declining in employment.

2. Evasion declines in response to increase in benefit rate, \(b\) (as for younger workers following pension reform):

\[
\frac{dw_u^*}{db} = - \frac{1}{(1 - (\tau - b))^2 \varphi c''(w_u^*(\varphi))} < 0
\]
Theoretical framework (cont.)

- Theoretical punchlines:

1. Evasion declining in productivity in cross-section:

\[
\frac{d\omega_u^*}{d\varphi} = -\frac{\tau - b}{\varphi^2 c''(w_u)(1 - (\tau - b))} < 0
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2. Evasion declines in response to increase in benefit rate, \( b \) (as for younger workers following pension reform):

\[
\frac{d\omega_u^*}{db} = -\frac{1}{(1 - (\tau - b))^2 \varphi c''(w_u^*(\varphi))} < 0
\]

3. Incidence of increase in \( b \) on \( w_e, w_{net}, w_f \) ambiguous, depends on elasticity of labor supply, \( \rho \), and extent of firm heterogeneity.

- Note: implications for evasion do not depend on incidence.
Differentiating labor-market-clearing condition with respect to $b$ and re-arranging:

\[
\frac{d w_e}{d b} = \frac{\int_{\varphi_{\min}}^{\varphi_{\max}} [w_r^*(w_e, \varphi)] \frac{(p^*)^{-\sigma-1}}{\varphi^2} g(\varphi) d\varphi}{1 - \tau + b \left( \frac{\sigma - 1}{\sigma} \right) \rho B w_e^{\rho - 1} + \int_{\varphi_{\min}}^{\varphi_{\max}} \frac{(p^*)^{-\sigma-1}}{\varphi^2} g(\varphi) d\varphi}
\]

Effect can be bounded:

\[
\lim_{\rho \to \infty} \frac{d w_e}{d b} = 0
\]

\[
\lim_{\rho \to 0} \frac{d w_e}{d b} = \int_{\varphi_{\min}}^{\varphi_{\max}} \mu(\varphi) [w_r^*(w_e, \varphi)] g(\varphi) d\varphi \equiv \overline{w}_r^*(w_e)
\]

where \(\mu(\varphi) = \frac{\frac{(p^*)^{-\sigma-1}}{\varphi^2}}{\int_{\varphi_{\min}}^{\varphi_{\max}} \frac{(p^*)^{-\sigma-1}}{\varphi^2} g(\varphi) d\varphi}\)
Incidence (cont.)

- It follows immediately that:

\[
\frac{d w_r^\ast}{d b} = \frac{1}{\varphi c''(w_u^\ast(\varphi))(1 - \tau + b)^2} + \frac{1}{1 - \tau + b} \left\{ \frac{d w_e}{d b} - w_r^\ast(w_e, \varphi) \right\}
\]

\[
\frac{d w_{net}^\ast}{d b} = -\frac{b}{\varphi c''(w_u^\ast(\varphi))(1 - \tau + b)} + \frac{1 - \tau}{1 - \tau + b} \left\{ \frac{d w_e}{d b} - w_r^\ast(w_e, \varphi) \right\}
\]

- In special case when firms are homogenous, we have:

\[
\frac{d w_{net}^\ast}{d b} < -\frac{b}{\varphi c''(w_u^\ast(\varphi))(1 - \tau + b)} < 0
\]

- But effect on \( w_{net} \) (or \( w_r \)) cannot be signed in general case.

- Intuition: with reform (\( b \uparrow \))

  - Gov’t pays more of effective wage: tends to reduce \( w_{net} \).
  - \( \frac{d w_e}{d b} \) can be shown to be bounded above by average response; an individual firm’s response depends on its own \( w_r \), so \( \left\{ \frac{d w_e}{d b} - w_r^\ast(w_e, \varphi) \right\} \) term is of ambiguous sign.
### Table A6: Comparison of IMSS and ENEU, 1990, women

<table>
<thead>
<tr>
<th></th>
<th>IMSS baseline sample (1)</th>
<th>full ENEU sample (2)</th>
<th>ENEU w/ IMSS (3)</th>
<th>ENEU w/o IMSS (4)</th>
<th>ENEU permanent w/ IMSS (5)</th>
<th>ENEU full-time w/ IMSS (6)</th>
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<td>A. 1990</td>
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<td></td>
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<tr>
<td>real avg. daily post-tax wage</td>
<td>88.29 (0.08)</td>
<td>133.55 (2.16)</td>
<td>136.91 (2.65)</td>
<td>124.84 (3.59)</td>
<td>128.57 (2.50)</td>
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<tr>
<td>age</td>
<td>28.12 (0.01)</td>
<td>28.35 (0.21)</td>
<td>28.03 (0.23)</td>
<td>29.17 (0.47)</td>
<td>27.82 (0.24)</td>
<td></td>
</tr>
<tr>
<td>fraction employed in ests &gt;100 employees</td>
<td>0.55 (0.00)</td>
<td>0.45 (0.01)</td>
<td>0.54 (0.01)</td>
<td>0.21 (0.02)</td>
<td>0.54 (0.01)</td>
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<td>N (raw observations)</td>
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<td>6685</td>
<td>5126</td>
<td>1559</td>
<td>4745</td>
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<tr>
<td>N (population, using weights)</td>
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<td>1023858</td>
<td>738698</td>
<td>285160</td>
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<td>B. 2000</td>
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<td></td>
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</tr>
<tr>
<td>real avg. daily post-tax wage</td>
<td>90.86 (0.07)</td>
<td>128.04 (1.82)</td>
<td>135.88 (2.21)</td>
<td>109.72 (3.06)</td>
<td>140.56 (2.49)</td>
<td>129.65 (2.18)</td>
</tr>
<tr>
<td>age</td>
<td>30.44 (0.01)</td>
<td>30.34 (0.18)</td>
<td>29.85 (0.19)</td>
<td>31.50 (0.40)</td>
<td>30.17 (0.21)</td>
<td>29.71 (0.20)</td>
</tr>
<tr>
<td>fraction employed in ests &gt;100 employees</td>
<td>0.64 (0.00)</td>
<td>0.49 (0.01)</td>
<td>0.62 (0.01)</td>
<td>0.19 (0.01)</td>
<td>0.64 (0.01)</td>
<td>0.62 (0.01)</td>
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<tr>
<td>N (raw observations)</td>
<td>1251832</td>
<td>9670</td>
<td>7227</td>
<td>2443</td>
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<tr>
<td>N (population, using weights)</td>
<td>1251832</td>
<td>1652164</td>
<td>1157184</td>
<td>494980</td>
<td>1001866</td>
<td>1056013</td>
</tr>
</tbody>
</table>
Fig. A1: Employment, IMSS vs. ENEU samples, women
Fig. A2: Wage histograms, women, 1990

- IMSS admin. records
- ENEU household survey

Real daily salary (constant 2002 pesos)
Fig. A3: Wage histograms, women, 1990, low wages
Fig. A4: Wage histograms, women, 1990, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Fig. A5: Wage histogram, women, 1993, EIA plants

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Fig. A6: Wage histogram, women, 1993, EMIME plants

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Fig. ??: Wage densities by age group, women
Fig. B17: Average age by firm size, men
Fig. B18: Average age by firm size, men, deviated from metro-year means
Fig. B11: Excess mass (below 50th perc.) by firm size
Fig. B12: Excess mass (below 50th perc.) by firm size, deviated
Fig. ??: Wage gaps by age group, women

[Graph showing wage gaps by age group from 1988 to 2002.]
Fig. ??: Wage gaps by age group, women, deviated from metro-year means
Fig. ??: Kullback-Liebler divergence by age group, women
Fig. ??: Kullback-Liebler divergence by age group, men
Table ??: Differential effects on wage gap, women

dep. var.: log(median wage, ENEU) - log(median wage, IMSS)

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(age &gt; 55)*1988</td>
<td>-0.477***</td>
<td>-0.457***</td>
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<tr>
<td></td>
<td>(0.178)</td>
<td>(0.164)</td>
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<tr>
<td>1(age &gt; 55)*1989</td>
<td>-0.362**</td>
<td>-0.370**</td>
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<td>(0.158)</td>
<td>(0.155)</td>
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<tr>
<td>1(age &gt; 55)*1990</td>
<td>-0.147</td>
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<tr>
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<td>(0.218)</td>
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<td>(0.175)</td>
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<td>1(age &gt; 55)*1998</td>
<td>-0.363**</td>
<td>-0.350**</td>
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<td>1(age &gt; 55)*1999</td>
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<td>1(age &gt; 55)*2000</td>
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<td>1(age &gt; 55)*2001</td>
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<td>(0.174)</td>
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<td>1(age &gt; 55)*2002</td>
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<td>(0.163)</td>
<td>(0.156)</td>
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metro area effects  
year effects  
metro-year effects  
age category effects  
R-squared  
N

Return
Fig. ??: Coeffs. on age*year interaction (Table 4 Col 3)
### Table ??: Differential effects on employment gap, women

<table>
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<td>1(age &gt; 55)*1988</td>
<td>-0.141</td>
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<td>0.161</td>
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Wage histograms, men, 1993, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Wage histograms, men, 1997, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Wage histograms, men, 2000, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Wage histograms, men, 2003, by firm size

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Wage histograms, men, 1993, by firm size, non-EIA plants

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Wage histogram, men, 1993, non-EIA plants

Notes: Bins are 2 pesos wide. Average 2002 exchange rate: 9.66 pesos/dollar.
Firm size distributions, IMSS vs. ENEU, 1990

Share of employment by firm size

- IMSS admin. records
- ENEU household survey

- 1−10 emp.
- 11−50 emp.
- 51−100 emp.
- 101−250 emp.
- >250 emp.

Fraction of sample
Firm size distributions, IMSS vs. ENEU, 1993

Share of employment by firm size

- IMSS admin. records
- ENEU household survey

- 1−10 emp.
- 11−50 emp.
- 51−100 emp.
- 101−250 emp.
- >250 emp.

Sample fraction

0.1
0.2
0.3
0.4
0.5
Firm size distributions, IMSS vs. ENEU, 1997

Share of employment by firm size

- IMSS admin. records
- ENEU household survey

- Fractions of sample for different employment size categories:
  - 1−10 emp.
  - 11−50 emp.
  - 51−100 emp.
  - 101−250 emp.
  - >250 emp.

The diagram illustrates the comparison between IMSS admin. records and ENEU household survey data for firm size distributions in 1997.
Firm size distributions, IMSS vs. ENEU, 2000

Share of employment by firm size

- **IMSS admin. records**
- **ENEU household survey**

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<th>Employment Size</th>
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<th>ENEU</th>
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<td>&gt;250 emp.</td>
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Firm size distributions, IMSS vs. ENEU, 2003

Share of employment by firm size

- IMSS admin. records
- ENEU household survey

- 1–10 emp.
- 11–50 emp.
- 51–100 emp.
- 101–250 emp.
- >250 emp.
Employment, IMSS vs. EIA

![Graph showing employment trends for IMSS and EIA from 1993 to 2003. The graph compares the number of employees (in thousands) for each year, with IMSS represented by a dashed blue line and EIA by a solid red line. There is a significant increase in employment for both IMSS and EIA during the 1998-1999 period.](image-url)
Mean, median, minimum wages

![Graph showing mean, median, and minimum wages over time. The x-axis represents years from 1988 to 2002, and the y-axis represents wage in constant 2002 pesos per day. The graph includes lines for median real wage, IMSS, ENEU, and real minimum wage.]
ENEU wage distributions, full-time vs. permanent w/ IMSS, men, 1994
Log median daily wages, men, IMSS data, by age group

Year


log(median wage, IMSS)
Wage histograms, covered vs. not covered by IMSS, men, 1990
Wage distributions, by metro area, men, 1990
Wage gaps (in means) by age group, men
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<th>Years in IMSS</th>
<th>16-25 (%)</th>
<th>26-35 (%)</th>
<th>36-45 (%)</th>
<th>46-55 (%)</th>
<th>56-65 (%)</th>
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**Dep. var.: excess mass (below indicated ENEU percentile)**