ESNIE 2006: Organization and Productivity

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Introduction

- The class will discuss three papers in a unified framework
  - Managerial Incentives and International Organization of Production (Grossman/Helpman 2004)
  - Incentive Contracts and Total Factor Productivity (Bental/Demougin forthcoming 2006)
  - Institutions, Bargaining Power and Labor Shares (Bental/Demougin 2006)

  In particular, I will adjust the model by Grossman/Helpman keeping their intuition, but using the Bental/Demougin framework

Stylized facts

- Variations in the model that we will discuss provide a possible answer to a number of puzzling facts that have characterized the last few decades
  - Increase in outsourcing
  - Dislocation of some of the production in developing countries
  - Large unexplained differences in total factor productivity TFPs
  - Blanchard 2006 documents that over the last 25 years, numerous countries have been characterized by significant reductions in
    - the labor share,
    - the real wage per efficiency unit
    - the ratio between employment in efficiency units and capital

The basic model

- ve = value of the project. The project requires the use of an intermediary input where $v \sim G(v)$
- e = value of intermediary input which is assumed not contractible, hereafter "effort"
- $s \in \{0, 1\}$ is a verifiable signal with $\Pr[s = 1|e, \theta] = e^{\theta}$
  - $\theta \in [o, 1]$ measures precision
  - Intuition: the value of the intermediary output, e, is measured by the probability of observing a positive signal given that monitoring is "perfect" (see Demougin/Fluet EER, 2001)
- $c(e)$ = costs of effort
- F = fixed payment
- b = bonus paid whenever $s = 1$

The Principal-Agent Problem: 1

- Take v as exogenously given

$$\begin{array}{rrcl} & \pi^{**}(v) & = & \max_{e,b,F} \; ve - be^{\theta} - F \\ \text{(LLC)} & 0 & \leq & F \\ \text{(PC)} & s & \leq & F + be^{\theta} - c(e) \\ \text{(IC)} & 0 & = & \theta b e^{\theta - 1} - c'(e) \end{array}$$

- (IC) $\Rightarrow be^{\theta} = \frac{e}{\theta} c'(e) = B(e, \theta)$ measures the expected bonus necessary to implement e. It allows to eliminate b from the optimization problem
- $B(e, \theta) - c(e) \geq 0$ is increasing in e and decreasing in θ

The Principal-Agent Problem: 2

- The Lagrangian becomes

$$L = ve - B(e,\theta) - F + \lambda\left[F + B(e,\theta) - c(e) - s\right] + \mu F$$

yielding the foc

$$\begin{aligned} v - B_e + \lambda\left[B_e - c'\right] &= 0 \\ -1 + \lambda + \mu &= 0 \end{aligned}$$

- The second foc implies there are three possible cases:
  1. $\lambda = 1, \mu = 0 \Rightarrow F = 0$ and $e = e^*(v)$
  2. $\lambda = 0, \mu = 1 \Rightarrow F > 0$ and $e = e^{**}(v)$
  3. $\lambda, \mu \in (0,1)$ F and e are dictated by the constraints

The Principal-Agent Problem: 3

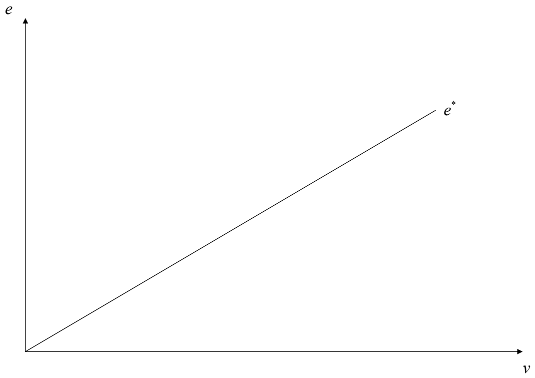

Figure: The first best solution

The Principal-Agent Problem: 4

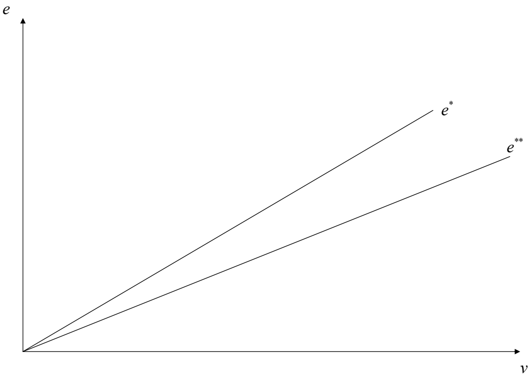

Figure: The first and the second best solution

The Principal-Agent Problem: 5

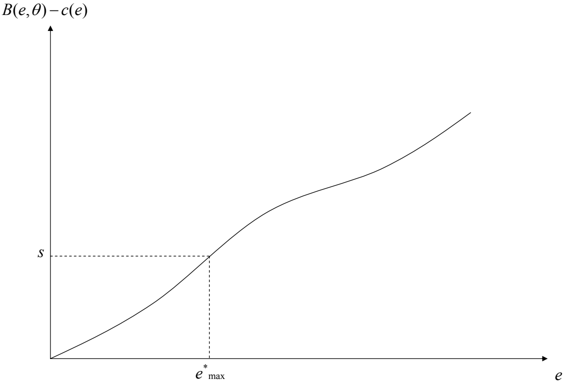

Figure: The maximal first best effort

The Principal-Agent Problem: 5

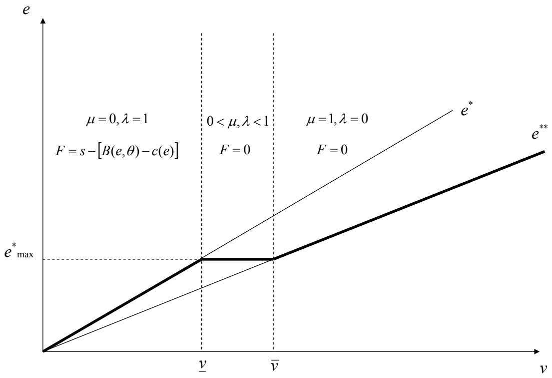

Figure: The solution to the P-A problem

The Principal-Agent Problem: 6

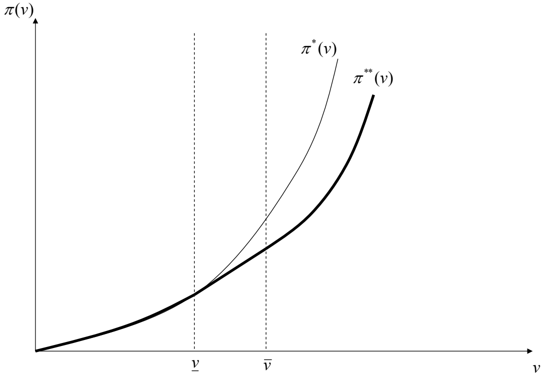

Figure: The principal's profit

Applying the model to in vs. outsourcing: 1

- The heuristic follows directly from Grossman/Helpman 2004. Their paper makes the following central assumption
- Creating a division for producing the intermediary product and employing a manager implies an employment contract with monitoring precision θ_I. The principal must pay additional costs for inputs of k
- Outsourcing the production of the intermediary product yields an incentive contract with monitoring precision $\theta_O < \theta_I$. However, the agent carries the additional costs of k.
  $\Rightarrow$ the principal has the choice between two different optimization problems

Applying the model to in vs. outsourcing: 2

- Outsourcing

$$\begin{aligned}\pi_O^{**}(v) &= \max_{e,F} \; ve - B(e,\theta_O) - F \\ & \quad F, F + B(e,\theta_O) - c(e) - k - s \geq 0\end{aligned}$$

- Insourcing

$$\begin{aligned}\pi_O^{**}(v) &= \max_{e,F} \; ve - k - B(e,\theta_I) - F \\ & \quad F, F + B(e,\theta_I) - c(e) - s \geq 0\end{aligned}$$

Applying the model to in vs. outsourcing: 3

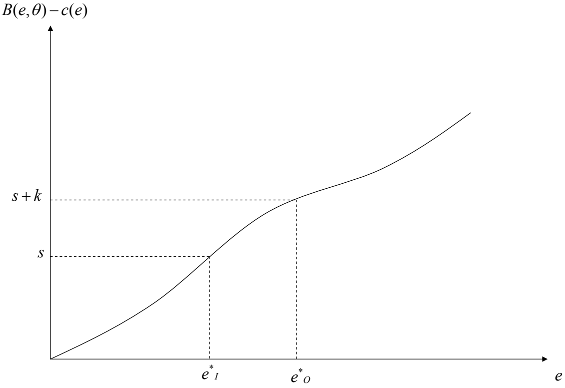

Figure: First best: in vs. outsourcing

Applying the model to in vs. outsourcing: 4

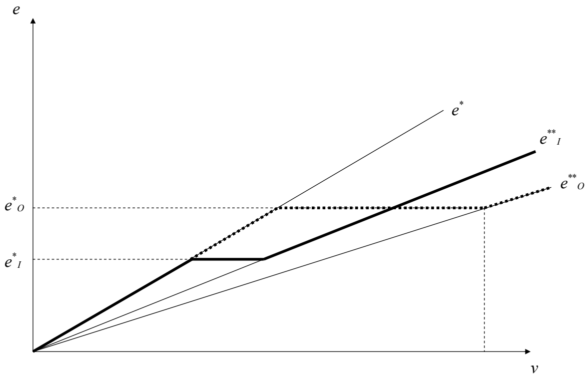

Figure: Effort: in vs. outsourcing

Applying the model to in vs. outsourcing: 5

- Outsourcing is better for small v because it implements the first best for more values and extracts parts of the rent
- For large v insourcing is better because it implements a more efficient second best effort
  $\Rightarrow$ The organizational form emerges endogenously depending on the productivity of the firm

Applying the model to in vs. outsourcing: 4

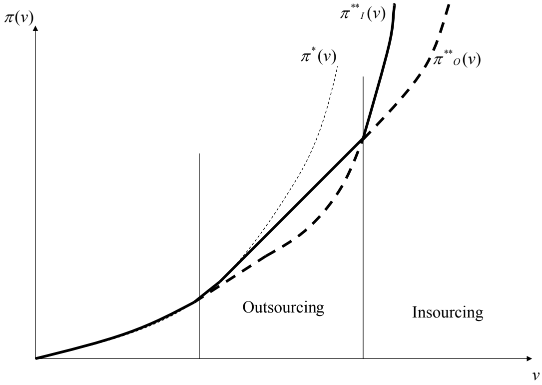

Figure: Profit: in vs. outsourcing

Extension: monitoring costs 1

- In the foregoing, we exogenously imposed $\theta_O < \theta_I$: Instead, we could introduce monitoring costs and assume

$$C_O^m(\theta) \geq C_I^m(\theta), \frac{\partial C_O^m}{\partial \theta} \geq \frac{\partial C_I^m}{\partial \theta}$$

  $\Rightarrow$ Monitoring with $\theta_O \leq \theta_I$ would emerge endogenously
- Suppose the $\theta's$ are bounded, it may induce that for very large v outsourcing again dominates insourcing

Extension: monitoring costs 2

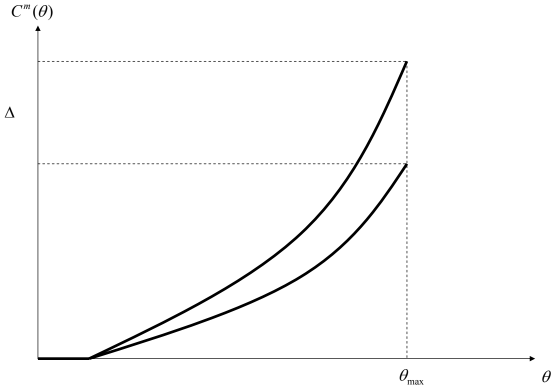

Figure: Monitoring costs functions

Extension: monitoring costs 3

- For large v, the agent's rent is sufficiently large that under either organizational choice the principal sets $\theta_O = \theta_I = \theta_{max}$ $\Rightarrow$ under both organizational form the incentive contract is the same, but with outsourcing the agent carries the costs k $\Rightarrow$ under Outsourcing rent is smaller $\Rightarrow$ if $k - \Delta > 0$ outsourcing is beneficial
- Grossman and Helpman introduce the possibility to FDI and outsourcing in developing countries. Again, they get an exogenous organizational form

Extension: monitoring costs 4

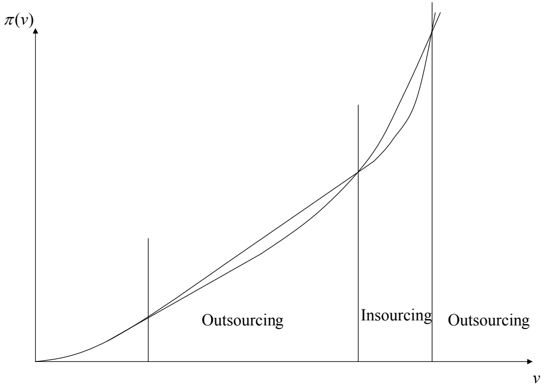

Figure: Monitoring costs functions

Incentive Contracts and Total Factor Productivity (forthcoming, IER)

- Great income differences among countries
- TFP differences are responsible for a large part of the differences in income. Hall and Jones (1999) decompose output/worker into:
  - Contribution of physical capital
  - Contribution of human capital
  - Contribution of productivity

    $\Rightarrow$ Prescott (1998):Needed: A Theory of TFP

Incentive Contracts and Total Factor Productivity 2

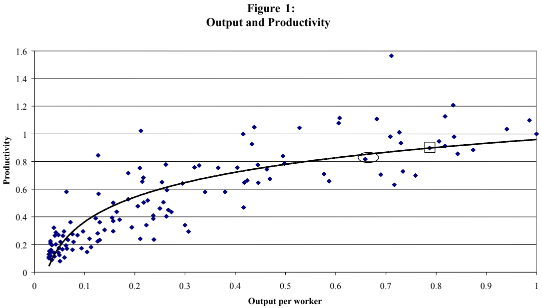

Figure: Correlation between output and productivity

Potential explanations

- Existing literature
  - Access to technology: Romer (1993)
  - Factor endowments: Mankiw, Romer and Weil (1992)
  - Monopolists prevent the adoption of superior technologies: Parente and Prescott (1999)
  - Social obstacles: Hall and Jones (1999)
  - Contract enforcement: Kocherlakota (2001)
  - Mismatch of technologies and human capital: Acemoglu and Zilibotti (1999)
- Our explanation: merge organization theory and growth:
  - Labor contracts are subject to rents due to incentive contracts under asymmetric information
  - Optimal contracts trade off costs (rents and monitoring) against benefits (effort and output)
  - Tradeoffs change as economy grows: More effort (TFP increase) and more monitoring
- In the paper, we cite lots of supportive evidence

Bernanke and Grkaynak (2001)/ Hall and Jones (1999) 1

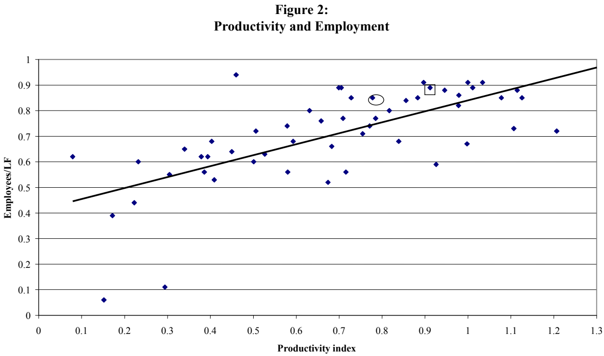

Figure: Correlation between productivity & the share of corporate employees

Bernanke and Grkaynak (2001)/ Hall and Jones (1999) 2

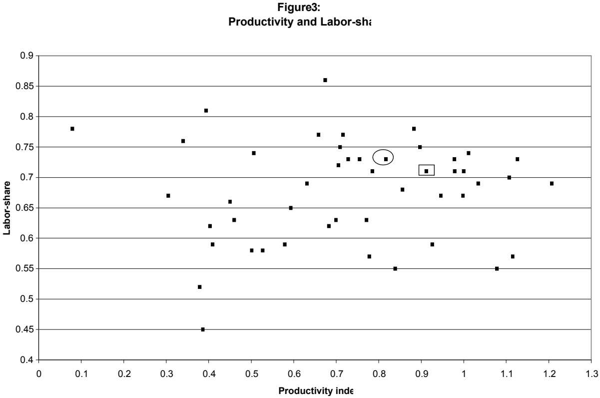

Figure: Correlation between labor share in income and productivity

Radner (1992)

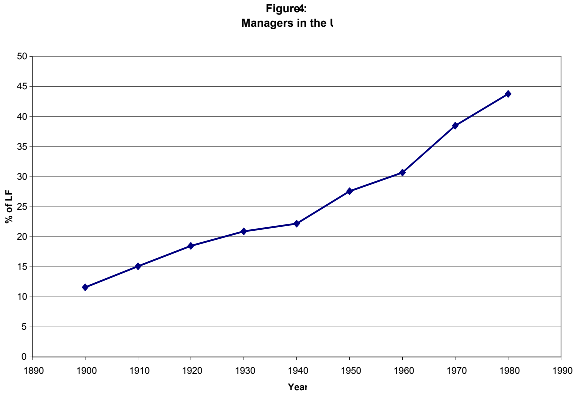

Figure: Fraction of management in the U.S. 1900 to 1980

The Model 1

- Single good, discrete time economy with constant population of infinitely lived households indexed on the unit interval by h
- Household owns $k_h(t)$ units of capital and one unit of labor. Both are inelastically supplied. However, effort ϵ_t is variable
- Household maximize

$$\sum_{t=0}^{\infty} \eta^t u(x_t, \epsilon_t)$$

where for momentary utility, we specify

$$u(x_t, \epsilon_t) = x_t - c(\epsilon_t)$$

  - $\eta =$ discount factor
  - $x_t =$ consumption in period t
  - $c(\epsilon_t) =$ disutility of effort assumed convex

The Model 2

- Household h may be self employed and produce $y(h), y' > 0$, at no effort cost
- Household h may choose to be employee. Its productivity depends on effort as determined by the household
- As in the foregoing model, effort is not contractible, $s \in \{0, 1\}$ is a contractible proxi and θ denotes the precision

$$p(\epsilon, \theta) = a(\epsilon)^{\theta}, a(\epsilon) = \exp(-\epsilon^{-\nu})$$

$$\phi(\theta) = \phi \cdot \theta^{\alpha}, \ \ \alpha \geqslant 1$$

$$c(\epsilon) = c \cdot \epsilon^{\beta}, \ \ \beta \geqslant 1$$

$$y(z) = y_0 z^{\mu}$$

$$f(k, \epsilon) = Tk^{\gamma}\epsilon^{1-\gamma} \ \ 0 < \gamma < 1$$

Main results 1

- Given the functional forms the model yields close form solution. We verify the following results

Theorem

Lower steady-state interest rates are associated with higher capital-labor ratios and higher effort (i.e. TFP)

Theorem

Lower steady-state interest rates are associated with higher precision and higher contract power (expected bonus)

Theorem

Lower steady-state interest rates are associated with a larger fraction of the labor force choosing to become employees

Impact of monitoring: variations in ν 1a

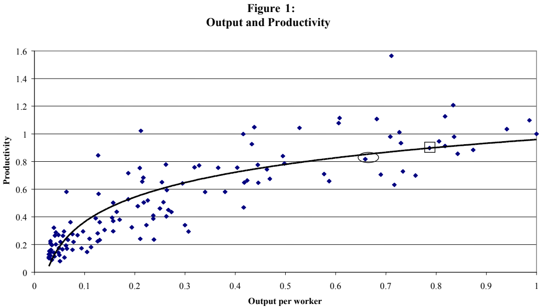

Figure: Correlation between output and productivity in the data

Impact of monitoring: variations in ν 1b

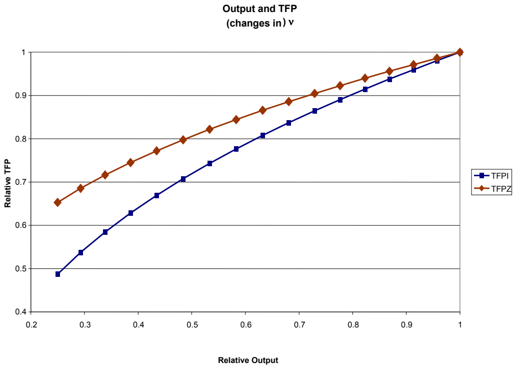

Figure: Correlation between output and productivity in the model

Impact of monitoring: variations in ν 2a

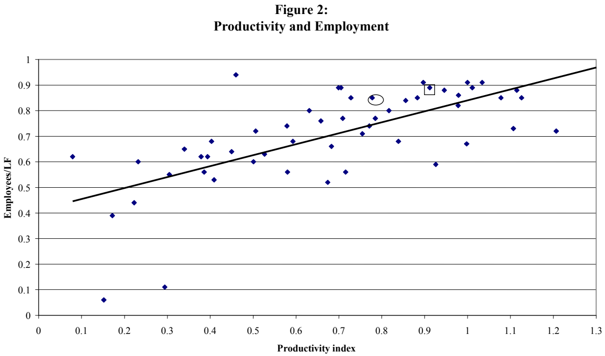

Figure: Correlation between productivity & the share of corporate employees in the data

Impact of monitoring: variations in ν 2b

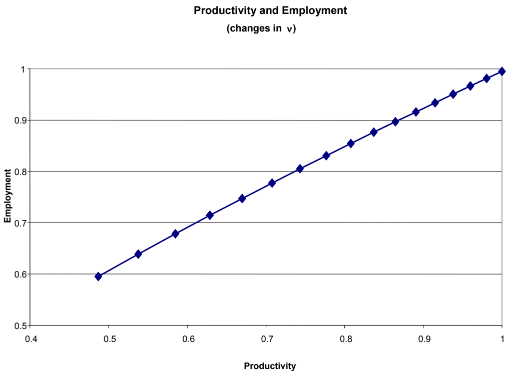

Figure: Correlation between productivity & the share of corporate employees in the model

Impact of monitoring: variations in ν 3a

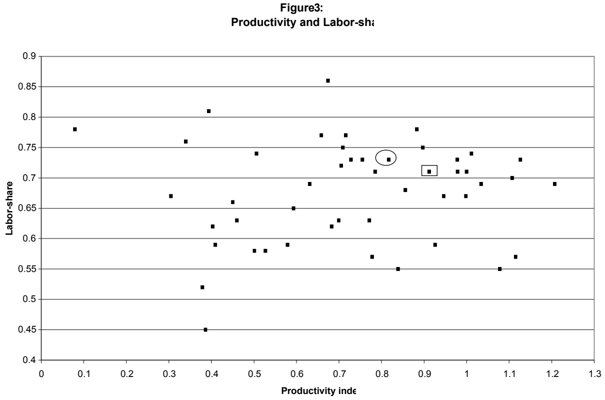

Figure: Correlation between labor share in income and productivity in the data

Impact of monitoring: variations in ν 3b

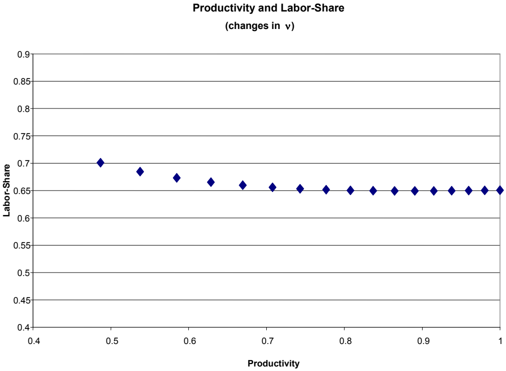

Figure: Correlation between labor share in income and productivity in the model

Dynamics 1

- We start the economy with $1/3$ of its steady-state capital
- TFP changes amount to approximately 40 % of output growth
- **Intuition:**
  - More capital needs more workers
  - Employers must draw labor from better self-employed
  - Labor contracts must improve
  - These induce more monitoring and more effort, i.e. TFP increase

Dynamics 2

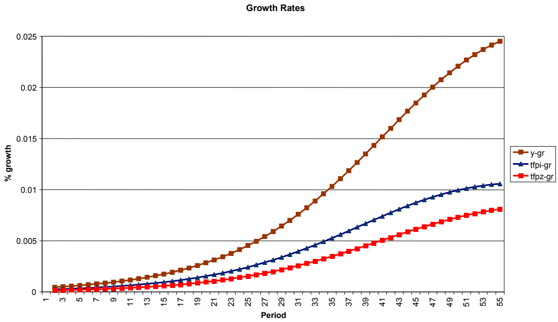

Figure: Growth in both sectors and in the overall economy

Monitoring and employment 1a

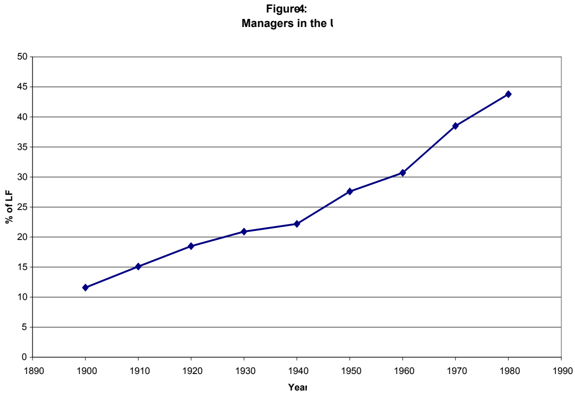

Figure: Monitoring measured as Fraction of management

Monitoring and employment 1b

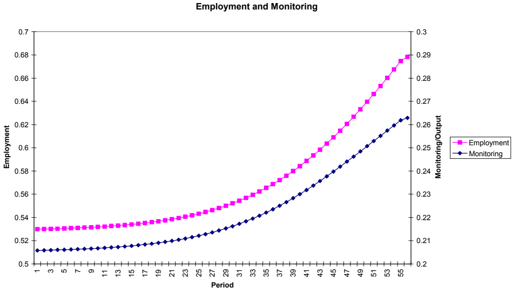

Figure: Monitoring and employment in the model along the growth path

Institutions, Bargaining Power and Labor Shares, SFB649 Discussion paper

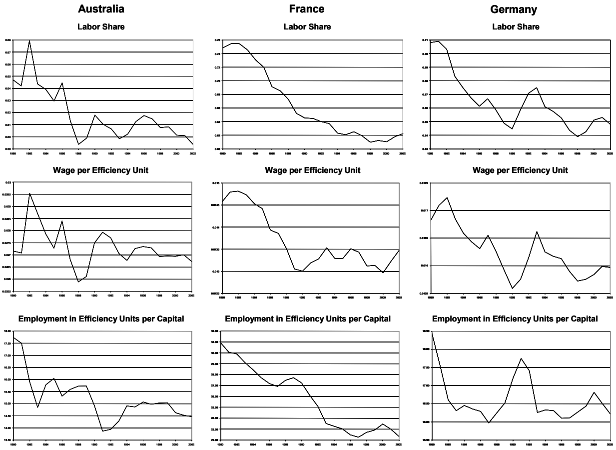

Figure: A puzzle

Introduction 2: Conventional Wisdom

- Labor share
  - reflects technology
  - with Cobb Douglas reflects output elasticity with respect to labor $\Longrightarrow$ supposed to be constant
- Wage per efficiency unit
  - With Harrod neutral technological change should be constant
- Employment in efficiency unit per capital
  - With Harrod neutral technological change should also be constant
  - Moreover, given the violation of fact 2, should be raising

Introduction 3: Blanchard's explanation

- His explanation focusses on the French case
- Main story: labor hording
  - During the 70's French firms were labor hording
  - In the 80's: tougher governance because of competition $\Longrightarrow$ firms shed excess labor $\Longrightarrow$ labor share drops
  - Profits go up, firms invest $\Longrightarrow$ in the short run employment to capital is decreasing. Eventually employment should increase: puzzle, this has not happened
  - No explanation for the declining wage per efficiency unit
- Blanchard, 2006: *I see the labor share puzzle as largely unsolved*

Introduction 4: Outline of answer

- We replace competitive wage setting with bargaining (DMP literature)
- We introduce:
  - Moral hazard $\Longrightarrow$ parties are bargaining over incentive compatible labor contracts
  - Holdup in capital
- Bargaining power reflects institutions (e.g. dismissal procedures, employment conditions, collective relation laws, social security laws etc. see Botero et al., 2004)

Introduction 5: Outline of answer

- Demougin and Helm, 2006 have bargaining with moral hazard and no holdup
  - Increasing bargaining power leads to higher rents, but raises efficiency
  - The regulator doesn't care about rents $\Longrightarrow$ should raise bargaining power to attain first best
- This provides a rationale for government involvement in labor relations
- Holdup in capital introduces a counter veiling effect
- The optimal institutional setup trades off labor efficiency (given capital) against a misallocation of capital

Introduction 6: the role of monitoring

- Contracts are founded on verifiable proxy variables
- Improved monitoring means that the proxy variables better reflect effort, thereby increasing the efficiency of the labor contract.
  - It decreases the optimal amount of bargaining power leading to increased effort and capital investment
  - A consequence of the reduction in the bargaining power of labor is a smaller labor share
  - The model we develop also generates the other puzzling features presented by Blanchard
- It is well know that monitoring has improved during the last two decades due to the rapid development of *ICT*
- Green (2004) exploits British survey data over the last two decades. He reports that the use of performance related pay schemes has increased and that work has intensified

The model 1

- The economy is populated by risk neutral agents
- Firms own a technology that employs capital and labor
  - Physical labor input of worker is normalized to be one
  - The effectiveness of capital and labor depends on the respective workers' effort. Effort is not perfectly verifiable $\Rightarrow$ moral hazard
- The production per-worker takes the form

$$F(e,k) = e^{\nu} f(k)$$

  - $e =$ the worker's effort, as before not contractible
  - $e, \nu \in [0,1]$
  - Proxi yielding $p(e) = e^{\theta} =$ probability of a positive signal
  - $f(\cdot)$is increasing concave, with $f(0) = 0$
  - $c(e) = c \cdot e$
  - Workers are financially constrained $\Rightarrow$ standard bonus contract

Timing of the game between the parties

For a given α

1. Firms hire capital per-worker at a given rental rate, *r* (Implicitly, we assume that the capital stock is fixed, and that there exists an alternative technology)
2. Workers are matched with a unit of *capital per-worker*. Each worker bargains individually with the firm.
3. The outcome of the bargaining stage can be represented by Nash bargaining, where α represents the bargaining power of labor
4. Finally, the contract is executed, workers exert effort, *s* is observed and payments are made

While α is not controlled by the parties, it is a societal choice variable

The worker's effort decision

- Applying backward induction, we start with the worker's effort choice. At this stage, the labor contract is already specified

$$R = \max_{\widehat{e}} \; A + Bp(\widehat{e}) - c(\widehat{e})$$

- The first order condition yields the worker's effort choice as a function of the bonus and the underlying parameters:

$$e = \lambda^{\frac{1}{1-\theta}} B^{\frac{1}{1-\theta}}, \text{where } \lambda = \frac{\theta}{c}$$

- An increase in B raises the power of the contract thereby raising effort
- Effort increases as monitoring becomes more effective

The negotiation game 1

- We ignore fixed payment because in any optimal allocation of bargaining power $A = 0$
- At this stage of the game, the capital labor ratio is already determined. Moreover, the parties anticipate the worker's effort choice

$$\Pi = \max_{B,e} \; [F(e,k) - Bp(e)]^{1-\alpha} [Bp(e) - c(e)]^{\alpha}$$
$$s.t. \; e = \lambda^{\frac{1}{1-\theta}} B^{\frac{1}{1-\theta}}$$

- Solving the FOC for B yields:

$$B = [(1-\alpha)\nu + \alpha]^{\frac{1-\theta}{1-\nu}} \lambda^{\frac{\nu-\theta}{1-\nu}} f(k)^{\frac{1-\theta}{1-\nu}}$$

The negotiation game 2

- B is increasing in the bargaining power of labor
  1. α provides the worker with a share of the quasi rent
  2. Once forced to yield a fraction of the quasi rent, the parties find it optimal induce effort
- B is increasing in the level of capital: a higher level of capital increase the marginal benefit of effort
- The quality of monitoring has an ambiguous effect:
  1. For a given level of effort, raising θ reduces the bonus. Thus, the marginal cost of inducing effort decreases.
  2. The firm would like to increase effort $\Rightarrow$ B must rise

The negotiation game 3

- Substituting back e and B yields:

$$y = \lambda^{\frac{\nu}{1-\nu}} \left[(1-\alpha)\nu + \alpha\right]^{\frac{\nu}{1-\nu}} f(k)^{\frac{1}{1-\nu}}$$

- y is unambiguously increasing in improved monitoring
- The "reduced form" for output raises the $f(k)$ to a power larger than unity $\Rightarrow$ according to our model the usual "growth accounting" exercises must be modified
  1. Labor share is not equal to the marginal product of labor (see Bental and Demougin 2005)
  2. ν affects the contribution of capital growth to output growth. It suggests that *TFP* growth rates should be correlated with the quality of monitoring and the institutional setup

The firm's investment decision

- The firm will anticipate the effect of its decision on contract negotiation and on the worker's effort:

$$\pi = \Phi(\alpha, \theta) f(k)^{\frac{1}{1-\nu}} - rk$$

where

$$\Phi(\alpha, \theta) = \lambda^{\frac{\nu}{1-\nu}} \left[(1-\alpha)\nu + \alpha\right]^{\frac{\nu}{1-\nu}} \left[(1-\nu)(1-\alpha)\right]$$

- the firm's FOC implicitly defines $k(\alpha, \theta)$

$$\frac{1}{1-\nu} \Phi(\alpha, \theta) f(k)^{\frac{\nu}{1-\nu}} f'(k) - r = 0$$

Bargaining power from the point of view of the firm

- Suppose firms could determine α on their own. α has two conflicting effects on profits. Consider increasing α
  - It raises the workers' output share in output $\Rightarrow$ direct negative impact on profits
  - It has a positive effect on the worker's effort and potentially also on profits
- Applying the envelope theorem on the firm's optimization problem yields

$$\pi_\alpha = \Phi_\alpha f(k)^{\frac{1}{1-\nu}} \ ,$$

where

$$\Phi_\alpha = -\alpha\lambda^{\frac{\nu}{1-\nu}} \left[(1-\alpha)\nu + \alpha\right]^{\frac{\nu}{1-\nu}-1} (1-\nu) < 0.$$

$\Rightarrow$ Firms would like to drive α to zero

Bargaining power from the point of view of Labor

- An increases in α has three separate effects
  - It raises their output share; from their point of view this is positive However:
  - Capital investment decreases, so output to be shared decreases
  - Workers anticipate that in the negotiation game they will be induced to work harder
- The worker's rent is given by

$$R = \Omega(\alpha, \theta) f(k)^{\frac{1}{1-\nu}},$$

where

$$\Omega(\alpha, \theta) = (1 - \theta)\, \lambda^{\frac{\nu}{1-\nu}} \left[(1 - \alpha)\nu + \alpha\right]^{\frac{1}{1-\nu}} \quad .$$

- Workers would not drive α to 1. Indeed, with $\alpha = 1$ firms do not invest and workers obtain no rent. Workers trade off their "share of the pie" in order to increase the "size of the pie"

Bargaining Power from the Point of View of Society

- We Define welfare as the sum of the firm's profit and the worker's rent

$$W = \underbrace{\left[\Phi(\alpha,\theta)f(k)^{\frac{1}{1-\nu}} - rk\right]}_{\pi} + \underbrace{\Omega(\alpha,\theta)f(k)^{\frac{1}{1-\nu}}}_{R} .$$

- The benevolent regulator balances the conflicting interests of the workers and the firms
- It is easily verified
  1. For all $\theta \in (0,1)$, we have $\alpha^* \in (0,1)$
  2. For $\theta \to 1$, we find $\alpha \to 0$
  3. Improved monitoring (i.e. an increase in θ) implies a reduction in α^*.

The Cobb-Douglas Technology 1

- To gain further insights, we assume a Cobb-Douglas technology. It allows us to run numerical experiments and match some phenomena observed in the data.
- specifically, we assume

$$F(e, k) = e^{\nu} k^{\gamma}.$$

- The FOC of the regulator's simplifies to

$$\left[\frac{1-\nu}{(1-\theta)\left[(1-\alpha)\nu+\alpha\right]} - \frac{1}{\alpha}\right] - \left[\frac{1}{1-\alpha}\right]\frac{\gamma}{\gamma+\nu-1} = 0$$

- We depict the relationship between α^* and θ, arbitrarily holding $c = 1.1, \nu = 0.5$ and $\gamma = 0.3$

The Cobb-Douglas Technology 2

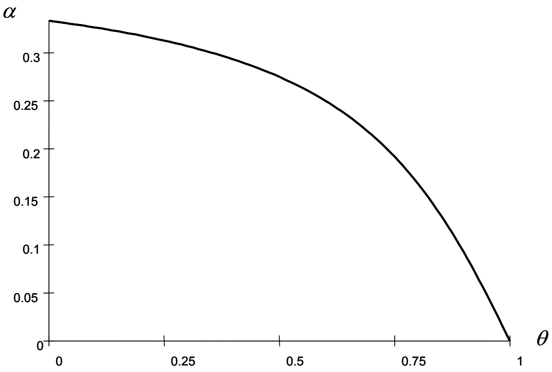

Figure: The socially optimal bargaining power

The Cobb-Douglas Technology 3

- Intuitively, as monitoring improves, the moral hazard problem becomes less significant
  - At the social optimum the balance between the moral hazard problem and the holdup friction tilts towards the holdup problem
  - the social planner finds it optimal to shift the allocation of bargaining power towards capital and away from labor
  - With $\theta = 1$, the moral hazard problem completely disappears and $\alpha^* = 0$

The Labor Share 1

- In our framework, the labor share is captured by the ratio of expected bonus over output. Taking the relevant variables from the output effort and bonus equations we find:

$$LS = [(1-\alpha)\nu + \alpha]$$

- Clearly, the labor share is increasing in α. Moreover, α is decreasing in θ. Thus the 'optimal' labor share drops with improvement in monitoring

The Labor Share 2

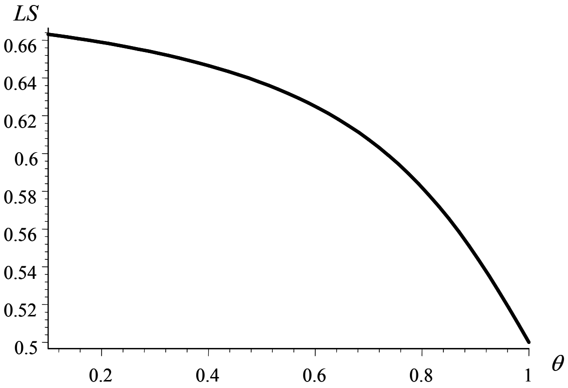

Figure: Labor Share with an optimal adjustment of α^*

The real wage per efficiency unit 1

- Thinking of a Harrod-neutral productivity factor that affects labor efficiency, the Cobb-Douglas technology implies:

$$e^{\nu} k^{\gamma} = k^{\gamma} E^{1-\gamma}.$$

- Total factor productivity translates into labor efficiency units as follows:

$$E = e^{\frac{\nu}{1-\gamma}}$$

- Applying these definitions the "real wage per efficiency unit" becomes:

$$\frac{pB}{E} = [(1-\alpha)\nu + \alpha]\,(1-\alpha)^{\frac{\gamma}{1-\gamma}} \left[\frac{\gamma}{r}\right]^{\frac{\gamma}{1-\gamma}}$$

The real wage per efficiency unit 2

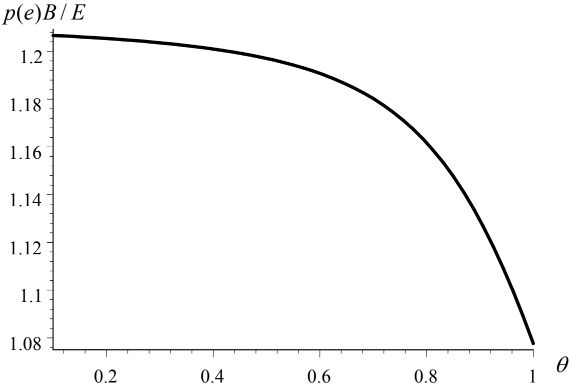

Figure: Real wage per efficiency unit with an optimal adjustment of α^*

Labor efficiency units to capital 1

- Applying the definition of efficiency unit and using the firm's capital choice yields for the Cobb-Douglas case:

$$\frac{E}{k} = \left[\frac{r}{\gamma(1-\alpha)}\right]^{\frac{1}{1-\gamma}}$$

- The ratio is obviously increasing in α. Since α^* is decreasing in θ, we find that "labor in efficiency units to capital" should be decreasing in the quality of monitoring

Labor efficiency units to capital 2

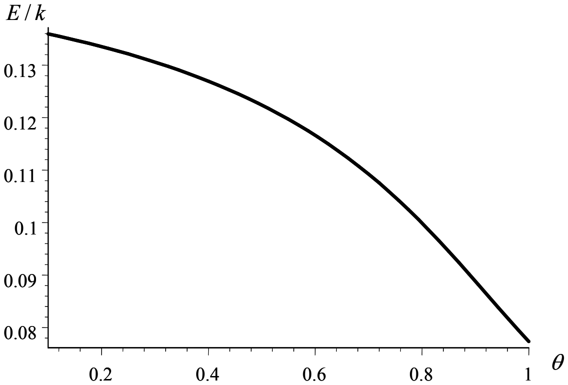

Figure: Labor efficiency units to capital with an optimal adjustment of α^*

Conclusion 1

- The paper introduces two frictions that hinder a smooth functioning of the economy
  - Moral hazard problem that forces firms to leave rents to workers
  - A holdup problem that causes investment to decrease as workers' share in output increases
- The socially optimal allocation of bargaining power is determined by the relative importance of either friction
- The optimal allocation of bargaining power is affected by the economy's underlying parameters, in particular by the quality of monitoring
  - When the quality of monitoring improves, the moral hazard problem becomes less significant and the social planner reduces the bargaining power of labor

Conclusion 2

- The foregoing mechanism can explain trends observed in the French and other data over the last two decades
  - Decreasing labor share, decreasing ratios of labor efficiency units per capital and decreasing wages per efficiency unit can all be generated if monitoring has improved and the bargaining power of labor adjusted accordingly
- Improved monitoring and its consequences leads to potential increased tensions between the institutional structure preferred by labor and by society
  - In our model this increased tension manifests itself by a growing gap between the bargaining power labor would like to obtain and that chosen by the social planner
  - Moreover, if monitoring functions very well, further improvements would lead to reductions in workers' rents while profits keep growing