Real Effects of Price Stability with Endogenous Nominal Indexation

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The transmission of inflation shocks to the real sector of the economy requires some form of nominal rigidity.

We explore the role played by ‘nominal financial contracts’ in a model with incomplete markets.

We then study how different monetary regimes affect the propagation of inflation shocks:

- Across different types of borrowers (firms);
- for the whole economy.
Why are contracts nominally denominated?

- We need a theory of nominal rigidities (endogenous nominal contract).

- We adopt the idea of Jovanovic-Ueda (JPE 1997): The general price is observed with delay.

- We embed this idea in an industry dynamics model with repeated moral hazard:
  - Clementi-Hopenhyan (2006);
  - Gertler (1992);
1. Optimal and renegotiation-proof contracts are not fully indexed. 

   Therefore, inflation shocks have real effects.

2. Contracts are less indexed for smaller and more constrained firms.

   Therefore, the impact of an inflation shock is bigger for small firms.

3. The degree of nominal indexation increases with price uncertainty.

   Therefore, a given inflation shock has a bigger impact in economies with lower price uncertainty.
OUTLINE

- Introduction
- Model
- Long-term contract (Commitment)
- Renegotiation-proof contract
- Numerical example
- Conclusion
Jovanovic-Ueda (JPE 1997)

- **Environment:**
  - A risk-neutral principal hires a risk-averse agent for production.
  - The agent’s effort is private information.

- **Timing:**
  1. Agent chooses the effort.
  2. Nominal output is observed.
  4. Price level is revealed and real output is known.

- Optimal contracts do not insure the agent fully.

- **Contract with commitment:**
  - An optimal contract is a **real** contract.

- **Contract without commitment:**
  - An optimal contract is a **nominal** contract.
Jovanovic-Ueda (JPE 1997)

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  3. *Potential renegotiation*.
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Optimal contracts do not insure the agent fully.

Contract with commitment:

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Contract without commitment:

- An optimal contract is a nominal contract.
Continuum of risk-neutral investors (i.e., the principal).

Continuum of risk-neutral entrepreneurs (i.e., the agent).

Entrepreneurs generate nominal sales: $s = p z k^\theta$

$p = \text{aggregate nominal price shock.}$

$z = \text{idiosyncratic shock.}$

$k = \text{capital input.}$
INFORMATION AND TIMING WITHIN A PERIOD

1. \( k \): Publicly observable and chosen before \( z \) and \( p \) realize.

2. \( s \) \( \equiv pzk^\theta \): Observable by the entrepreneur.

3. After observing \( s \), the entrepreneur can divert the revenues without being detected:

   \[ \hat{s} = p\hat{z}k^\theta = \text{reported revenues}. \]
   \[ \hat{z} = \text{shock inferred from } \hat{s}, \text{ once we know } p. \]

4. \( p \): Observed with delay.

5. \( z \): NOT publicly observable (but inferred after observing \( s \) and \( p \)).
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LONG-TERM CONTRACT (i.e., with Commitment)

Maximize investor’s value subject to entrepreneur’s value:

\[ V(q) = \max_{k, u(z,p)} \left\{ -k + \delta E \left[ zk^\theta + W(u(z, p)) \right] \right\} \]

subject to

\[ E \left[ u(z, p) \mid s \right] \geq E \left[ \phi z k^\theta + u(0, p) \mid s \right] \quad \text{(IC)} \]

\[ q = \beta E \left[ u(z, p) \right] \quad \text{(Promise-keeping)} \]

\[ u(z, p) \geq 0 \quad \text{(Limited liability)} \]
CONCAVE VALUE FUNCTION

\[ W(u) \]

\[ u \]
**Proposition.** The optimal policy for the entrepreneur’s value depends only on $z$, not $p$.

Intuition: Incentive for diverting the nominal sales depends on the *real* value of sales.

Implication: $u(z, p) = u(z)$ and fully indexed contract.
1. $k$: Publicly observable and chosen before $z$ and $p$ realize.

2. $s = pzk^\theta$: Observable by the entrepreneur.

3. **RENEGOTIATION**

4. $p$: Observed with delay.

5. $z$: NOT publicly observable (but inferred after observing $s$ and $p$).
Proposition. The optimal policy for next period promised utility (i.e., net worth) after the observation of $s$ does not depend on $z$ and, instead, it depends on $s$, $u(s)$.

Intuition: Incentive to insure the entrepreneur.

Implication:

- After observing $s$, the contract (i.e., $u(z)$) will be renegotiated.
- Real payment depends on nominal variables.

$\Rightarrow$ Endogenous degree of nominal indexation
RENEGOTIATION-PROOF CONTRACT

\[ V(q) = \max_{k,u(s)} \left\{ -k + \delta E \left[ z k^\theta + W(u(s)) \right] \right\} \]

subject to

\[ u(s) \geq \phi E \left[ z k^\theta \mid s \right] + u(0) \quad \forall s \]

\[ q = \beta Eu(s) \]

\[ u(s) \geq u \]
**Proposition.** Consider a one-time unexpected increase in price. The impact of the shock on the next period net worth strictly decreases in $\sigma_p$.

**Intuition:**

- When $\sigma_p = 0$, $s \uparrow$ comes solely from $z \uparrow$. Hence, the next period net worth for the entrepreneur will increase.

- As $\sigma_p$ becomes higher, $s \uparrow$ is interpreted less as $z \uparrow$. Hence, the next period net worth for the entrepreneur will increase less.
NUMERICAL Example

- Steady state investment and firm size distribution
- Degree of indexation by firm size
- Aggregate degree of indexation
INDEXATION BY FIRM SIZE

Define the degree of indexation by the elasticity of the next period net worth to a price shock.

- **High elasticity** implies that a (nominal) price shock affects the (real) net worth greatly.

⇒ *low degree of indexation*
Degree of Indexation (elasticity of $U'$ with respect to $P$)

Entrepreneur's value ($q$)
Weighted Average Elasticity

Low Price Uncertainty: 0.667  ⇒  Low indexation

High Price Uncertainty: 0.011  ⇒  High indexation
CONCLUSION

- We have shown that inflation shocks can have real economic effects because of endogenous limited indexation of financial contracts.

- We find that the impact of an inflation shock is bigger for smaller firms as their contracts are less indexed.

- We also find that a given inflation shock has a bigger effect in the economy with lower price uncertainty as the degree of indexation increases with uncertainty.