Arne Bigsten et all. 1999. Adjustment costs, irreversibilities and investment patterns in African manufacturing. IMF working paper 99/99 (July).

Irreversibilities

Irreversibilities in investment happen when there are significant costs in reversing the investment made, such that the firm has to consider these costs before undergoing any investment project.

These (irreversible) costs of making investment could be:

- the selling price of capital is lower than the buying price of capital, such that:

$$Costs_{rev} = P_k^b - P_k^s > 0 \tag{1.1}$$

- there are no perfect matches for old machines and changes have to be made, such that investment to replace machines involves investment in learning and technology transfers, as well as long periods of installation and interruption in production;

- there are reorganization difficulties associated with the introduction of new machines and technology;

- there are training costs;

- reorganisation difficulties and training costs:

    - delay the benefits of the investment;
    - add to costs of investing;
    - involve foregone profits during the period of installation and adjustment.

On the other hand, the benefits of making the investment could be:

- the adoption of more productive technology and capital, which will lower costs, eventually increase standards and quality and increase competitiveness. This benefit is higher the shorter the period of adjustment, and lower the longer that period of adjustment;

- the firm will be operating capital that is not depreciated, whereas the capital in use is depreciating at a given rate.

If the firm does not undertake the investment, it will also incur costs, namely:

- its mandated investment will increase, which will be reflected in loss of competitiveness. The larger is the mandated investment, the less scope the firm has to avoid adjustment and the larger is the capital costs of the firm to adjust the capital stock.

$$I_{man} = K_{des} - K_{act} \tag{1.2}$$

- depreciation of the existing capital will continue at a given rate, until the firm's assets are worth nothing. Therefore, the firm will not be capable of selling its capital in the second hand market to cover part of the costs of new capital.

The point here is that the firm has costs, when undertaking investment, that cannot be reversed if the firm wants to reverse the investment made.

The firm will invest taking into account the risks associated with undertaking the investment, the irreversibility of some of the investment costs, the costs of not making the investment and the benefits from investing. Thus:

$$I = I\left(Risk, Cost_K, Costs_{irr}, Costs_{no-I}, Benefits_I\right) \tag{1.3}$$

If costs were not irreversible, there would not be any reason why a firm would not make continuous small adjustments to its capital stock, rather than investing in lumps (as the empirical evidence shows firms do).

Fixed costs

This is another possible explanation why firms do make continuous, small adjustments to their capital stock: because of the fixed costs of making the adjustment. If these costs are high, firms will benefit from large, lumpy investment rather than small, continuous investment.

Fixed costs are associated to time of interruption of production, costs of installation, re-training, researching for new technology, re-branding, etc.

Although there are benefits from undertaking investment, there are two problems that may make firms to decide for lumpy investment:

- benefits of adjustment are not immediate, because of the time of installation, profits foregone because production has been stopped, the time that it takes for the firm to master the new production process and technology. Hence, benefits are discounted as a function of time (n) and a rate of discount (r), so that:

$$\pi^{real} = \pi^{hip}(1-r)^n \tag{1.4}$$

- there are fixed costs that are not related to the scale of adjustment, but only to deciding and starting any adjustment.

Therefore, firms will prefer lumpy adjustment instead of continuous, small adjustments to their capital stock.