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Research Statement

My research interests: Empirical Industrial Organization, Applied Microeconometrics.

My research in empirical industrial organization and applied microeconometrics studies firm productivity, technology adoption, and market power. I develop and apply econometric methods to distinguish changes in production efficiency from changes in pricing behavior when firms choose inputs using information unavailable to researchers. My empirical work focuses on digital adoption in manufacturing and productivity dynamics in banking; my methodological work addresses production-function identification, causal mechanisms, and heterogeneous treatment effects.

Job Market Paper: Digitalization, Productivity, and Market Power

My job market paper, **"Digitalization, Factor-Biased Productivity, and Market Power"** (with Subal C. Kumbhakar), asks how digitalization changes labor-augmenting productivity, Hicks-neutral productivity, and markups. Separating these channels distinguishes advances in production technology from changes in pricing power.

The labor productivity concept in this paper is *labor-augmenting productivity*: the efficiency of labor due to technical change, which increases the productive services obtained from a given number of labor hours. It is distinct from output per worker or hour. Hicks-neutral productivity scales output for a given bundle of effective inputs, including effective labor. A restricted translog production function identifies both components from input choices and productivity transition equations. A price-taking benchmark establishes the decomposition; an imperfect-competition extension allows for markups. The ratio of the labor and materials first-order conditions removes the common markup. Additional dynamic restrictions allow productivity and markup dynamics to be studied jointly.

I use the Encuesta Sobre Estrategias Empresariales (ESEE), an annual panel of Spanish manufacturing firms, over 2000–2019. A thirteen-variable index covers IT technologies, digital human capital, automation, and technologies for interacting with customers and suppliers. Digital human capital is measured using a stock constructed from external expenditure on employee training in computing and IT. Labor is measured in total hours worked, and firm-specific price indices deflate output and materials. The pooled price-taking benchmark uses 17,087 firm-year observations from 2,213 firms, with coverage varying across specifications. Interpreting recovered labor efficiency as technical change relies on the model's identification assumptions; hours measure labor quantity but do not separately identify worker effort.

Lagged digitalization is positively associated with both productivity components in the price-taking benchmark, with stronger labor-augmenting gains among small firms. Digital human capital, IT technologies, and automation have positive labor-augmenting associations in several samples. Allowing for imperfect competition preserves the positive overall labor-augmenting association. The overall markup coefficient is small and positive, and significantly lower in high-digital than in low-digital industries; the negative estimate in high-digital industries is not individually significant. These findings distinguish changes in production technology from changes in pricing behavior.

Productivity and Industry Dynamics in Banking

In **"The Scale–Technology Paradox: Technological Progress and Productivity Decline in Nigerian Banking"** (with Subal C. Kumbhakar; published in *Economic Modelling*, 2026, article 107859), I examine why technological modernization and consolidation need not translate into higher productivity. Banks produce loans and investments using common resources, so a single-output production function can miss important features of their technology. The paper estimates a multi-output input distance function with a control-function approach grounded in cost minimization. This framework accommodates endogenous input choices and separates productivity change from technical change without requiring input price data.

Using annual data for seventeen Nigerian commercial banks over 2000–2023, we estimate an average annual productivity decline of 3.5 percent, with larger and internationally licensed banks experiencing steeper declines. At the same time, technical change is cost-reducing and estimated returns to scale average 1.46. Lending is the principal source of cost pressure. These findings document a gap between improvements in production possibilities and realized productivity performance: technological upgrading and consolidation alone may be insufficient to raise productivity. They motivate further investigation of lending efficiency, asset quality, and barriers to realizing scale economies. This project extends my production-function research to a regulated, multi-output industry and informs questions about financial intermediation and banking policy.

Causal Mechanisms and Flexible Econometric Methods

My working paper **"Mediation Analysis in Production Functions with Unobserved Productivity"** (with Subal C. Kumbhakar; under review at *Economics Letters*) studies the channels through which digitalization affects output. I distinguish the direct effect from the indirect effect operating through changes in the quantity of labor used, measured in total labor hours. Conventional mediation methods can misattribute these channels when unobserved productivity affects adoption, labor demand, and output. Correcting the production equation for endogenous inputs alone does not resolve this confounding in the labor-hours equation.

The paper develops a sequential estimator that combines an Ackerberg–Caves–Frazer-style production-function estimator with a labor-hours regression controlling for recovered productivity. It derives direct, labor-mediated, and total effects, including specifications in which treatment interacts with labor. A firm-block bootstrap repeats the estimation stages to account for the generated productivity control. Monte Carlo experiments show that the estimator recovers the effects under the model's assumptions, whereas omitting productivity from the labor-hours equation can substantially overstate the indirect effect. The application uses the Spanish ESEE panel for 2000–2019, with an estimation sample spanning 2001–2019, total labor hours as the mediator, and lagged digitalization as the treatment. The contribution is a framework for studying mechanisms when firms choose the mediator using information unavailable to the researcher.

My published paper, **"Causal Forests versus Penalized Splines for Heterogeneous Treatment Effects"** (with Ivan Korolev and Nency Dhameja, *Economics Letters*, 2026), addresses a complementary question: which flexible methods best recover variation in treatment effects? We compare causal forests with varying-coefficient penalized splines in simulations with randomized treatment assignment. This design isolates the recovery of heterogeneity from the separate problem of adjusting for confounding from nonrandom treatment assignment.

Forests perform best in designs with sharp, localized treatment-effect transitions. Penalized splines generally perform better when heterogeneity is smooth, when the baseline outcome and treatment effect have different structures, and in designs combining continuous, binary, and group-level covariates. As the number of groups rises, regularized group effects help splines remain accurate while forest performance deteriorates. These findings give applied researchers practical guidance about estimator choice and demonstrate the value of matching flexibility to the structure of the empirical problem. They also motivate my ongoing work on methods that preserve economically meaningful quantities rather than optimizing predictive accuracy alone.

Ongoing Work and Future Research

My next projects build on these contributions in two directions. In **"Artificial Intelligence and Spatial Factor-Biased Productivity"** (with Subal C. Kumbhakar), I am extending the digitalization framework to study AI adoption in Spanish manufacturing industries. I examine how adoption changes the relative productivity of inputs within firms and how those changes spread to other firms in the same industry, firms linked through supply chains, and neighboring regions. Knowledge flows, worker mobility, and input-output linkages may transmit gains beyond an adopting firm. I plan to compare exposure measures based on geographic proximity and economic relationships, and use simulations to assess whether the model distinguishes spillovers from common shocks. The empirical design will require measures that identify the AI applications used and the production activities they affect.

In my solo project, **"Regularization in Translog Production Models,"** I evaluate Lasso, Ridge, Elastic Net, principal component regression, and partial least squares as responses to multicollinearity in flexible production models. The central criterion is the accuracy and interpretability of output elasticities, which underpin measures of scale and market power. This project asks when regularization can stabilize economically relevant estimates without distorting the production relationships they are intended to recover.

Over the longer term, I plan to connect heterogeneous treatment-effect methods with production models in which adoption and input choices are jointly endogenous. I also intend to develop diagnostics and sensitivity exercises for the timing, persistence, and exclusion restrictions used to recover latent productivity and markups. My goal is to explain how digital technologies change production efficiency and market power, and how their effects spread across firms and industries, while making the identifying assumptions explicit and assessing the sensitivity of the results.

References

Publications

[1] "Causal Forests versus Penalized Splines for Heterogeneous Treatment Effects," with Ivan Korolev and Nency Dhameja. *Economics Letters*, 268, 113205, 2026. doi:10.1016/j.econlet.2026.113205.

[2] "The Scale–Technology Paradox: Technological Progress and Productivity Decline in Nigerian Banking," with Subal C. Kumbhakar. *Economic Modelling*, 107859, 2026. doi:10.1016/j.econmod.2026.107859. Replication code.

Job Market Paper

[3] "Digitalization, Factor-Biased Productivity, and Market Power," with Subal C. Kumbhakar. Job market paper, September 2026.

Working Papers

[4] "Mediation Analysis in Production Functions with Unobserved Productivity," with Subal C. Kumbhakar. Under review at *Economics Letters*.

Work in Progress

[5] "Regularization in Translog Production Models." Solo-authored.

[6] "Artificial Intelligence and Spatial Factor-Biased Productivity," with Subal C. Kumbhakar.