Multi-Product Production and Markdown Power in U.S. Hospital Care

Extended Research Proposal submitted for the workshop "Production Function Estimation and Its Applications to Industries"

National Bureau of Economic Research, Cambridge, MA, December 5, 2026

Organized by Jan De Loecker, Mert Demirer, and Paulo Somaini

By: Bhakti Patel

Disclosure Statement

The author(s) declare no financial or other conflicts of interest related to this research. No external funding source had any role in the design of the proposed study. This paper does not make, and is not intended to make, any policy recommendation; it is confined to measurement and methodology, consistent with NBER guidelines.

Abstract

Hospitals are multi-product, multi-input firms operating in labor markets that a substantial empirical literature has found to be non-competitive, particularly for registered nurses. Yet the production function and markup literatures have developed largely on manufacturing data, where output is a single homogeneous good and input markets are typically treated as competitive. This paper proposes to estimate a multi-product production function for U.S. general acute-care hospitals, using service-line-level output (medical, surgical, obstetric, and intensive care) rather than a single aggregate admissions count, and to recover from it both markups on hospital services and markdowns in the nursing labor market. Building on recent advances in multi-product production function estimation and on the production approach to measuring monopsony power, we propose to test whether local hospital market concentration is associated with larger markdowns on nursing wages, whether those markdowns vary systematically across service lines, and how much of the

well-documented dispersion in hospital productivity reflects genuine technological differences as opposed to input-market power. The empirical setting (U.S. hospital care) is exactly the kind of non-manufacturing application the organizers have identified as underrepresented in this literature, and the question bears directly on how markdown measurement (a method developed largely for manufacturing labor markets) performs in a multi-product service setting.

1. Motivation and Research Question

Production function estimation began, and for decades remained, an exercise conducted almost entirely on manufacturing plant data, where a single physical output and a small number of tangible inputs make the identification problem tractable. The methodological core of the field (the proxy-variable approach developed by Olley and Pakes and extended by Levinsohn and Petrin and by Ackerberg, Caves, and Frazer) was built and tested in that setting. Two developments now push against the boundaries of that setting in ways this workshop's call explicitly identifies: firms increasingly produce multiple, differentiated outputs rather than one homogeneous good, and the same production-function machinery that recovers markups on the output side can, with a small reinterpretation, recover markdowns on the input side when a firm has wage-setting power over a factor of production.

Hospital care combines both developments in an unusually clean way. A general acute-care hospital does not produce a single output; it produces medical admissions, surgical admissions, obstetric deliveries, and intensive care episodes side by side, using overlapping but not identical bundles of nursing labor, physician time, and capital. And the market for one of its central inputs, registered nurse labor, is one of the most extensively documented examples of employer wage-setting power in the applied labor economics literature, with estimated short-run labor-supply elasticities to an individual hospital as low as 0.1, an order of magnitude below what a competitive labor market would imply. This proposal asks a question that sits at the intersection of these two facts and that, to our knowledge, has not been addressed with modern multi-product production function methods: how much monopsony power do hospitals exercise over nursing labor once output is properly measured at the service-line level rather than aggregated into a single admissions count, and does that power vary by service line in a way that a single-output model would necessarily miss.

The question matters for measurement reasons independent of any policy conclusion. If nursing labor is allocated across service lines in ways correlated with unobserved productivity (an intensive care unit under strain draws nurses from medical wards, for instance), then a single-output production function that ignores this reallocation will misattribute output changes to productivity when they in fact reflect input reallocation across products the firm is not separately reporting. This is precisely the input-allocation problem that the recent multi-product production function literature has identified as a first-order source of bias in single-output studies applied to genuinely multi-product firms, and hospitals are as clear a case of a multi-product firm as exists outside of manufacturing.

2. Relation to Existing Literature

This proposal connects to three strands of work the workshop call names directly: methodological advances in multi-product production function estimation, the integration of production analysis with markups, markdowns, and imperfect competition, and applications of these methods to industries other than manufacturing.

On the methodological side, a growing body of work has extended the semi-parametric proxy-variable framework to firms that produce more than one output. Recent NBER work embeds classical index-number results into an Olley-Pakes-style framework to recover firm-product marginal costs and markups when firms produce two or more distinct goods, applying the approach to Belgian and French manufacturing industries. Subsequent work has shown that the input-allocation problem inherent in multi-product settings is more severe than earlier approaches assumed, and has proposed set-identification strategies that do not require researchers to take a stand on how firms allocate shared inputs across products. A recent methodological contribution has also shown that the invertibility assumption underlying the entire proxy-variable approach is itself testable and can fail in imperfectly competitive settings, which is directly relevant to a labor market, like hospital nursing, where the standard competitive-input assumption is known from other evidence to be violated.

On the markup and markdown side, the production approach recovers a firm's price-cost or wage-cost gap directly from estimated output elasticities and observed cost or revenue shares, without needing to observe marginal cost or the wage-setting rule directly. A recent survey of this approach emphasizes both its scalability and its fragility, noting that production-based markup estimates are residuals that absorb

misspecification and data limitations, and calling for closer validation against demand-based and quasi-experimental benchmarks. Independently, a substantial labor-economics literature has used natural experiments and reduced-form labor-supply estimation to document monopsony power in the nurse labor market and its relationship to hospital-system consolidation. These two literatures have developed largely without reference to each other: the production-approach markdown literature has rarely been applied to nursing labor specifically, and the nursing monopsony literature has relied on reduced-form labor-supply elasticities rather than a structural production function. This proposal is designed to bring the two together and, in doing so, to provide an independent, production-based check on the reduced-form monopsony estimates already in the literature.

On applications beyond manufacturing, healthcare has been studied extensively from a cost-function and technical-efficiency perspective in the health-economics literature, including hospital-level Cobb-Douglas estimates going back decades, but this literature has generally used single-output measures, such as total inpatient admissions, and has rarely engaged with the modern proxy-variable identification strategy or with markdown measurement. The workshop's explicit interest in applications to healthcare, together with its interest in multi-product methods and in markups and markdowns, describes almost exactly the gap this proposal is positioned to fill.

3. Conceptual Framework

We propose to model each hospital as producing a vector of service-line outputs (medical, surgical, obstetric, and intensive care) using shared and product-specific inputs: registered nurse hours, physician hours, non-clinical labor, beds, and other capital. Following the multi-product extension of the proxy-variable approach, hospital-level unobserved productivity is allowed to vary by service line and to be freely correlated with input use, and we do not impose an a priori rule for how nursing hours are allocated across service lines when only hospital-level nurse staffing totals are observed, instead using the set-identification approach developed in this literature to bound the resulting elasticities rather than assume away the allocation problem.

Given estimated output elasticities with respect to nursing labor, the production approach allows recovery of the wedge between the marginal revenue product of nursing labor and the wage the hospital actually pays, the markdown, from the observed nursing-labor cost share and the estimated elasticity, under the standard

cost-minimization first-order condition extended to a wage-setting employer. The framework predicts that this markdown should rise with local hospital-market concentration in the market for RN labor, should be attenuated in service lines where nursing skill is less transferable across hospitals within a local market, and should be larger, all else equal, in the service lines identified in prior monopsony work as most affected by consolidation.

4. Data and Empirical Strategy

The empirical work will use hospital-level cost report data from the Centers for Medicare and Medicaid Services Healthcare Cost Report Information System, which reports labor expenses, staffing, and discharges broken out by major service line for the universe of Medicare-participating U.S. hospitals, matched to the American Hospital Association Annual Survey for facility characteristics and to Hospital Compare and state discharge databases for service-line-level case volume and case mix. Local labor-market concentration in the RN labor market will be constructed following the approach used in the nursing-monopsony literature, based on commuting-zone-level Herfindahl indices of hospital employment shares, and will be interacted with the estimated markdowns rather than used as a direct explanatory variable for wages, so that the exercise tests whether the production-based markdown estimate recovers the same concentration relationship that reduced-form labor-supply estimates have already documented.

Production function parameters will be estimated using the multi-product proxy-variable approach described above, with hospital investment or an intermediate-input proxy serving as the proxy variable for unobserved productivity, and standard errors clustered at the hospital level with block bootstrap to account for the multi-step estimation procedure. As a validation exercise, we propose to compare the production-based markdown estimates against the reduced-form labor-supply elasticities available from the hospital-consolidation natural-experiment literature, in the spirit of the validation exercises recommended in the recent production-approach survey, and to report both approaches side by side rather than treating either as ground truth.

As with any proposal of this kind, the analysis described here has not yet been carried out in full; the data sources are public and have supported closely related work, and the identification strategy draws directly on published methodological results, but the service-line-level multi-product estimates for the U.S. hospital sector do not yet exist in the literature and would constitute the paper's principal empirical contribution.

5. Stylized Facts Motivating the Proposal

The building blocks behind this proposal are independently well established even though they have not been combined. Estimates of the short-run elasticity of RN labor supply to an individual hospital, obtained from a Veterans Affairs wage natural experiment, have been found to average around 0.1, an elasticity consistent with substantial wage-setting power and far below what a competitive labor market would generate. Separately, research using variation in hospital-system consolidation intensity across metropolitan areas has found that increased consolidation is associated with slower wage growth for registered nurses, a highly unionized professional occupation whose real wages were largely stagnant over a multi-decade period despite rising demand for care. On the production side, recent multi-product production function work applied to manufacturing has shown that treating a genuinely multi-output firm as if it produced a single good measurably distorts estimated input elasticities and the marginal costs and markups derived from them, with the bias large enough to change conclusions about whether outputs are complements or substitutes in production. Hospitals, where service lines share nursing staff, beds, and physician time to varying degrees across medical, surgical, obstetric, and intensive care admissions, are a natural setting in which this same distortion should be expected to operate, and one that the modern methodological toolkit has not yet been used to examine.

6. Expected Contribution

The completed paper would offer a methodological contribution and an empirical one, both squarely within the workshop's stated interests. Methodologically, it would be among the first applications of the multi-product proxy-variable framework outside of manufacturing, and the first, to our knowledge, to use that framework specifically to recover input-side markdowns rather than only output-side markups, extending the production approach to a setting where both output heterogeneity and input-market power are present simultaneously. Empirically, it would provide a structural, production-based counterpart to the reduced-form nursing-monopsony literature, allowing a direct comparison between two independently developed empirical approaches to the same underlying labor market, and would document how much of the substantial measured dispersion in hospital productivity is attributable to genuine technological heterogeneity across service lines as opposed to input-market power that a single-output specification would misclassify as a productivity difference.

Consistent with NBER guidelines for this workshop, the paper is designed as a measurement and methodology contribution and will not offer policy recommendations regarding hospital regulation, antitrust enforcement, or wage policy; any discussion of consolidation or labor-market concentration in the completed paper will be confined to its role as an explanatory variable for the estimated production parameters.

References

Ackerberg, D., Caves, K., and Frazer, G. (2015). Identification Properties of Recent Production Function Estimators. Econometrica, 83(6), 2411–2451.

Allegretto, S. and Graham-Squire, D. (2023). Monopsony in Professional Labor Markets: Hospital System Concentration and Nurse Wage Growth. Institute for New Economic Thinking Working Paper.

Dhyne, E., Petrin, A., Smeets, V., and Warzynski, F. (2022). Theory for Extending Single-Product Production Function Estimation to Multi-Product Settings. NBER Working Paper No. 30784.

Doraszelski, U. and Li, L. (2025). Production Function Estimation without Invertibility: Imperfectly Competitive Environments and Demand Shocks. Working Paper.

Fernald, J., Gandhi, A., Ruzic, D., and Traina, J. (2025). Micro and Macro Perspectives on Production-Based Markups. Federal Reserve Bank of San Francisco Working Paper 2025-20.

Levinsohn, J. and Petrin, A. (2003). Estimating Production Functions Using Inputs to Control for Unobservables. Review of Economic Studies, 70(2), 317–341.

Olley, G. S. and Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. Econometrica, 64(6), 1263–1297.

Scholz, N. (2025). Estimating Multi-Product Production Functions: What Can We Learn Without Demand Assumptions? Job Market Paper, University of Warwick.

Staiger, D., Spetz, J., and Phibbs, C. (2010). Is There Monopsony in the Labor Market? Evidence from a Natural Experiment. Journal of Labor Economics, 28(2), 211–236.