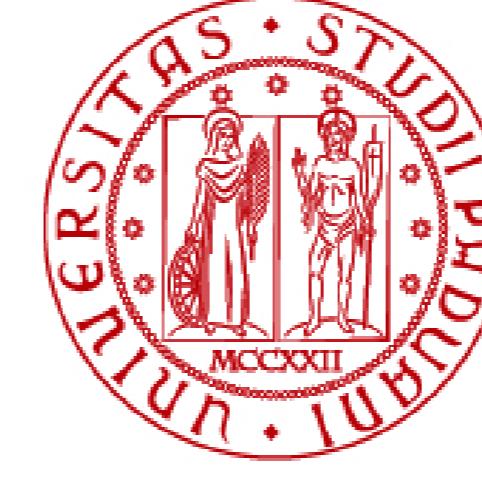


Labor Productivity and Factor Remuneration in a Vertical Market

Luca Sandrini
University of Padova
Department of Economics and Management
luca.sandrini.3@phd.unipd.it



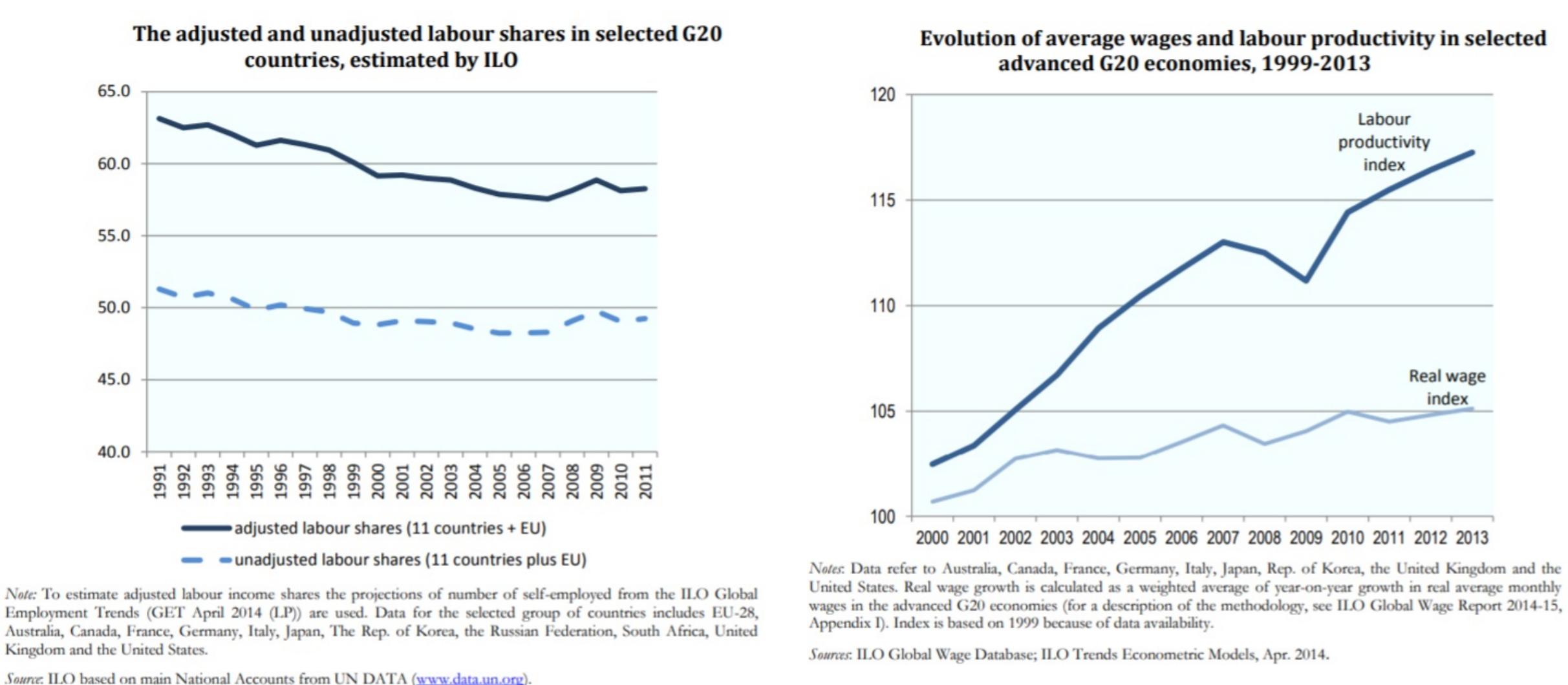
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Abstract
In this paper, I show how technological progress fostered by productivity enhancing innovation affects the remuneration of factors of production in the industry. Moreover, innovation implies a redistribution of the income generated in the industry from sector to sector, reducing the labor share of income in the downstream layer and increasing the profits upstream and the remuneration of capital. Unionization makes it possible to balance this transfer, by extracting part of the upstream profits. Also, I show how innovation affects the bargaining solution of the wage negotiation between workers and firms, with the workers obtaining a higher wage per unit of output, and the firms paying a lower wage-bill. Moreover, I try to demonstrate how productivity enhancing innovation is profitable only when the low-skilled workers' wage is less sensible to productivity than demand for labor. This implies that firms are more willing to invest when the wage scheme is relatively inelastic, allowing them to save resources from the wage-bill by reducing the amount of labor in the production process. On the contrary, when wages increases by the same proportion of the decrease in the factor's demand, the incentives to invest are nil.

Introduction

During the last four decades we have witnessed a persistent decline in the labor share of income. The reasons of this decline, which is important also for theoretical implication on micro and macro models where the labor share is usually assumed to be fixed, are still not clear. Among the many possible explanations there are the fall in capital input prices relatively to wages and the increasing market power due to deregulation. This paper aim at contributing this lack of explanations focussing on the role played by innovative activities that foster factor's productivity at the firm level.



The two figures above (OECD 2015) show the decline in the labor share and the increase in the productivity of labor in the last decades. As it is possible to see, real wages have increased less than proportionally to labor productivity. Taking this picture as a starting point, this paper want to analyze the effects of innovation on wages and on the distribution of income at the industry level. Starting from an inelastic wage scheme, I model a vertical market where the productivity of labor in the downstream sector depends on the quality of the intermediate good produced upstream. The producers of the intermediate good invest resources to increase the quality of the input in order to lower the labor cost for the producer of the final good. However, the suppliers of the intermediate good extract the surplus from the adoption of the innovative input through the price of the input itself.

Main Objectives

- To analyze the role played by innovation on the decline in the labor share of income.
- To analyze the effect of the adoption of innovation on low-skilled and high-skilled workers.
- To investigate the incentives for firms to invest in innovation, given the labor market characteristics.
- To provide the policy maker with a proper set of tools which are useful to manage the technological progress led by innovation activities

Model and Timing

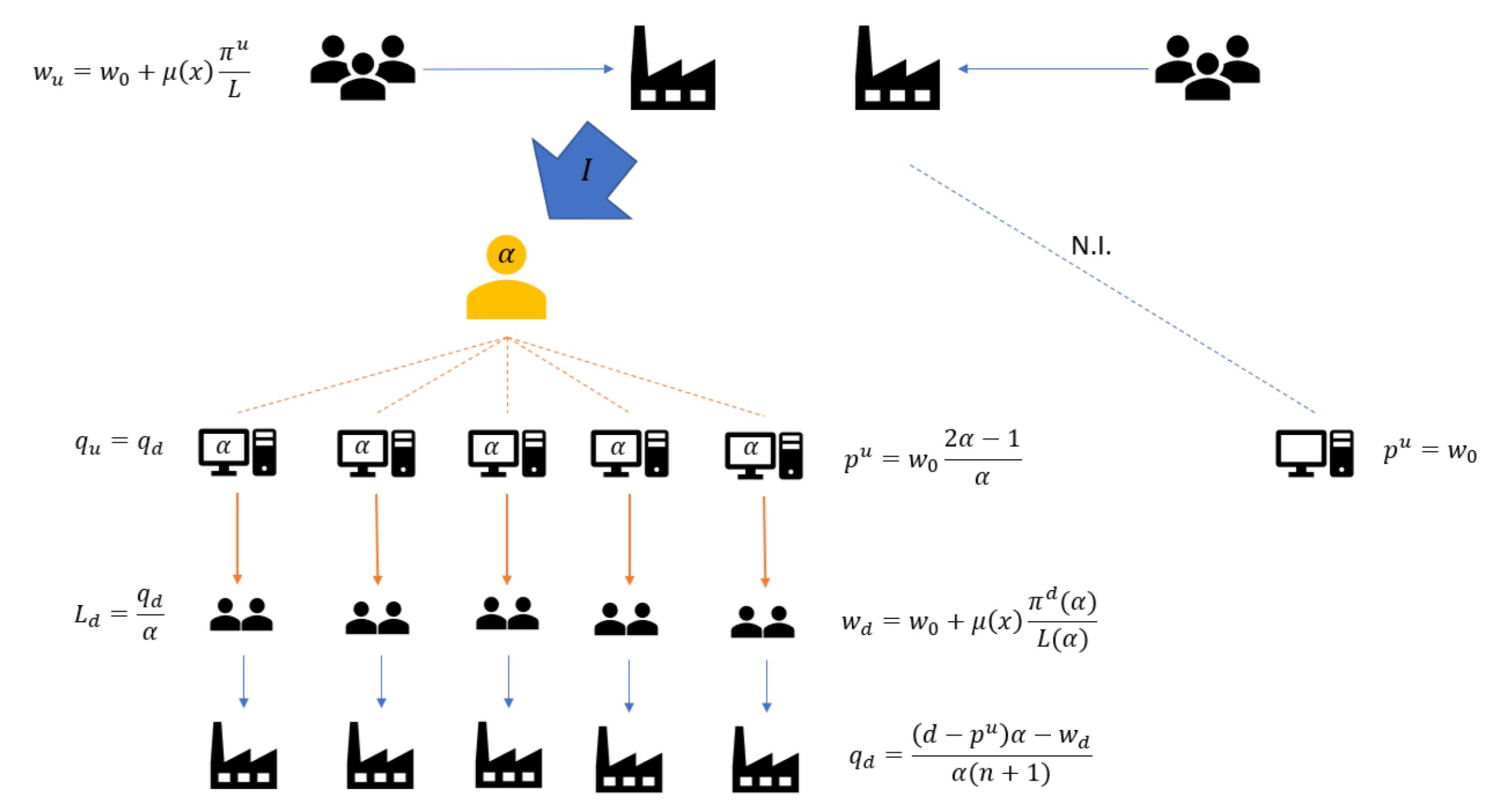
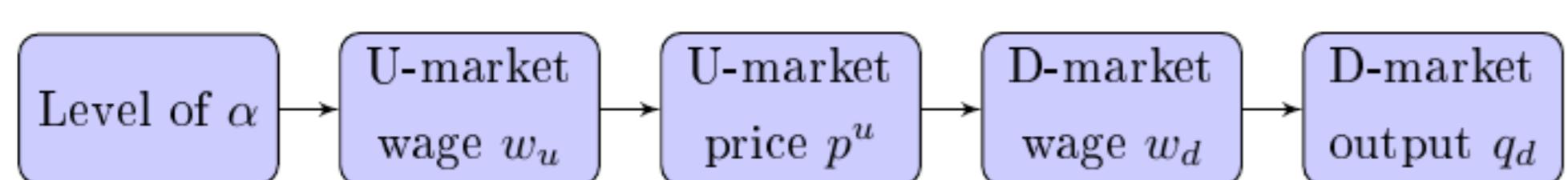
There are two market layers ($k = d, u$). Upstream, there are two firms producing a capital input (q_u , by means of labor) of quality α for the downstream sector and compete in prices (Bertrand). Downstream, $n \geq 2$ firms produce an homogeneous final good (q_d , by means of labor and the capital input) and compete in quantities (Cournot). Upstream firms can invest in order to increase the quality α of the capital input (probability of success $\phi_j < 1$); a better input implies a higher productivity of labor in the downstream sector $q_d = \alpha L$.

Downstream and upstream firms' objective function:

$$\Pi_d = \underbrace{P(Q_d) \cdot q_d}_{\text{Total Revenue}} - \underbrace{w_d \cdot \frac{q_d}{\alpha}}_{\text{Total Costs}} - p_u \cdot q_u^\alpha; \quad \Pi_u = \underbrace{\frac{q_u^\alpha \cdot p_u}{\text{Total Revenue}}}_{\text{Total Revenue}} - \underbrace{\frac{q_u^\alpha \cdot w_u}{\text{Labor Costs}}}_{\text{Labor Costs}} - \underbrace{\gamma(\alpha^2 - 1)}_{\text{Investment}} \quad (1)$$

Workers' objective function:

$$w_k = \max_{w_k} [\Pi_k]^{1-x} [L_k(w_k - w_0)]^x = w_0 + \mu(x) \frac{\Pi_k}{L_k} \quad (2)$$



Results

The optimal level of investment in innovation is:

$$\alpha^* = \left(\frac{\phi_j \cdot n(d - 2w_0)(2 - x)}{2\gamma} \cdot \frac{w_0(1 - x)}{2} \right)^{\frac{1}{3}} \quad (3)$$

From where it is clear the link between firms' incentive to innovate:

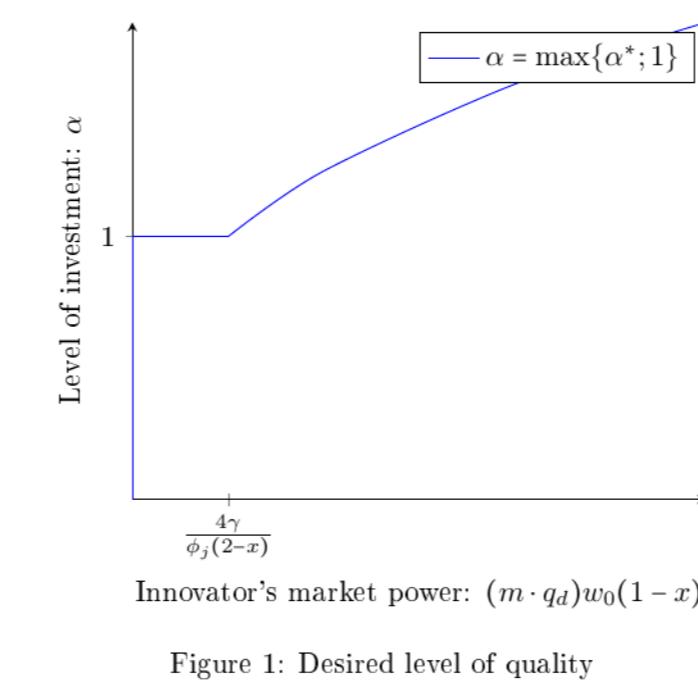


Figure 1: Optimal α

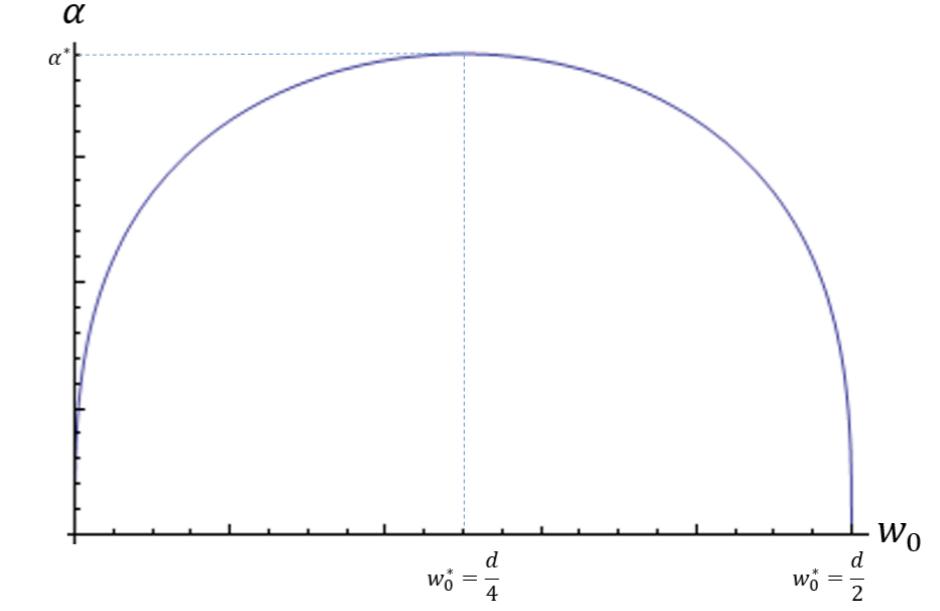


Figure 2: Trade-Off α and w_0

Moreover, we can say that:
there is a trade off between the income effect on the demand of factors due to an increase in the relative price, and the firms incentives to foster factors' productivity which increases as their prices increase ("market generator effect").

Also, innovation makes it possible to change the distribution of the income generated at the firm level, by transferring share of income from the remuneration of labor towards the remuneration of the intermediate good. This transfer is mitigated by upstream bargaining activities between workers and firms.

$$\begin{aligned} \Delta \Pi_d &= \Pi_d^{\alpha^*} - \Pi_d^1 =; \\ \Delta L_d w_d &= L_d^{\alpha^*} w_d^{\alpha^*} - L_d^1 w_d^1 = -\frac{n(d - 2w_0)(2 - x)w_0}{2(n + 1)} \cdot \frac{\alpha - 1}{\alpha} < 0 \\ \Delta \Pi_u &= \Pi_u^{\alpha^*} - \Pi_u^1 = \frac{n \cdot w_0(d - 2w_0)(2 - x)(1 - x)}{2(n + 1)} \cdot \frac{\alpha - 1}{\alpha} - I > 0 \\ \Delta L_u w_u &= L_u^{\alpha^*} w_u^{\alpha^*} - L_u^1 w_u^1 = \frac{n(d - 2w_0)w_0(2 - x)x}{2(n + 1)} \cdot \frac{\alpha - 1}{\alpha} > 0 \end{aligned}$$

where $I = \gamma(\alpha^2 - 1)^*$. One can see that the profits in the downstream sector has not changed, while the labor share is lower. Moreover:

$$\Delta L_d w_d - \Delta \Pi_u - \Delta L_u w_u - I = 0;$$

Finally, the effect of innovation on wages, for both downstream and upstream sector, is positive.

$$\begin{aligned} w_d &= w_0 + \frac{x(\alpha(d - w_0) - w_0)}{2}; \quad w_u = w_0 + \frac{w_0(\alpha - 1)x}{\alpha} \\ \frac{\partial w_d}{\partial \alpha} &> 0; \quad \frac{\partial w_u}{\partial \alpha} > 0 \end{aligned} \quad (4)$$

Conclusions

- Innovation in labor productivity is profitable if the cost of labor is sufficiently high
- Firms' incentive to innovate increases in downstream wages as long as the income effect is lower than the "market generator" effect
- Innovation does imply a shift from labor share of income to capital share (at the firm level)
- The profit sharing mechanism implicitly assumed in the bargaining scheme for wage determination should lead to an increase in real wages, as long as workers have any bargaining power.

Forthcoming Research

- Welfare analysis of the equilibrium results
- Empirical analysis of the results