A Theory of Non-Coasean Labor Markets

James Tobin's 1972 presidential address to the AEA: How does monetary policy "grease the wheels of the labor market"?

• Keynesian (Non-Coasean) tradition:
  ◦ Rigid wages may lead to inefficient employment

• Search-theoretic labor market (Coasean) tradition:
  ◦ Theory of unemployment, job creation and destruction, pure wage dispersion

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Why Non-Coasean Labor Markets?

Good theoretical reasons:

1. Asymmetric information (Barro '77; Myerson & Satterthwaite '83; Hall & Lazear '84)

2. Morale effects, status comparisons, fairness norms (Akerlof & Yellen '90; Bewley '99)

3. Institutional constraints on wages (Castellanos et al. '04; Elsby & Solon '19; Ahn et al. '22)

Also good empirical reasons:

1. Quits $\neq$ layoffs (McLaughlin '90, '91; Elsby et al. '10, '11)

2. Monetary policy non-neutrality in the labor market (Graves et al. '23)

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Empirical Reason 1: Quits ≠ Layoffs (Elsby et al. ’10)

Unemployment Inflows by Reason for Unemployment

Monthly hazard rate

Labor force entrants

Layoffs

Quits
Empirical Reason 2: Labor Market Non-Neutrality (Graves et al. ’23)

Impulse Responses to a Contractionary Monetary Policy Shock

- EU: $\Pr(EU) = 0.014$
- EU (Quit): $\Pr(EU(Quit)) = 0.002$
- EU (Layoff): $\Pr(EU(Layoff)) = 0.010$
Empirical Reason 3: Sticky Wages $\implies$ Layoffs (Davis & Krolikowski ’23)

Percent of UI Recipients Who Would Accept a Pay Cut to Save Lost Job

<table>
<thead>
<tr>
<th>Size of proposed pay cut</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent layoffs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60.6</td>
<td>52.3</td>
<td>43.7</td>
<td>38.4</td>
<td>32.4</td>
</tr>
<tr>
<td></td>
<td>(2.4)</td>
<td>(2.5)</td>
<td>(2.5)</td>
<td>(2.4)</td>
<td>(2.3)</td>
</tr>
<tr>
<td></td>
<td>404</td>
<td>413</td>
<td>410</td>
<td>419</td>
<td>423</td>
</tr>
<tr>
<td>Temporary layoffs</td>
<td>54.5</td>
<td>42.9</td>
<td>35.8</td>
<td>34.3</td>
<td>37.4</td>
</tr>
<tr>
<td></td>
<td>(5.0)</td>
<td>(5.0)</td>
<td>(4.9)</td>
<td>(4.7)</td>
<td>(4.9)</td>
</tr>
<tr>
<td></td>
<td>101</td>
<td>98</td>
<td>95</td>
<td>102</td>
<td>99</td>
</tr>
</tbody>
</table>

For permanent layoffs: “Would you have been willing to stay at your last job for another 12 months at a pay cut of X percent?”

For temporary layoffs: “Suppose your employer offered a temporary pay cut of X percent as an alternative to the temporary layoff. Would you have been willing to accept the temporary pay cut to avoid the layoff?”
A Theory of Non-Coasean Labor Markets
Overview of Our Theory

We develop a theory of Non-Coasean labor markets featuring:

1. Directed search
2. Nominally rigid wages within jobs
3. Idiosyncratic productivity and aggregate monetary shocks
4. Two-sided lack of commitment

Implications:

1. Directed search ⇒ Costly to find and fill jobs
2. Nominally rigid wages within jobs ⇒ Real wages do not track productivity
3. Idiosyncratic productivity and aggregate monetary shocks ⇒ Workers and firms play a game in Markov strategies
4. Two-sided lack of commitment ⇒ Inefficient separations through unilateral worker quits and firm layoffs
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1. $\implies$ Inefficient separations through unilateral worker quits and firm layoffs
Preferences and Technology

• Agents: unit measure of heterog. workers, endogenous measure of homog. firms

• Time: continuous, indexed by $t$

• Preferences: $E_0 \left[ \int_0^{\infty} e^{-\rho t} C_t \, dt \right]$

• Worker's state:
  ◦ Employment status $s_t$, either employed ($h$) or unemployed ($u$)
  ◦ Log productivity $z_t$ follows $dz_t = \gamma dt + \sigma dW_z$

• Production: $y(s_t, z_t) = \begin{cases} e^{z_t} & \text{for } s_t = h \\ \tilde{B} e^{z_t} & \text{for } s_t = u \end{cases}$
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Search and Matching

• Workers and firms direct search across markets indexed by $(z, w)$
  
  $z = \log$ worker productivity, $w = \log$ real wage [later: monetary economy]

• Firms post vacancies and wages at cost $\tilde{K}_z$

• Match creation follows $m(V, U) = U^{\alpha} V^{1-\alpha}$, $\alpha \in (0, 1)$

• Market tightness: $\theta(w, z) = V(w, z) / U(w, z)$

• Worker's finding rate: $f(\theta) = \theta^{1-\alpha}$, firm's filling rate: $q(\theta) = \theta - \alpha$

• Free entry: $\theta(z; w) > 0 \Rightarrow \tilde{K}_z = \text{firm's expected value}$

• Key friction: wages are rigid after match formation [in paper: Calvo hazard]
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Exogenous and Endogenous Job Separations

- Exogenous match separation: $\tau_\delta \sim \text{Exponential}(\delta)$

- Endogenous separation due to unilateral worker quit or firm layoff:
  - $Z_h(w) =$ set of productivities s.t. worker does not quit
  - Worker's stopping time $\tau_h(z; w) = \inf\{t \geq 0 : z_t \in Z_h(w), z_0 = z\}$
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- Match duration: $\tau_m = \min\{\tau_\delta, \tau_h, \tau_j\}$
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    \[ \implies \text{Worker’s stopping time } \tau^h(z; w) = \inf\{t \geq 0 : z_t \notin Z^h(w), z_0 = z\} \]
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Characterizing Equilibrium Quits and Layoffs

Suff. Conditions

\[ h(z; w) \]

\[ j(z; w) \]

\[ u(z) \]

\[ 0 \]

\[ z^{-}(w) \]

\[ z^{+}(w) \]

Productivity
Characterizing Equilibrium Quits and Layoffs

Suff. Conditions

$\mathcal{Z}^{h^*}(w)$

Value matching condition: $z \notin \mathcal{Z}^{h^*}(w) \implies j(z; w) = 0$
Characterizing Equilibrium Quits and Layoffs

**Suff. Conditions**

\[ h(z; w) > u(z) \text{ and } j(z; w) > 0 \]

**Firms’ value under optimal policy:**
\[(\rho + \delta)j(z; w) = \max \left\{ e^z - e^w + \frac{\sigma^2}{2} j_{zz}(z; w), 0 \right\}, \quad \forall z \in \mathcal{Z}^{h^*}(w) \]

**Smooth pasting condition:**
\[ j(\cdot; w) \in C^1(\mathcal{Z}^{h^*}(w)) \cap C(\mathbb{R}) \]
Characterizing Equilibrium Quits and Layoffs

Suff. Conditions

\[ h(z; w) > u(z) \text{ and } j(z; w) > 0 \]

Firm’s continuation set: \( Z^j^* (w) = \text{int} \{ z \in \mathbb{R} : e^z - e^w > 0 \text{ or } j(z; w) > 0 \} \)

\( \tau^j^* (z; w) = \inf \{ t \geq 0 : z_t \notin Z^j^* (w), \ z_0 = z \} \)
Equilibrium Existence and Uniqueness

Proposition 1 (Equilibrium Existence and Uniqueness).

There exists a unique block-recursive equilibrium.

- Extends Menzio & Shi ('10) to case of two-sided limited commitment
- Leverages continuous-time methods from stochastic diff. games literature
- Specifically, application of the Birkhoff-Tartar fixed point theorem
Equilibrium Characterization
Characterizing the Game’s Equilibrium

- State reduces to wage-productivity ratio $\hat{w} \equiv w - z$
  - Normalized values: $\hat{W}(\hat{w}) \equiv (h(z; w) - u(z))/e^z$, $\hat{J}(\hat{w}) \equiv j(z; w)/e^z$, $\hat{U} \equiv u(z)/e^z$
  - Normalized discount rate $\hat{\rho} \equiv \rho - \gamma - \sigma^2/2$

- Unemployed workers’ policy: $\hat{w}^* \equiv w^*(z) - z$

- Optimal continuation region: $(S, s)$ band in wage-productivity ratio $\hat{w} \in (\hat{w}^-, \hat{w}^+)$

- Match surplus $\hat{S}(\hat{w}) \equiv \hat{J}(\hat{w}) + \hat{W}(\hat{w})$ and worker’s surplus share $\eta(\hat{w}) \equiv \hat{W}(\hat{w})/\hat{S}(\hat{w})$
Proposition 2 (Surplus and Entry Wage).

1. Match surplus: $\hat{S}(\hat{w}) = (1 - \hat{\rho}\hat{U})\mathcal{T}(\hat{w}, \hat{\rho})$ with $\mathcal{T}(\hat{w}, \hat{\rho}) \equiv \mathbb{E}^{\hat{w}} \left[ \int_{0}^{\tau^{m*}} e^{-\hat{\rho}t} \, dt \right]$, $\hat{\rho}\hat{U} \in (\tilde{B}, 1)$

2. The entry wage solves a “Nash bargaining problem”:

$$\hat{w}^{*} = \arg \max_{\hat{w}} \left\{ \hat{J}(\hat{w})^{1-\alpha}\hat{W}(\hat{w})^{\alpha} \right\} = \arg \max_{\hat{w}} \left\{ (1 - \eta(\hat{w}))^{1-\alpha}\eta(\hat{w})^{\alpha}\mathcal{T}(\hat{w}, \hat{\rho}) \right\}$$

with FOC

$$\eta'(\hat{w}^{*}) \left( \frac{\alpha}{\eta(\hat{w}^{*})} - \frac{1 - \alpha}{1 - \eta(\hat{w}^{*})} \right) = - \frac{\mathcal{T}'_{\hat{w}}(\hat{w}^{*}, \hat{\rho})}{\mathcal{T}(\hat{w}^{*}, \hat{\rho})}$$

Share channel

Surplus channel

3. Job finding rate: $f(\hat{w}^{*}) = \left[ (1 - \eta(\hat{w}^{*}))(1 - \hat{\rho}\hat{U})\mathcal{T}(\hat{w}^{*}, \hat{\rho})/\tilde{K} \right]^{\frac{1-\alpha}{\alpha}}$

- Share channel: higher wage vs. higher job-finding rate [as in Moen (’97)!]
- Surplus channel: entry wage $\Rightarrow$ match duration $\Rightarrow$ surplus $\Rightarrow$ job-finding rate [novel!]
Aggregate Shocks in a Non-Coasean Labor Market
Aggregate Fluctuations with Sticky Wages

- Monetary economy summarized by distribution of real wage-to-productivity ratios:
  \[ \hat{w} = w - z - p \]

- Consider unanticipated one-off price level increase by \( \zeta \) from steady state: \( p_t = p_{t^-} + \zeta \)

- Employed workers’ nominal wages are sticky, so real wages become \( \hat{w}_t = \hat{w}_{t^-} - \zeta \)

- New hires’ nominal wages fully flexible  
  [in paper: sticky entry wages!]
Effects of an Inflationary Shock: An Illustration

A. Distribution of real wages, $\hat{w}$

B. Mean real wage, $\bar{w}_t - \bar{w}_{ss}$

C. Aggregate employment, $\mathcal{E}_t - \mathcal{E}_{ss}$

- Cumulative Impulse Response (CIR) summarizes on-impact size and persistence of Impulse Response Function (IRF) of aggregate employment ($\mathcal{E}_t$) to monetary shock $\zeta$:

$$CIR_{\mathcal{E}}(\zeta) = \int_0^\infty IRF_{\mathcal{E}}(\zeta, t) dt$$
Proposition 3 (CIR under Flexible Entry Wages).

Sufficient statistic for CIR based on observed wage changes across jobs:

\[
\frac{\text{CIR}_\varepsilon(\zeta)}{\zeta} = \frac{1}{3} \times \frac{1}{f(\hat{w}^*)} \times \frac{1}{\text{Var}_D[\Delta w]} \times \mathbb{E}_D \left[ \Delta w \frac{\Delta w^2}{\mathbb{E}_D[\Delta w^2]} \right] + o(\zeta)
\]

- Statistic captures marginal quits and layoffs on-impact + future dynamics
- Inflationary shock reduces real wages of employed workers
  - \( f(\hat{w}^*) \) measures exit rate from unemployment
  - \( \text{Var}_D[\Delta w] \) measures total incidence of quit vs. layoff risk
  - “skewness” measures asymmetric incidence of quit vs. layoff risk
Graphical Intuition: Symmetric Steady State

Zero skewness of real-wage-to-productivity ratios

$\Rightarrow$ Zero employment effects of inflation
Graphical Intuition: Expansion

Negative skewness of real-wage-to-productivity ratios
\[ \Rightarrow \text{Negative employment effects of inflation} \]

- Density $g(\hat{w})$
- Quit threshold $\hat{w}^-$
- Layoff threshold $\hat{w}^+$
- Real wage-to-prod. ratio $\hat{w}$
Graphical Intuition: Recession

Positive skewness of real-wage-to-productivity ratios $\Rightarrow$ Positive employment effects of inflation
Empirical Application
Overview of Model Identification

Model parameters $\mathcal{P}$

Unobservable implications $\mathcal{M}$

Observable implications $\mathcal{D}$

We provide a closed-form mapping between $\mathcal{P}$, $\mathcal{M}$ and $\mathcal{D}$
U.S. Labor Market Data

• Monthly employment and income (wage, salary) information
• Standard selection criteria and cleaning procedures (Barattieri et al. '14)
• Wage filter to correct measurement error (Blanco et al. '22)
• Two periods: hot labor market 1996–2000 and cold labor market 2008–2012

Future work:
1. Low to medium inflation in U.S. (LEHD) from 2001–2022
2. High inflation in Brazil (RAIS) from 2015–2018
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U.S. Labor Market Data

Survey of Income and Program Participation (SIPP)

- Monthly employment and income (wage, salary) information
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Expansionary Monetary Policy in Hot and Cold Labor Markets

According to our model estimates, an expansionary monetary policy shock:

1. leads to net decrease in employment in hot labor market (U.S. 1996–2000)
   - Increase in quits > decrease in layoffs
2. leads to net increase in employment in cold labor market (U.S. 2008–2012)
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<tr>
<th>Period</th>
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\[ CIR = \frac{1}{f} \times \frac{1}{Var(\Delta w)} \times \text{“Skewness”} \]
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⇒ inflation greases the wheels of the labor market (Tobin ’72)
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• Novel characterization of inefficient separations in the form of layoffs vs. quits

• First step towards quantitative analysis: labor market heterogeneity ⇐⇒ monetary policy

Future work:
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◦ Additional channels: on-the-job search, costly renegotiations
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Backup
Assumption: one-period game. $e^z - e^w > 0$, $e^w \, dt + \mathbb{E}_z[e^{-\rho \, dt}U(z')] > U(z)$

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Necessary and Sufficient Conditions

1. Lower bounds for values [GLB]:

\[
(h(z;w), j(z;w)) \geq (u(z), 0)
\]

value of match

\[
\text{value of outside option}
\]

2. Firm’s and worker’s continuation sets [GCS]:

\[
C^j_w := \text{int} \{ z \in \mathbb{R} : j(z;w) > 0 \text{ or } 0 < e^z - e^w \}
\]

\[
C^h_w := \text{int} \left\{ z \in \mathbb{R} : h(z;w) > u(z) \text{ or } 0 < e^w - \rho u(z) + \gamma \frac{\partial u(z)}{\partial z} + \frac{\sigma^2}{2} \frac{\partial^2 u(z)}{\partial z^2} \right\}
\]

with stopping times given by

\[
\tau^j_*(w,z) = \inf \left\{ t \geq 0 : z_t^z \notin C^j_w \right\}
\]

\[
\tau^h_*(w,z) = \inf \left\{ t \geq 0 : z_t^z \notin C^h_w \right\}
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\[\tau^h_{w,z} = \inf \{ t \geq 0 : z_t \notin C^h_w \} \]
Necessary and Sufficient Conditions

3. Game’s value matching conditions \([GVM]\):

\[
z \notin C^w_j \implies h(z; w) = u(z), \quad z \notin C^w_h \implies j(z; w) = 0
\]

4. Firm’s and workers optimal layoff and quit policies \([GOP]\):

\[
\begin{align*}
\text{if } z \in C^h_w & \quad \rho j(z; w) = \max \left\{ e^z - e^w + \gamma \frac{\partial j(z; w)}{\partial z} + \frac{\sigma^2}{2} \frac{\partial^2 j(z; w)}{\partial z^2} - \delta j(z; w), 0 \right\} \\
& \quad j(\cdot; w) \in C^1(C^h_w) \cap C(\mathbb{R}) \\
\text{if } z \in C^j_w & \quad \rho h(z; w) = \max \left\{ e^w + \gamma \frac{\partial h(z; w)}{\partial z} + \frac{\sigma^2}{2} \frac{\partial^2 h(z; w)}{\partial z^2} + \delta (u(z) - h(z; w)), \rho u(z) \right\} \\
& \quad h(\cdot; w) \in C^1(C^j_w) \cap C(\mathbb{R})
\end{align*}
\]
5. Free entry condition [FEC]:

\((K(e^z) - q(w, z)j(z; w))\theta(w, z) = 0, \quad K(e^z) - q(w, z)j(z; w) \geq 0, \quad \theta(w, z) \geq 0 \quad \forall (w, z)\)

6. Firm’s and workers optimal layoff and quit policies [HBJ U]:

\[\rho u(z) = \tilde{B}e^z + \gamma \frac{\partial u(z)}{\partial z} + \frac{\sigma^2}{2} \frac{\partial^2 u(z)}{\partial z^2} + \max_w f(w, z)[h(z; w) - u(z)],\]
Cross-sectional Distribution of $\hat{w}$

- Kolmogorov Forward Equation:

$$\delta g(\hat{w}) = \gamma g'(\hat{w}) + \frac{\sigma^2}{2} g''(\hat{w}) \quad \text{for all } \hat{w} \in (\hat{w}^-, \hat{w}^+)/\{\hat{w}^*\}$$

- Border conditions:

$$g(\hat{w}^-) = g(\hat{w}^+) = 0, \quad 1 = \int_{\hat{w}^-}^{\hat{w}^+} g(\hat{w}) \, d\hat{w}, \quad g(\hat{w}) \in \mathbb{C}$$
Cross-sectional Distributions of $\Delta z$

- **KFE for employed workers**

  $$\delta g^h(\Delta z) = \gamma (g^h)'(\Delta z) + \frac{\sigma^2}{2} (g^h)''(\Delta z) \quad \text{for all } \Delta z \in (-\Delta^-, \Delta^+)/\{0\}$$
  $$g^h(\Delta z) = 0, \text{ for all } \Delta z \notin (-\Delta^-, \Delta^+)$$

- **KFE for unemployed workers**

  $$f(\hat{w}^*) g^u(\Delta z) = \gamma (g^u)'(\Delta z) + \frac{\sigma^2}{2} (g^u)''(\Delta z) \quad \text{for all } \Delta z \in (-\infty, \infty)/\{0\}$$
  $$\lim_{\Delta z \to -\infty} g^u(\Delta z) = \lim_{\Delta z \to \infty} g^u(\Delta z) = 0$$

- **Measure 1 of worker, constant employment, and regularity conditions**

  $$1 = \int_{-\infty}^{\infty} g^u(\Delta z) \, d\Delta z + \int_{-\Delta^-}^{\Delta^+} g^h(\Delta z) \, d\Delta z$$

  $$f(\hat{w}^*)(1 - \mathcal{E}) = \delta \mathcal{E} + \frac{\sigma^2}{2} \left[ \lim_{\Delta z \downarrow -\Delta^-} (g^h)'(\Delta z) - \lim_{\Delta z \uparrow \Delta^+} (g^h)'(\Delta z) \right]$$

  $$g^h(\Delta z), g^u(\Delta z) \in \mathbb{C}$$
Step 1: Recover model parameters $\mathcal{P}$

\[
\gamma = \frac{E_D[\Delta w]}{E_D[\tau]} \quad \sigma^2 = \frac{E_D[(\Delta w - \gamma \tau)^2]}{E_D[\tau]} \text{ where } \tau = \tau^m + \tau^u
\]

Intuition:
- average $\Delta w$ must compensate for productivity trend between jobs
- dispersion of (detrended) $\Delta w$ captures dispersion of cumulative shocks during $h$-$u$-$h$
From Data to Model

- **Step 1:** Recover model parameters ✓
- **Step 2:** Recover distribution of $\Delta z$ conditional on a $h-u$ transition

**Intuition:**

$$\Delta w = w_{t_0} + \tau^m + \tau^u - w_{t_0}$$

$$= \underbrace{w_{t_0} + \tau^m + \tau^u - z_{t_0} + \tau^m + \tau^u}_{= \hat{w}^*} - \underbrace{(w_{t_0} - z_{t_0}) + z_{t_0} + \tau^m + \tau^u - z_{t_0}}_{= \hat{w}^*}$$

$$= z_{t_0} + \tau^m + \tau^u - z_{t_0} + \tau^m + z_{t_0} + \tau^m - z_{t_0}$$

$$= -(\Delta z | h-u \text{ transition } + \Delta z | u-h \text{ transition at } z_{t_0} + \tau^m)$$

$$= -(\Delta z | h-u \text{ transition } + \underbrace{\Delta z | u-h \text{ transition}}_{\text{independent and known}})$$
• Step 1: Recover model parameters ✓

• Step 2: Recover distribution of $\Delta z$ conditional on a $h$-$u$ transition ✓

• Step 3: Recover unconditional distribution of $\Delta z$

   **Intuition:**
   
   ◦ conditional distribution + model during inaction $\Rightarrow$ unconditional distribution
From Data to Model

- **Step 1**: Recover model parameters ✓
- **Step 2**: Recover distribution of $\Delta z$ conditional on a $h-u$ transition ✓
- **Step 3**: Recover unconditional distribution of $\Delta z$ ✓
• **Money supply**: \( \text{dlog}(M_t) = \pi \text{d}t + \zeta \text{d}W^m_t \); \( W^m_t \) is a Wiener process

• **Preferences**: \( \mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \left( C_{it} + \mu \log(\hat{M}_{it}/P_t) \right) \text{d}t \right] \)

• **Complete financial markets**

• **Budget constraint**: \( \mathbb{E}_0 \left[ \int_0^\infty Q_t \left( P_t C_{it} + i_t \hat{M}_{it} - Y_{it}(lm^{it}) - T_{it} \right) \text{d}t \right] = \hat{M}_0 \)
  - \( Q_t \): time-zero Arrow-Debreu price
  - \( Y_{it}(lm^{it}) \): nominal labor income
  - \( lm^{it} \): labor market strategy

• **Market clearing**:
  \[
  \int_0^1 \hat{M}_{it} \text{d}i = M_t
  \]
  \[
  \int_0^1 \left( C_{it} + \theta_{it} \mathbb{1}_{\{e_{it}=u\}} K(Z_{it}) \right) \text{d}i = \int_0^1 \left( e^{\gamma_{it}} \mathbb{1}_{\{e_{it}=h\}} + B(Z_{it}) \mathbb{1}_{\{e_{it}=u\}} \right) \text{d}i
  \]
Lemma. (Equilibrium Prices and Workers’ Problem)

Let \( Q_0 = 1 \) be the numéraire and \( \mu = \rho + \pi + \frac{\xi^2}{2} \). Then, \( P_t = M_t \). Define \( V_0(z, M_t) \) as the worker’s optimal value, then

\[
V_0(z, M) = \max_{\{lm_{it}\}} \mathbb{E}_0 \left[ \int_0^{\infty} e^{-\rho t} \frac{Y_{it}(z_{it}, lm_{it})}{M_t} \, dt \right] + \text{terms independent of policy}
\]

- In equilibrium, monetary shocks translate one-to-one to prices
- Since worker is risk neutral in consumption
  
  \[
  \text{maximizing consumption} = \text{maximizing PDV of real income}
  \]
- New state for the worker: \( \hat{w} = w - z - m \)