44. Intangibles over decades – Evidence from Finnish LEED data

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This paper analyzes technical change, R&D and organizational capital (OC) as inputs and innovativity in longer period 1986-2016 in Finland. Aim is to evaluate the over the period growth driven by technological push of innovation work in intangible capital accumulation and the degree of convergence of industries over the period depending on the degree of intangible and tangible capital accumulation. Intangibles are derived from the labor costs of innovation-type occupations using full register-based dataset of Finnish firms for the period 1986–2016 from Statistics Finland. Firms can have a strategy of improving quality of innovation work and thereby innovativity, proxied here by relative compensations for innovation work. Production function including intangible accumulation and innovative work labor share is used to get the respective relative productivity of innovative work in each Nace 3-digit industry (Piekkola, 2020a). The method thus evaluates quality of innovation work around the direct effect that intangible capital accumulation has on productivity.

The "final" good of consumers is produced here by perfectly competitive firms using inputs: quality adjusted labor $A(L_O L_R)L$, R and O with the Cobb-Douglas production technology.

$$Y_t = (A(L_O, L_R)L)_t^{\alpha_L} K_t^{\alpha_K} R_t^{\alpha_R} O_t^{\alpha_O}, \qquad (1)$$

where Y_t is value added in period t, A_t is a parameter that reflects the productivity of the O and R labor input in that period and $\alpha_L = 1 - \alpha_L - \alpha_R - \alpha_O$. The AL_t refers to the economy's effective labor supply L_t, where the quality A_t creates IBTC. IBTC depends on the share of workers engaged in innovation labor and on the gap between existing skills of innovation workers and all workers an average so that the first term in production function (1) is written as:

$$\begin{aligned}(A(L_O, L_R)L)_t^{\alpha_L} &= \left(A_t(L_{Rt}, L_{Ot}) + (L_t - L_{Rt} - L_{Ot})\right)^{\alpha_L} \\ &= \left(\left(\frac{a_{Rt}L_{Rt}}{\bar{w}_t} + \frac{a_{Ot}L_{Ot}}{\bar{w}_t}\right) + (L_t - L_{Rt} - L_{Ot})\right)^{\alpha_L}, \qquad (2)\end{aligned}$$

where a_{Rt}, a_{Ot} are the quality of innovation workers relative the average wages in the firm (subindex for firm i is not shown here). We are interested in IBTC for given L determined by the marginal productivity of labor in a straightforward matter on labor not engaged in innovation work $L_t - L_{Rt} - L_{Ot}$. The terms in the inner brackets can be rewritten as:

$$\frac{a_{Rt}L_{Rt}}{\bar{w}_t}+\frac{a_{Ot}L_{Ot}}{\bar{w}_t}=\left(\frac{a_{Rt}}{\bar{w}_t}-1\right)L_{Rt}+\left(\frac{a_{Ot}}{\bar{w}_t}-1\right)+L_{Rt}+L_{Ot} \qquad (3)$$

(2) is using (3) then in log form approximated by

$$\alpha_L \ln L+\alpha_L\left((a_{Rt}/\bar{w}_t-1)L_{Rt}/L+(a_{Ot}/\bar{w}_t-1)L_{Ot}/L\right), \qquad (4)$$

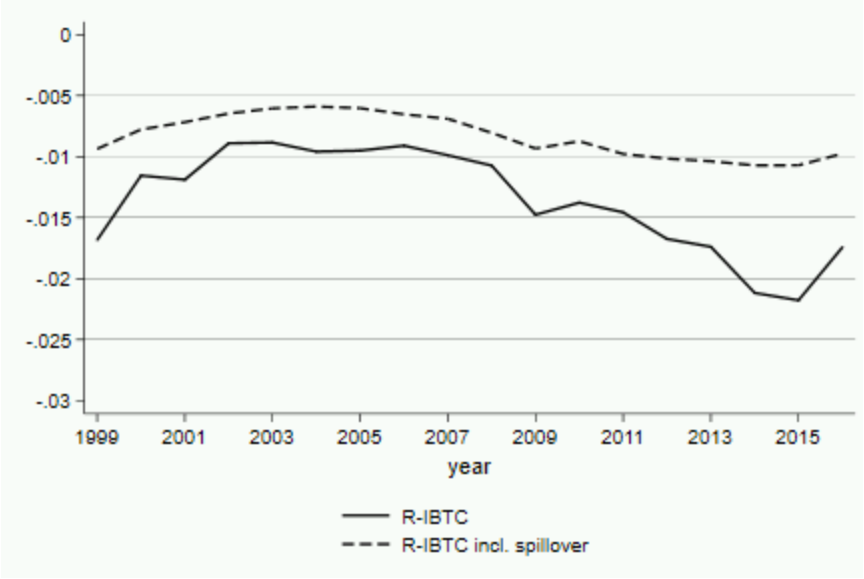
where the approximation is $ln\left((a_{Rt}/w_t-1)L_{Rt}/L+(a^*_{Ot}/w_t-1)L_{Ot}/L+1\right)\approx (a_{Rt}/w_t-1)L_{Rt}/L+(a^*_{Ot}/w_t-1)L_{Ot}/L$ given that the first two terms are not too far from zero. Such innovation-biased technical change IBTC will go up depending on the improvement of the quality of labor and the increase in the share of IA workers. "Stepping on toes" argument is that marginal productivity of new innovation type work may be decreasing in the amount of existing $L_{IA,t}/L_t$ (the marginal returns decrease in the amount in the share of $L_{IA,t}/L_t$). "Fishing out" says that all good ideas are used first so that improved relative quality of innovation workers a_{IAt}/w_t, $IA=R,O$ can have less positive effects.

Given this set of results on technological change in Nace 3-digit industries and they intangibles we approximate the growth around the steady-state as implied by Aghion and Howitt (2008) Schumpeterian growth framework. We consider average intangible assets and technical change to explain the adjustment to the end production. Method relies on evaluating the speed of convergence around stable growth as done for analysing growth factors across countries that account for intellectual capital such as human capital (Mankiw, Romer, & Weil, 1992), e.g. as applied in Sorensen, Jacobsen (2010 ch. 6).

An important contribution is the own estimate of industry-specific technical change. Earlier paper on innovation-labor biased technical change IBTC in shorter period shows that the relative quality of innovation workers vary around the average of zero. IA accumulation already captures much of the average effect on the quality of intangible. About 68% of observations are in one standard deviation range -0.4 - +0.4. R&D work driven IBTC and OC work driven IBTC explains large part of the distribution of labor productivity around the median given that median log of value added is 1.9.

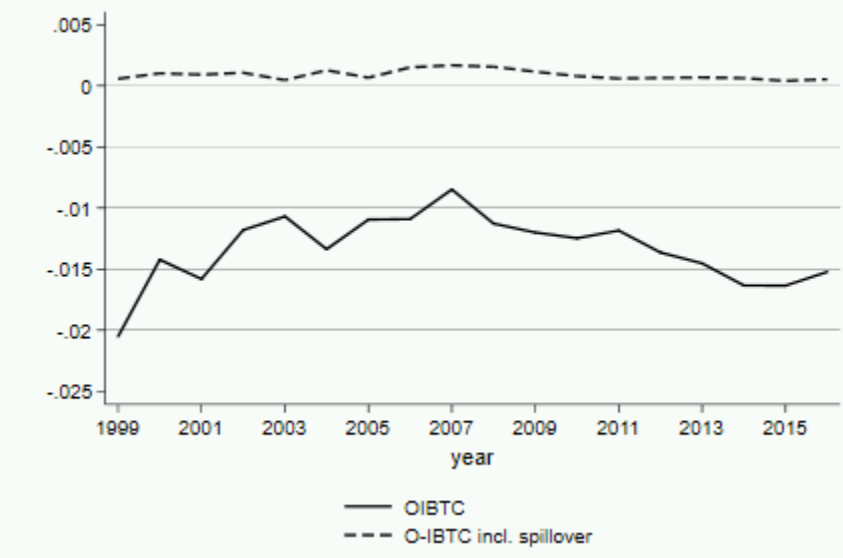
In later estimations we consider IBTC combined with IBTC spillovers that are available for all industries. Figure 1 shows the development of these figures for R-IBTC for the about twice large set of firms for which IBTC is available in full sample

Figure1. R&D driven IBTC also including spillovers



It is seen that average R-IBTC has been on average negative and decreased over time reaching the lowest levet in 2015. R-IBTC spillovers that account for firm-size is rather stable over the years so that the decline is mild taking this into account. Following figure shows O-IBTC

Figure 2. OC driven IBTC also including spillovers



OC driven IBTC has increased until 2017 and since then decrased less than R-IBTC. Inclusion of OC driven IBTC spillovers makes the average values flat over the years. There appears to have been structural shift from ongoing knowledge spillovers in large firms with investment in

qualified innovative workers away from smaller firms in the industries have not been able to follow.

Piekkola (2020b) finds OC and OC driven IBTC pivotal for growth besides organizational innovations. Innovation policy should include all the elements of innovation value chain: product, organizational and marketing innovations. Organizational capital appears always to have positive effects also through O-IBTC on product innovations. The other related channel is organizational innovations that together with product innovations improves productivity growth. R&D improves product innovativity and thereby growth, while R-IBTC has been on decline in recent years.

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