

Structural transformation: feedbacks from capital embodied technology adoption and capital-skill complementarity *

Julieta Caunedo[†], David Jaume[‡], Elisa Keller[§]

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EXTENDED ABSTRACT

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[†]Department of Economics, Cornell University. Email: julieta.caunedo@cornell.edu

[‡]Department of Economics, Cornell University. Email: djj56@cornell.edu

[§]School of Business and Economics, University of Exeter. Email: e.keller@exeter.ac.uk

1 Extended Abstract

Labor reallocation from agriculture to other more productive sectors is key to the development process. There is an extensive literature that studies the role of demand-side and supply-side forces in explaining this reallocation. On the supply-side, capital deepening is an important driver of changes in the return to labor and labor reallocation. There are two margins that are relevant to capital deepening, the intensive and the extensive margins of capital accumulation. In this paper, we study the role of shifts in the average quality of the capital stock for the process of structural transformation.

The return to labor in a given sector depends on the technology of such a sector through the share of capital in production, and through the pattern of complementarity between capital and labor inputs. Disparities in the patterns of complementarity between capital of different vintages and labor across sectors generate unbalanced growth as newer vintages of higher quality arrive to the economy.

Baumol (1967), later formalized by Acemoglu and Guerrieri (2008), first suggested that capital deepening can also induce unbalanced growth across sectors. To date, there are no systematic measures of the impact of capital deepening on structural transformation across countries. Dennis and Iscan (2009) evaluate the role of capital deepening for the reallocation of workers out of agriculture in the last two centuries in the US. The feature that generates unbalanced growth in response to capital deepening in these papers is the disparity in the share of capital across sectors.

This paper advances the literature in two dimensions: a) by exploring the role of capital-embodied technology adoption (quality) for structural transformation, and b) by arguing that an additional feature that generates unbalanced cross-sectorial growth as higher quality capital arrives to the economy, is the disparate complementarity between capital and labor across sectors.

Formally, we study a multisector vintage capital model where heterogeneous workers are assigned to different sectors and vintages of machine. Workers are heterogeneous in their efficiency units of labor, their education and their complementarity with vintages of capital. Each workers draw a vector of efficiency units associated to each capital-vintage and sector from a Frechet distribution, in the tradition of McFadden (1974) and Eaton and Kortum (1992). We assume that newer cohorts of workers are more complementary to vintages of capital introduced to the economy when such a cohort hit working age than any other vintage in the economy. Each period, workers assign themselves to different vintages and sectors following their comparative advantage. At the same time, households decide how much to consume of the goods produced in agriculture and non-agriculture, which vintages of capital to purchase and how much capital to accumulate of each available vintage.

We characterize the optimal allocation of workers to vintages, as well the price of capital in the economy. We show that, as standard in the literature on capital-embodied technology adoption Greenwood et.al. (1988), the inverse of the relative price of investment to consumption pins down the rate of change in the quality of newer stocks. We also show that the return to labor in each sector depends endogenously on the allocation of workers, as well as on the pattern of capital-labor complementarities of different cohorts of workers.

To bring the model to the data, we use data on labor shares and average labor returns (wages) in agriculture and non-agriculture from IPUMS. The identification of the complementarity patterns is key to our exercise. Given our assumptions on the pattern of complementarity and absent any frictions, a worker is assigned to the best vintage of capital available at the time in which his cohort hit the labor market. The allocation of workers of a given educational group to sectors and vintages pins down the average efficiency units in production for each vintage-sector. In addition, for a given vintage, the probability of a worker-education group to be assigned to a sector pins down the efficiency units in production across educational groups. Given the random arrival of the vector of worker efficiency

by sector and vintage, the probability of assignment maps one-to-one to the share of workers in that sector vintage. We use data on wages to calibrate the distribution of talent across cohorts and sectors.

We present reduced form evidence in line with the predictions of the model. In particular, we measure the rate of capital-embodiment using data from Penn World Tables on the price of consumption relative to the price of investment. We show that, across countries, the share of workers in agriculture is lower in countries with higher education of their labor force and higher rate of capital-embodied technology adoption. This is consistent with the pattern of complementarity between labor and capital vintages uncovered by our identification and the predictions of the model in terms of capital deepening.

In our paper, the main exercise consists on computing the allocation of workers in the agricultural and non-agricultural sectors predicted by the model to match the path of labor allocation observed in the data. Then we use the model to understand what is the role of capital embodied technology adoption and capital-skill complementarities for the dynamic of wage gaps, labor reallocation and ultimately, labor productivity.

The closest paper to ours is Burstein, Morales and Vogel (2017) who characterize a static allocation of workers to different type of capital. Relative to theirs, we study an environment with a non-trivial capital accumulation dynamic with multiple assets. This feature is key to uncovering the role of capital-embodied technology adoption (a form of capital deepening) for labor reallocation and wage gaps across sectors.