Industry Dynamics and the Minimum Wage: A Putty-Clay Approach

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The opinions and conclusions are solely those of the authors, and should not be construed as representing the opinions, views or policies of the Federal Reserve System or the U.S. Bureau of Labor Statistics.
**WHAT WE FIND**

Following minimum wage hikes

- Restaurant exit goes up (not surprising qualitatively);
- Restaurant entry also goes up (surprising);
- Entry effect strongest in chains, which are more capital intensive;
- No change in employment at continuing restaurants.

Putty clay model fits these facts.

- Incumbents cannot substitute away from labor while new entrants can.
- New entrants are at a cost advantage relative to incumbents;
- Entering firms replace incumbents ⇒ entry and exit rise.
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IMPLICATIONS

We estimate a small short run disemployment effect of the minimum wage (consistent with most of the evidence).

- Commonly interpreted as monopsony:
  - search: Burdett and Mortensen (1998); Flinn (2006);
  - other models: Rebitzer and Taylor (1995); Bhaskar and To (1999);
  - minimum wages potentially increase efficiency.

- Putty clay models also produce small short run disemployment effects ...

- But big long run disemployment effects (Sorkin 2015)
  - over time, labor intensive restaurants are replaced by more capital intensive restaurants
  - minimum wages have potentially large long run disemployment effects and thus large negative efficiency effects.

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- Putty clay models also have other implications consistent with the facts.
Empirical setting: the restaurant industry

Why the restaurant industry?
- 29 percent of minimum wage* workers are employed in the restaurant industry (2004-6 in CPS).
- 20 percent of workers in the restaurant are minimum wage workers (2004-2006 in CPS).

*Minimum wage worker = someone with salary divided by hours worked less than 120% of minimum wage.
Data: Quarterly Census of Employment and Wages (QCEW)

- Universe of establishments paying UI taxes:
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- High quality data starting in most states in 2000
- At 6 digit NAICS level (722211): limited-service restaurants.
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- Universe of establishments paying UI taxes:
  - Monthly panel data.
- High quality data starting in most states in 2000
- At 6 digit NAICS level (722211): limited-service restaurants.
- Restaurant level data: information on location, number of workers.
- Detailed geography:
  - we know exact location of restaurants, including the county the restaurant is in;
  - allows us to compare restaurant entry and exit at a given location to entry and exit at nearby counties within different states.
### The Minimum Wage Hikes We Use

<table>
<thead>
<tr>
<th>Year</th>
<th>State</th>
<th>Old</th>
<th>New</th>
<th>% Change</th>
<th>Comparison states</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 2001</td>
<td>California</td>
<td>5.75</td>
<td>6.25</td>
<td>8.7</td>
<td>OR, NE, AZ</td>
</tr>
<tr>
<td>Jan. 2002</td>
<td>California</td>
<td>6.25</td>
<td>6.75</td>
<td>8</td>
<td>OR, NE, AZ</td>
</tr>
<tr>
<td>Jan. 2003</td>
<td>Oregon*</td>
<td>6.50</td>
<td>6.90</td>
<td>6.2</td>
<td>ID</td>
</tr>
<tr>
<td>Jan. 2004</td>
<td>Illinois</td>
<td>5.15</td>
<td>5.50</td>
<td>6.8</td>
<td>IN, IA, KY, MO</td>
</tr>
<tr>
<td>Jan. 2005</td>
<td>Illinois</td>
<td>5.50</td>
<td>6.50</td>
<td>18.2</td>
<td>IN, IA, KY, MO</td>
</tr>
<tr>
<td>Aug. 2005</td>
<td>Minnesota</td>
<td>5.15</td>
<td>6.15</td>
<td>19.4</td>
<td>IA, ND, SD</td>
</tr>
<tr>
<td>Jan. 2005</td>
<td>DC</td>
<td>6.15</td>
<td>6.60</td>
<td>7.3</td>
<td>MD, VA</td>
</tr>
<tr>
<td>Jan. 2006</td>
<td>DC</td>
<td>6.60</td>
<td>7.00</td>
<td>6.1</td>
<td>MD, VA</td>
</tr>
</tbody>
</table>

Matching outcomes across borders

Key idea: Compare restaurant entry and exit in two states that share a common border

- One with a minimum wage hike,
- One with no minimum wage hike.
Matching outcomes across borders

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Nearby restaurants geographically
⇒ economic environments should be similar, but one state faces a minimum wage hike
Matching outcomes across borders

Key idea: Compare restaurant entry and exit in two states that share a common border

- One with a minimum wage hike,
- One with no minimum wage hike.

Nearby restaurants geographically
⇒ economic environments should be similar, but one state faces a minimum wage hike

- Use firms only in counties that share a common border.
- Add in controls for border segments.
We measure the following outcomes $Y_{ispt}$:

- **Entry:** $Y_{ispt} = 1$ if, conditional on existing at time $t$, restaurant did not exist at time $t - 1$,

- **Exit:** $Y_{ispt} = 1$ if, conditional on existing at time $t - 1$, restaurant did not exist at $t$,

- Employment among continuously-operating establishments,

for restaurant $i$, state $s$, border segment $p$, time $t$. 
**Table:** Descriptive Statistics, QCEW

<table>
<thead>
<tr>
<th></th>
<th>Exit rate</th>
<th>Entry rate</th>
<th>Exit sample</th>
<th>Entry sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited service restaurants</td>
<td>0.057</td>
<td>0.087</td>
<td>31.7</td>
<td>31.7</td>
</tr>
<tr>
<td>Chains</td>
<td>0.033</td>
<td>0.071</td>
<td>31.6</td>
<td>31.2</td>
</tr>
<tr>
<td>Non-chains</td>
<td>0.075</td>
<td>0.099</td>
<td>31.8</td>
<td>32.0</td>
</tr>
<tr>
<td>Full service restaurants</td>
<td>0.068</td>
<td>0.095</td>
<td>42.6</td>
<td>43.3</td>
</tr>
</tbody>
</table>

Note: This table reports the exit and entry rates, as well as the average employment size, for limited and full service restaurants with a minimum employment threshold of 15. The average size of limited service restaurants in the exit sample with at least 1 employee is 16.7 (all), 25.7 (chains), and 13.9 (non-chains).
**Empirical Specification**

We use the Dube, Lester, Reich (2010) approach and estimate

\[ Y_{ispt} = \beta w_{ist} + a_{pt} + \alpha_s + \epsilon_{ispt} \]

where

- \( a_{pt} \) is a full set of border segment-time dummies; e.g., eastern Illinois-western Indiana,
- \( \alpha_s \) is a state dummy,
- \( w_{ist} \) is the time \( t \) minimum wage in state \( s \)
- \( \beta \) is the impact of the minimum wage.
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- \( \beta \) is the impact of the minimum wage.

We use data points only for restaurants along a state border

- and only for the year before the hike,
- and the year after the minimum wage hike.
**Table**: Elasticity of exit, entry, and employment among continuing firms. Limited service restaurants only.

<table>
<thead>
<tr>
<th></th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Exit</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>(0.86)</td>
</tr>
<tr>
<td></td>
<td>[16,191]</td>
</tr>
<tr>
<td>B. Entry</td>
<td>1.37</td>
</tr>
<tr>
<td></td>
<td>(0.61)</td>
</tr>
<tr>
<td></td>
<td>[16,513]</td>
</tr>
<tr>
<td>C. Change in employment,</td>
<td>-0.05</td>
</tr>
<tr>
<td>continuing establishments</td>
<td>(0.07)</td>
</tr>
<tr>
<td></td>
<td>[14,993]</td>
</tr>
</tbody>
</table>

Note: Each cell is from a separate regression. For each regression, we report elasticities evaluated at sample means, (standard errors), and [sample sizes].
Heterogeneity in Responses

Chains are more capital intensive, less labor intensive Labor’s share

- All fast food restaurants: 32%
- Chains: 26%

Minimum wage hike ⇒ chains gain a cost advantage
**Table:** Elasticity of exit, entry, and employment among continuing firms. Limited service restaurants only.

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Chains</th>
<th>Non-chains</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Exit</strong></td>
<td>2.40</td>
<td>5.27</td>
<td>1.58</td>
</tr>
<tr>
<td></td>
<td>(0.86)</td>
<td>(2.14)</td>
<td>(0.91)</td>
</tr>
<tr>
<td></td>
<td>[16,191]</td>
<td>[6,961]</td>
<td>[9,230]</td>
</tr>
<tr>
<td><strong>B. Entry</strong></td>
<td>1.37</td>
<td>2.64</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>(0.61)</td>
<td>(1.02)</td>
<td>(0.74)</td>
</tr>
<tr>
<td></td>
<td>[16,513]</td>
<td>[7,188]</td>
<td>[9,325]</td>
</tr>
<tr>
<td><strong>C. Change in employment, continuing establishments</strong></td>
<td>-0.05</td>
<td>-0.08</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.10)</td>
</tr>
<tr>
<td></td>
<td>[14,993]</td>
<td>[6,555]</td>
<td>[8,438]</td>
</tr>
</tbody>
</table>

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### Table: Limited versus full service restaurants.

<table>
<thead>
<tr>
<th></th>
<th>Limited service</th>
<th>Full service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Exit</td>
<td>2.40 (0.86)</td>
<td>-0.75 (0.75)</td>
</tr>
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<td></td>
<td>[16,191]</td>
<td>[18,184]</td>
</tr>
<tr>
<td>B. Entry</td>
<td>1.37 (0.61)</td>
<td>0.14 (0.62)</td>
</tr>
<tr>
<td></td>
<td>[16,513]</td>
<td>[18,529]</td>
</tr>
<tr>
<td>C. Change in employment, continuing establishments</td>
<td>-0.05 (0.07)</td>
<td>-0.12 (0.07)</td>
</tr>
<tr>
<td></td>
<td>[14,993]</td>
<td>[16,825]</td>
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</tbody>
</table>

Limited service restaurants use more minimum wage labor than full service restaurants
⇒ bigger entry and exit responses.
SUMMARY OF EMPIRICAL RESULTS

Following a minimum wage hike:

- Exit rises;
- Entry rises, especially among chains;
- No change in employment at continuing restaurants.
- Small employment effect in the short run (elasticity of -0.1).
SUMMARY OF EMPIRICAL RESULTS

Following a minimum wage hike:

- Exit rises;
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Puzzle:

- Why do entry and exit both rise?
Summary of empirical results

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- Small employment effect in the short run (elasticity of -0.1).

Puzzle:

- Why do entry and exit both rise?

Key to answer:

- Entrants able to substitute away from labor and incumbents cannot.
Model setup

Putty-clay model with endogenous entry and exit. Characterize:

- Deterministic steady state;
- Effects of a surprise minimum wage (low skill labor cost) increase;
 CES Technology Ex Ante

\[ y_j = A_j (\alpha_k k^{\frac{\sigma-1}{\sigma}} + \alpha_m m^{\frac{\sigma-1}{\sigma}} + \alpha_h h^{\frac{\sigma-1}{\sigma}} + (1 - \alpha)l^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}} \]

- \( A_j \)—productivity of a restaurant aged \( j \);
- \( \sigma \)—elasticity of substitution (\( > 0 \));
- \( \alpha = \alpha_k + \alpha_m + \alpha_h \);
- \( k \)—capital;
- \( m \)—materials;
- \( h \)—high-skill labor;
- \( l \)—low-skill (minimum wage) labor.
Let $k_0$, $m_0$, $h_0$ and $l_0$ denote the initial input choices, and $y_j$ output at age $j$. Optimization implies

$$y_j = \begin{cases} 
A_j y_0 & \text{if } k \geq k_0, m \geq m_0, h \geq h_0, \text{ and } l \geq l_0 \\
0 & \text{otherwise,}
\end{cases}$$

where

$$y_0 = \left( \alpha_k k_0^{\frac{\sigma-1}{\sigma}} + \alpha_m m_0^{\frac{\sigma-1}{\sigma}} + \alpha_h h_0^{\frac{\sigma-1}{\sigma}} + (1 - \alpha) l_0^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1}{\sigma-1}}.$$
At age $j$:

$$A_j = e^{-\delta j}.$$
Productivity and Endogenous Exit

At age $j$:

$$A_j = e^{-\delta j}.$$ 

Resell capital for scrap (Campbell (1998) mechanism):
- Purchase a unit of capital for $p_k$.
- Resell for $\eta p_k$ ($\eta < 1$).
**Restaurant Problem**

Pick $k_0$, $m_0$, $h_0$, $l_0$ and $J$ (exit age) to maximize:

\[
\pi \equiv q_p y_0 - q_k k_0 - q_m m_0 - q_h h_0 - q_l l_0
\]
**Restaurant Problem**

Pick $k_0$, $m_0$, $h_0$, $l_0$ and $J$ (exit age) to maximize:

$$\pi \equiv q_p y_0 - q_k k_0 - q_m m_0 - q_h h_0 - q_l l_0$$

where:

$$\left(\alpha_k k_0^{\frac{\sigma-1}{\sigma}} + \alpha_m m_0^{\frac{\sigma-1}{\sigma}} + \alpha_h h_0^{\frac{\sigma-1}{\sigma}} + (1 - \alpha) l_0^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} = y_0,$$

- $r$—the interest rate,
- $q_p \equiv \int_0^J e^{-(r+\delta)j} P \, dj$—effective output price,
- $q_k \equiv p_k (1 - e^{-rJ \eta})$—effective capital price,
- $q_m \equiv \int_0^J e^{-rj} p_m \, dj$—effective materials price,
- $q_h \equiv \int_0^J e^{-rj} w^h \, dj$—effective high skill wage,
- $q_l \equiv \int_0^J e^{-rj} w \, dj$—effective low skill wage.

Endogenous variables in red. Restaurants take $P$ as given.
MC of producing for another period of time

\[ MC = k \ \eta p_k + mp_m + hw_h + lw \]

user cost \hspace{2cm} per period payments
MB of producing per period of time

\[ MB = Py_0 e^{-\delta j} \]

revenue
Steady State Exit Decision: Operate Until MB=MC

\[ \text{Exit: } Py_0 e^{-\delta J} = kr \eta p_k + mp_m + hw_h + lw \]
CLOSING THE MODEL

Steady state profit of a new entrant:

$$\pi \equiv q_p y_0 - q_k k_0 - q_m m_0 - q_h h_0 - q_l l_0.$$
CLOSING THE MODEL

Steady state profit of a new entrant:

\[ \pi \equiv q_p y_0 - q_k k_0 - q_m m_0 - q_h h_0 - q_l l_0. \]

If there is entry...

\[ \pi = 0, \]
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If there is entry...

\[ \pi = 0, \]

In steady state:

\[ \pi = 0 \Rightarrow q_p \equiv \int_0^J e^{-(r+\delta)j} P \, dj \Rightarrow P. \]
CLOSED THE MODEL

Steady state profit of a new entrant:

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If there is entry...

\[ \pi = 0, \]

In steady state:

\[ \pi = 0 \Rightarrow q_p \equiv \int_0^J e^{-(r+\delta)j} P dj \Rightarrow P. \]

Product demand:

\[ Q = \theta P^{-\gamma}. \]

Hence, we can solve for \( Q \).
Minimum wage hikes

We model the response to an unanticipated minimum wage hike at time $t_n$

- before the hike: minimum wage is $w_o$
- after the hike: minimum wage is $w_n$
- We will assume a 10% minimum wage hike in the calibrations
**Figure:** Exit decision of incumbents after a 10% hike in the minimum wage.

Note: figure shows marginal benefit and marginal cost of firms both before and after a 10% minimum wage hike. The intersection of the marginal benefit and marginal cost curves determine the exit age.
**Figure:** Marginal cost of incumbents rises by more than marginal cost of new entrants.

Note: Marginal cost curves of incumbents and new entrants before and after a 10% minimum wage hike.
# Calibration targets and results

<table>
<thead>
<tr>
<th>Moment</th>
<th>Target</th>
<th>Result</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s_L$</td>
<td>0.10</td>
<td>0.10</td>
<td>Min. wage labor share</td>
<td>Aaronson and French (2007)</td>
</tr>
<tr>
<td>$s_H$</td>
<td>0.20</td>
<td>0.20</td>
<td>High-skill labor share</td>
<td>Aaronson and French (2007)</td>
</tr>
<tr>
<td>$s_K$</td>
<td>0.30</td>
<td>0.30</td>
<td>Capital share</td>
<td>Aaronson and French (2007)</td>
</tr>
<tr>
<td>$s_M$</td>
<td>0.40</td>
<td>0.40</td>
<td>Materials share</td>
<td>Aaronson and French (2007)</td>
</tr>
<tr>
<td>Exit Spike</td>
<td>2.40</td>
<td>2.40</td>
<td>Elasticity of exit with respect to $w$</td>
<td>This paper</td>
</tr>
<tr>
<td>Entry Spike</td>
<td>1.37</td>
<td>1.37</td>
<td>Elasticity of entry with respect to $w$</td>
<td>This paper</td>
</tr>
<tr>
<td>$J$</td>
<td>17.54</td>
<td>17.54</td>
<td>Average life of a restaurant</td>
<td>This paper</td>
</tr>
</tbody>
</table>
Price, Quantity, and Employment following 10% MW hike

![Graphs showing market price, market quantity, and employment changes over time after a 10% minimum wage hike.](image)
% OF FIRMS ENTERING AND EXITING AFTER A 10% MINIMUM WAGE HIKE

Exit share = share of firms in operation a year ago not currently in operation.
Enter share = share of firms currently in operation not in operation a year ago.
Price and Employment Elasticities

<table>
<thead>
<tr>
<th></th>
<th>One year</th>
<th>Steady state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Employment</td>
<td>-0.08</td>
<td>-0.40</td>
</tr>
</tbody>
</table>

Price estimates:

- 0.07 (Aaronson 2001; Aaronson, French and MacDonald (2008));

Short run employment estimates:

- -0.05 to -0.30 (Brown 1999, Time Series); 0.02 (Dube, Lester, Reich (2010)); -0.1 (our estimates)

- But some evidence that disemployment effects are bigger in the long run: Baker et al. (1999), Meer and West (2015).
**Putty-clay contribution to entry and exit**

- **Without putty-clay**: incumbents *can* substitute away from labor.
- **With putty-clay**: incumbents *cannot* substitute away from labor.
Putty-clay contribution to entry and exit

- **Without** putty-clay: incumbents can substitute away from labor.
- **With** putty-clay: incumbents cannot substitute away from labor.

Next we re-solve and simulate the model assuming
- firm productivity declines over time
- firms can shut down and sell capital at a discount $\eta$
- but firms can re-optimize their capital labor ratio
“Total”: incumbents cannot re-optimize capital-labor ratio
“Standard”: incumbents can re-optimize capital-labor ratio
Conclusion

New facts:

▶ Following a minimum wage hike exit rises;
▶ Entry also rises, especially among chains;
▶ No change in employment among continuing restaurants.

Explanation:

▶ Accounting: entrants replace incumbents;
▶ Economics: entrants more flexible than incumbents.

Evidence for importance of putty-clay in understanding small short-run employment effects of minimum wages.
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# Calibration

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<th>Parameter</th>
<th>Value</th>
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<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Exogenously set parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$w$</td>
<td>1</td>
<td>Minimum wage</td>
<td>Normalization</td>
</tr>
<tr>
<td>$p^k$</td>
<td>1</td>
<td>Capital price</td>
<td>Normalization</td>
</tr>
<tr>
<td>$w^h$</td>
<td>2.76</td>
<td>High skill wage</td>
<td>Aaronson and French (2007)</td>
</tr>
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<td>$p^m$</td>
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<td>Materials price</td>
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<td>Elasticity of substitution</td>
<td>Aaronson and French (2007)</td>
</tr>
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<td>$r$</td>
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<td>Interest rate</td>
<td>Standard</td>
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<tr>
<td><strong>B. Parameters chosen to match targets</strong></td>
<td></td>
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<tr>
<td>$\delta$</td>
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<td>Depreciation rate</td>
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<td>Resale price</td>
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<td>$\gamma$</td>
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<td>Elasticity of product demand</td>
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<tr>
<td>$\alpha^k$</td>
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<td>Productivity of capital</td>
<td>Match $s_k$</td>
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<tr>
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<td>Productivity of $h$ labor</td>
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<tr>
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<td>0.34</td>
<td>Productivity of materials</td>
<td>Match $s_m$</td>
</tr>
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[Back to calibration results]