

Thibault FALLY - Paris-Jourdan Sciences Economiques (PSE)

Co-author: Juan Carluccio

## Financial constraints, technology transfers and ownership

In developing countries, transfer and assimilation of technologies developed in industrialized economies constitute a major source of productivity growth. Empirical evidence has stressed the role of firm specific relationships in shaping this process of technological transmission. In particular, “local suppliers” of a developing country may learn from “global buyers” using advanced technologies and desiring to source specific inputs at lower cost. Technology spillovers may also be observed within the boundaries of firms, when the local supplier is integrated by the foreign corporation. As some knowledge may flow naturally, technology transfers are often the result of voluntary decisions of global buyers in order to boost the productivity of their respective suppliers. Indeed, Teece (1977) shows that transfer costs are sizeable and range from 2% to 59% of total costs when a downstream firm transfers the capacity to manufacture a good to a local firm, which can be a subsidiary, a joint venture, or a licensee.

The literature has emphasized the role of intellectual patent protection, property rights and the risk of expropriation as institutional determinants of technology transfers, as well as human capital and investment in R&D at the firm level.

In this paper we focus on the impact of credit constraints affecting the local supplier. We develop a simple model to show that credit constraints may have a strong impact on the degree of technological knowledge that is transferred from the global buyer to the local supplier. A main assumption is that contracts are incomplete, following Grossman and Hart (1986) - more precisely we suppose that the quality of the traded input and specific efforts from the supplier are not contractible.

If financial constraints are not binding, technology transfers may be potentially large. Since we emphasize the role of specific efforts from the supplier, outsourcing is preferred to vertical integration in order to create more incentives and maximize the gains from technology transfers. However, if the supplier has limited wealth or access to credit, the model predicts that the degree of technology transfer is lower. As credit constraints further increase, vertical integration is eventually preferred to outsourcing, and technological transfers under vertical integration might then be higher than under outsourcing with credit constraints.

### The model

The central mechanisms of the baseline model may be described in the following terms.

The role of technology transfers is summarized by three main assumptions. Technology transfers increase the productivity of the supplier. However, the transfer of technology is costly for the global buyer and also requires complementary efforts from the supplier (if the supplier does not provide these efforts, technology transfers have no impact on the productivity of the supplier). These assumptions are consistent with Teece (1977).

In outsourcing, credit constraints affect the supplier in several ways because the supplier needs to finance both the licensing cost to the global buyer and the fixed investment corresponding to the specific efforts. When constraints are not tightening, the global buyer can extract the total surplus through initial payment, chooses the level of technology transfer that maximizes the total surplus and let the supplier provide high specific efforts. However, when financial constraints are stronger, the global buyer does not maximize the total surplus

because the supplier cannot pay for all costs of licensing and specific investments. Three effects of credit constraints on technology transfers and specific investment may be distinguished:

- First, technology transfers are lower because the global buyer does not receive all gains from the supplier cost reduction
- Efforts are lower because the global buyer prefers receiving a higher licensing upfront payment than financing supplier's efforts – the optimal effort from the supplier's point of view is higher than the effort that maximizes *ex post* profits of the global buyer.
- In turn, productivity gains from technology transfers are lower because the level of efforts is lower.

Clearly, lower degree of technology transfers will be associated with more tightening financial constraints in outsourcing.

Vertical integration may provide a simple way to limit the negative effects of financial constraints and increase *ex post* profits for the global buyer. Although integration is not optimal when there is no liquidity constraint because it does not give enough incentives to the supplier and reduces its efforts, it may become an interesting form of organization when constraints are stronger. Vertical integration has two virtues. First, the global buyer (now a multinational company) can extract a larger share of profits *ex post*, thus reducing the up front licensing cost. Second, internal financing can boost supplier's efforts in terms of investments in fixed capital. Although specific efforts from the supplier are lower under integration than under outsourcing without constraints, these efforts may be larger than under outsourcing with credit constraints. The negative impact of credit constraints on technology transfers is tempered under vertical integration: first, because the global buyer receives a larger fraction of the gains from supplier's productivity growth; second, because the specific complementary efforts from the suppliers are not too low, allowing positive effects of technology transfers on productivity.

A conclusion of our model is that both the degree of technology transfer and the optimal ownership structure evolve with access to finance. When credit constraints are not binding, outsourcing is preferred – efforts and technology transfers are the highest. When constraints increase, technology transfers and efforts are lower. When financial constraints are very strong, vertical integration is preferred and the decrease in efforts and technology transfers is limited. As a result, credit constraints globally have a negative impact on technology transfers but the relation may be non monotonic.

Moreover, the model provides rich predictions about differential impact of financial development across industries. Specifically, key parameters characterizing industries in the model are the complexity of tasks, the degree of technological compatibility between firms, and the relative importance of investment in human capital compared to investment in fixed capital.

We also consider an extension of the model with repeated interactions between the global buyer and the local supplier. We show that credit constraints may endogenously create a dynamic of technology transfers (if the supplier is constrained, technology transfers are lower at the beginning of the relation) as well as ownership structure (the supplier is first integrated and then become independent).

## Empirics

Empirical implications of the baseline model may be tested. In particular we want to check whether financial constraints have a negative impact on technology transfers.

A first source of data is the Worldbank Enterprise Survey that covers 50,000 firms in hundred countries. We restrict our sample to firms that export, sell to multinational firms or have a positive fraction of foreign capital (which yields a sample of 8000 firms for which we have information on technology transfers). The dependent variable, technology transfers, is equal to one if the “leading way in which the establishment acquired technological innovations” is either: transferred from the parent company, developed in cooperation with client firms, or from licensing – several alternative dependent variables can be used as robustness checks, such as innovation in product, innovation in process, which may provide indirect measures of technology transfers.

In order to assess the impact of credit constraints, we propose two identification strategies. First, we can exploit the cross-country dimension of the dataset (at least 20 countries in our sample of firms) and run a Probit regression of our measure of technology transfer on indices of financial development (private credit or stock market capitalization over GDP). Results are statistically significant with robust standard errors clustered by country, including into the regressions usual controls from the literature on economic growth (GDP per capita, human capital, government expenditures, investments, etc.). In the future, more precise results may be obtained by testing whether the level of financial development has a stronger impact on technology transfers in sectors that depend more heavily on external finance (following the method pioneered by Rajan and Zingales, “Financial Dependence and Growth”, AER 1998). The later estimation would permit to include sector and country fixed effects to control more precisely for the endogeneity of financial development.

Second, we can exploit the firm-level dimension, thus including country fixed effects that allow to controlling for any institutional factor. In order to identify firms that are credit constrained, several methods may be possible. First, the dataset provides a subjective question on whether financial constraints constitute an important obstacle for the firm. We find that a positive answer predicts significantly lower technology transfers, controlling for productivity, firm size, or other firm-level variables. Other questions that ask more precisely whether the firm has access to bank credit yield similar results. Finally, the data provides balanced sheets of firms with detailed information on liabilities. Again, we find that technology transfers are positively correlated with debt or cash flows over total assets.

In addition, we would like to test whether financial constraints also have an impact on the ownership structure, according to the technological characteristics of the parent company. Thus, further empirical work will analyze to what extent financial development of the supplying country affects (vertical) intra-firm versus arm’s length trade according to the level of technology and the characteristics of the sector. The source of data may include the “Survey on International Intra-group Exchanges” on French firms (“*Enquete Mondialisation*”, year 1999) which permits to differentiate between each type of flows and which could be matched with the French Manufacturing Survey (EAE) and Innovation survey (CIS3, 1998-2000) at the firm-level.

## Literature

Our paper relates to the literature on technological transfers and spillovers from multinationals, organization of firms and its institutional determinants. From a theoretical standpoint, Ethier and Markusen (1996) analyze dynamic choice of technology transfers when intellectual property rights are not perfectly enforceable. Lin and Saggi (2007), Mattoo, Olarreaga and Saggi (2001) consider the strategic implications of technology transfers with limited competition. Grover (2005) seems to be a rare case in which technology transfers affect bargaining positions. Moreover, there is a large recent literature on the choice between external versus intra firm trade. In particular, Antras and Helpman (2007) derive predictions

on the impact of contractual friction on the relative importance of outsourcing versus integration. Closer to our paper, Acemoglu, Antras and Helpman (2006) analyze the role of contractual frictions in determining the degree of technological complexity and the number of tasks outsourced by the downstream producer. Finally, Acemoglu, Aghion, Griffith and Zilibotti (2005) show how technology interacts with the structure of ownership.

On the empirical side, there is a large literature on spillovers from multinational firms (see, for example, Aitken and Harrison 1999). More specifically, Teece (1977) analyzes the cost of technology transfers. A recent literature investigates the link between financial development and FDI. In particular, Antras, Desai and Foley (2007) look at financial development as a determinant of vertical integration versus outsourcing according to the R&D intensity of the multinational firms. Alfaro et al (2007) shows that FDI has a stronger and more positive impact on productivity growth when the recipient country is better financially developed, but there is no detailed microeconomic analysis of the underlying mechanism.

This paper contributes to the literature in several ways. First, it develops a theoretical link between financial development and technology transfer. Because organizational structure has also an impact on technological choices, it provides new insights on the correlation between supplier credit constraints and vertical integration, as described by Antras, Desai and Foley (2007). Last but not least, our empirical findings enlighten a relation between financial constraints and the degree of technological transfers at the country and firm-level.