Shipment Networks and Market Power in U.S. Poultry Procurement

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Abstract

How do market power and geography shape the cost of supply-chain shocks in U.S. poultry procurement? Linking Commodity Flow Survey records to Census establishment microdata, I estimate a random-coefficients nested logit demand model with multi-product Bertrand competition on the supply side. Wholesale buyers are roughly three times as price sensitive as food-service buyers, and shipment distance raises marginal cost while lowering differentiated-product demand. In the counterfactual exercises, an industry-wide raw-poultry cost shock lowers total surplus by 17.7 percent, while localized plant shutdowns reduce total surplus by 4.8 percent, with losses concentrated in exposed destinations. A merger between the third- and fourth-largest firms converts 59 percent of downstream buyers' losses into deadweight loss.

JEL Codes: C45, C51, L13, L66, Q13, R41.
Keywords: differentiated-products demand, machine learning, markups, merger simulation, poultry shipments, procurement, transportation frictions.

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1 Introduction

U.S. poultry markets have drawn sustained attention from competition authorities and supply-chain planners. For example, in 2022, Cargill and Continental Grain acquired Sanderson Farms, then the third-largest U.S. broiler processor, and combined it with Wayne Farms to form a new third-largest firm (Cargill, 2022). The transaction closed under a Department of Justice consent decree, and the same segment of the industry remains under active federal scrutiny: the Department of Justice's suit against the information firm Agri Stats concerns processors' exchange and benchmarking of competitively sensitive downstream sales information (U.S. Department of Justice, 2023), and private antitrust litigation alleges coordinated supply restrictions over much of the sample period (In re Broiler Chicken Antitrust Litigation, 2016). Tornadoes and hurricanes have repeatedly idled processing plants across the Southeast, and disease outbreaks periodically remove capacity with little warning. Evaluating either consolidation or disruption requires quantitative answers to the same questions: how easily do downstream buyers substitute across plants and products, how much pricing power do processors hold over those buyers, and who bears the losses when part of the supply network fails? However, the relevant segment of the supply chain—shipments from processing plants into wholesale and retail channels that ultimately serve food-service establishments and households—is nearly invisible in standard data sources.

This paper studies that segment using restricted-use Census microdata and asks how market power and geography jointly determine the welfare cost of supply-chain shocks in U.S. poultry procurement. The setting is downstream procurement rather than household retail choice: buyers in a destination county source poultry from competing origin establishments and product categories. Products are establishment–commodity pairs, and markets are destination-county-year cells. This adapts the differentiated-products framework of Berry (1994) and Berry, Levinsohn, and Pakes (1995) to freight microdata, where differentiation comes from plants, geography, shipment attributes, and commodity class.

The empirical foundation links Commodity Flow Survey (CFS) shipment records to Census establishment microdata. I use CFS records to construct a poultry shipment network. I assign ambiguous processor-origin shipments conditional processor-to-retailer or processor-to-wholesaler labels with a random forest algorithm trained on channel labels derived from Longitudinal Business Database (LBD) destination composition. Wholesaler-origin shipments are assigned a pooled downstream-distribution label by construction. The resulting cell-level network measure, ToW, enters demand as a wholesale-channel share. I then use LBD food-service, retail, and wholesale establishments to build market-specific representative buyer records, so that the demand system can reflect each market's downstream buyer mix. The structural model estimates random-coefficients BLP demand with product-category nests and buyer-type-specific price sensitivity, recovers marginal costs under multi-product Bertrand pricing, and simulates plant-unavailability, distance, input-cost, and ownership shocks.

Three findings characterize baseline competition. First, procurement demand is elastic, with an average own-price elasticity of about -3.1. Shipment distance matters through two channels: it raises recovered marginal cost for all products, and it lowers mean utility for differentiated products. For commodity broilers, the demand-side penalty nets out, so geography operates through the cost channel alone. Second, buyer composition matters. The estimates imply that retail buyers are about twice as price sensitive as food-service buyers, while wholesale buyers are about 3.3 times as price sensitive. Because receiver-level choices are not observed, this heterogeneity is model-based and is identified from the covariation between market demand and each market's calibrated buyer mix. This ranking is consistent with, but does not identify, an institutional interpretation in which merchant wholesalers monitor quotations across suppliers more readily, whereas food-service demand is more insulated by menus and product specifications. Third, recovered price–cost margins average roughly 33 percent of the unit value, close to the level implied by the demand elasticity alone. Multi-product ownership adds a modest average markup increment but pricing power is concentrated in markets where firm portfolios overlap.

The counterfactuals quantify four distinct adjustment channels. Removing the products of a weather-exposed set of processing counties lowers total surplus by 4.8 percent, and a logistics shock that increases effective shipment distance by 20 percent lowers it by 4.6 percent. In both cases buyers partially reallocate toward unaffected plants, and losses concentrate in the most exposed destinations. An industry-wide 20 percent raw-poultry cost increase, which reaches every supplier, lowers total surplus by 17.7 percent. Because the four shocks differ in primitive scale, these figures should be interpreted as policy-relevant scenario comparisons rather than as measures of the intrinsic value of spatial substitution. They rank the welfare consequences of distinct mechanisms, not the value of substitution itself. A merger of the third- and fourth-largest firms leaves cost primitives unchanged but raises average unit values by about 7 percent. Downstream buyers lose \$6.53 billion, of which \$2.70 billion is transferred to producers and \$3.83 billion, or 59 percent, is deadweight loss. This scenario approximates the 2022 Sanderson–Wayne consolidation that opens the paper, which the Department of Justice addressed through a consent decree rather than a merger challenge (U.S. Department of Justice, 2022). The decomposition therefore speaks directly to the types of transactions that merger review in this industry is likely to confront.

Two boundaries clarify what the exercise measures. First, the market power estimated here is seller-side: the pricing power of multi-plant processing firms over their downstream buyers. It is the complement of the buyer power studied on the other side of the processing bottleneck. Recent structural work on beef packing estimates oligopsony markdowns in fed-cattle procurement while treating the downstream wholesale price as externally determined (Garrido et al., 2024; Moschini and Smith, 2026). Related work in agricultural economics examines production contracts and the integrator–grower relationship (Vukina, 2001; MacDonald, 2014). This paper supplies the sales side analysis that those studies hold fixed. In poultry, this side of the market is the natural object of study. Because 97 percent of broilers are grown under contract and no live-bird spot market exists, live birds move to processing plants through internal transfer pricing (Weng, Vukina, and Zheng, 2015). The upstream price interface modeled in beef is therefore largely internalized within the integrator, and the industry's main competitive interface sits downstream at the plant gate. In this paper, the upstream grow-out relationship enters only as motivation for the plant-unavailability scenario. Relatedly, the static Bertrand–Nash model of FOB-plant unit values should be interpreted as a benchmark conduct model. The pricing institutions behind this benchmark (Subsection 2.2) are important. Much poultry commerce relies on formula contracts indexed to wholesale quotations or on recurring negotiated agreements, so competitive conditions can be reflected in transaction prices at the model's annual frequency. Quantity commitments and bilateral bargaining with large buyers remain outside the model. The recovered margins should therefore be interpreted as summaries of average pricing incentives rather than a measure of transaction-level conduct. Second, the CFS records shipments to destination locations, not household purchases. The demand side is downstream procurement demand, and buyer surplus below is downstream-buyer surplus, not household consumer surplus.

The paper contributes to three strands of work. First, it contributes to the empirical industrial organization of differentiated products by showing that freight microdata can support a complete demand-and-supply system. Relative to spatial pricing studies built on plant-level shipments (Miller and Osborne, 2014) and to the merger-simulation tradition (Nevo, 2000b; Miller and Weinberg, 2017), the paper defines procurement markets using observed shipment links, plant costs, and buyer-composition heterogeneity. The closest structural analog is Wollmann (2018), who combines buyer-type demand heterogeneity with multi-product Bertrand supply for commercial trucks using vehicle registrations and list prices. In contrast, this paper estimates the system using observed shipment-level transaction values. To my knowledge, it is the first complete demand-and-supply system for the processor-to-buyer segment of a major U.S. meat industry. The closest data antecedent is Ganapati (2025), who combines related Census freight and establishment linkages to explain the rise of large wholesalers across manufacturing. This paper uses similar data infrastructure to study how food manufacturers price to heterogeneous downstream buyers. In method, Moschini and Perry (2026) provide a related precedent, recovering differentiated-products Bertrand pricing from micro-level purchase data in seed markets.

Second, the paper contributes to the agricultural-economics literature on imperfect competition in food markets (Sexton, 2013; Çakır and Balagtas, 2012) and vertical relationships in the food chain (Villas-Boas, 2007; Bonnet and Dubois, 2010). Recent structural work estimates oligopsony markdowns in cattle procurement (Garrido et al., 2024; Moschini and Smith, 2026) or decomposes meatpacking margins using production-function methods (Azzam, Jaumandreu, and Lopez, 2025). All of these approaches treat the downstream sales side as exogenous or aggregate, and the production-function approach recovers product-market power only as a scalar residual. This paper adds a downstream demand system at the plant-to-buyer segment, where merger review, the Packers and Stockyards rulemaking agenda, and federal information-exchange litigation are directly relevant (U.S. Department of Agriculture, Agricultural Marketing Service, 2024; U.S. Department of Justice, 2023).

Third, the paper contributes to work on supply-chain disruption, by complementing reduced-form evidence on shock propagation (Barrot and Sauvagnat, 2016; Boehm, Flaaen, and Pandalai-Nayar, 2019; Carvalho et al., 2021) and recent theory on how network structure shapes disruption losses (Elliott and Jackson, 2025) with an equilibrium framework in which the same network that transmits shocks also disciplines market power. The model therefore links the welfare costs of disruptions to both geography and strategic pricing. The business-to-business shipment unit also connects the paper to work on production networks and firm-to-firm linkages (Acemoglu et al., 2012; Atalay et al., 2011; Bernard, Moxnes, and Saito, 2019) and on vertical integration and input flows (Atalay, Hortaçsu, and Syverson, 2014). Machine learning enters as a data-construction tool for recovering unobserved shipment channels, in the sense of Mullainathan and Spiess (2017).

The rest of the paper proceeds as follows. Sections 2 and 3 describe the market setting, data, network classification, and representative-buyer construction. Section 4 presents the model and identification strategy. Sections 5 and 6 report estimates and counterfactuals. Section 7 discusses limitations and concludes.

2 Institutional Background and Market Definition

2.1 Poultry Shipment Channels

Poultry products move through a spatial supply chain that links processing plants, wholesalers, retailers, food-service buyers, and final consumers. I use the notation P for poultry processors, W for wholesalers, R for retailers, F for food-service establishments, and H for household final demand. The empirical CFS network focuses on three directed shipment channels: processor-to-retailer (PR) links, processor-to-wholesaler (PW) links, and wholesaler-origin downstream-distribution links, retained under the legacy label WR. The last category pools shipments from wholesalers to retail and food-service destinations; it is not the separately calibrated $W \to R$ edge in Figure 1. Distinguishing these links matters because wholesale and retail channels differ in shipment size, distance, inventory behavior, and likely substitution opportunities. A shipment from a processor to a wholesaler is not economically equivalent to a shipment from the same processor directly to a retailer, even if the commodity code is the same.

Poultry products are also differentiated by commodity form, processing technology, temperature-control requirements, origin plant, and destination. Fresh and chilled poultry shipments differ from frozen shipments because cold-chain constraints, delivery timing, and inventory management differ across these forms. Distance can therefore affect demand through delivery reliability and product quality as well as through marginal cost. This emphasis on delivery timing is consistent with trade evidence that time in transit can itself operate as a trade barrier (Hummels and Schaur, 2013). In a freight dataset, these demand and cost channels are observed through FOB-plant shipment unit values, weights, and distances rather than through scanner-level retail choices.

Figure 1 provides a stylized, flow-conserving accounting benchmark for domestic geographic distribution, separate from the CFS objects constructed in Section 3. I normalize in-scope domestic processor flow to 100 and exclude exports. A National Chicken Council processor survey reported distributor shares of 28.5 percent in both 2007 and 2009 and retail-grocery shares of 25.3 and 26.6 percent; conditioning on these two first-stop categories and averaging across the two years gives 52.3 percent PW and 47.7 percent PR, shown as 52 and 48 (MEAT+POULTRY, 2010).

USDA ERS reports similar broad at-home versus away-from-home poultry splits in 2007–08 and 2013–16 (Lin et al., 2016; Lin, 2020). The detailed 2013–16 shares allocate 12.9 percent to restaurants, 24.7 percent to fast food, and 54.9 percent to at-home use; conditioning on these retained categories places the narrower commercial food-service endpoint—used here as the closest public proxy for NAICS 7225—at 40.6 percent and at-home demand at 59.4 percent. I use the round-number benchmark 40:60. Under the maintained geographic-routing convention, all food-service-bound product passes through a W distribution node even when F orders from P. Hence $W \to F = 40$, $W \to R = 12$, and $R \to H = 60$ follow by flow conservation; they are not three additional independent estimates.

Figure 2 places these channels on the map. Broiler production is concentrated in a Southeastern belt: in 2017 the five largest producing states—Georgia, Arkansas, North

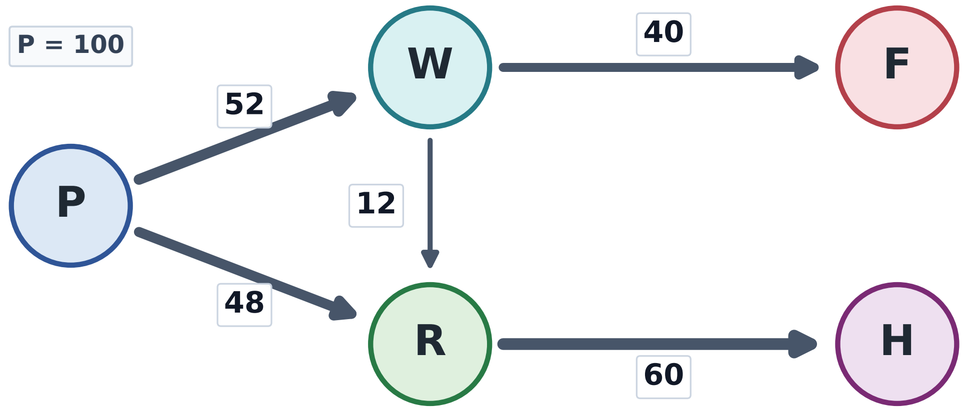

Figure 1: Stylized Calibration of Domestic Poultry Distribution Flows

Notes: P, W, R, F, and H denote processors, wholesalers and their distribution stage, retailers, commercial food service, and household demand. Edge labels are normalized domestic-flow units with $P = 100$, not pounds. Under the maintained routing convention, no separate $P \rightarrow F$ or $R \rightarrow F$ edge is included; exports are excluded, and losses and inventory changes are abstracted from. This is a stylized external accounting calibration, not an estimate from CFS microdata. In the CFS, household demand is unobserved and WR pools wholesaler-origin downstream shipments; consequently, 52:48 is not directly comparable to record counts or the simple across-market mean of ToW.

Carolina, Alabama, and Mississippi—accounted for 58 percent of U.S. broiler production by live weight (U.S. Department of Agriculture, National Agricultural Statistics Service, 2018). Demand is dispersed. Ranked by disclosure-cleared baseline inside sales summed over the three survey years, the ten largest destination states in the estimation sample of Section 3 take two-thirds of inside sales; they include California, Texas, New York, Pennsylvania, Illinois, Virginia, and Florida as well as Georgia, Arkansas, and Alabama, which both raise and receive large volumes. The wholesale hubs through which much of this product is redistributed—eight terminal-market cities covered by USDA Agricultural Marketing Service market news, from Hunts Point in New York to Los Angeles—all lie inside a top-ten destination state (U.S. Department of Agriculture, Agricultural Marketing Service, n.d.). Poultry procurement is therefore a shipping problem: product raised in a handful of Southern states must reach buyers across the country, often through a small number of distribution hubs, and shipment distance, channel, and ownership are the margins along which the model below lets competition operate.

2.2 Pricing Institutions in Poultry Procurement

How poultry is priced matters for how competition should be modeled. Contemporaneous public materials describe a thin spot layer alongside a much larger agreement-based layer. A 2016 private antitrust complaint characterizes 10–20 percent of broiler output as spot

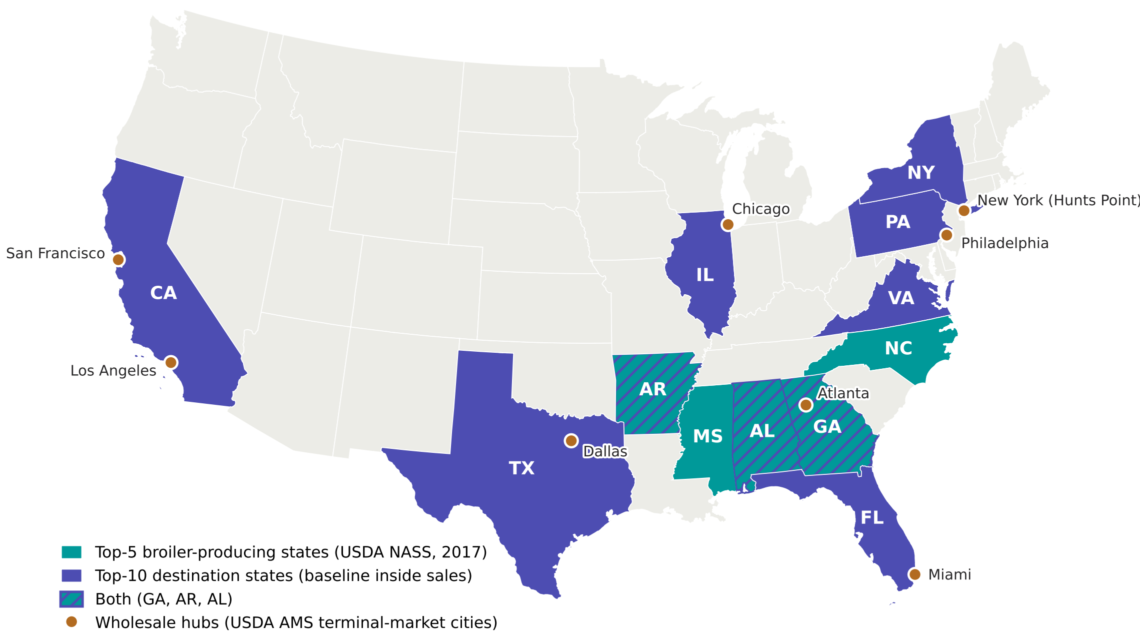

Figure 2: Broiler Production Belt, Largest Destination States, and Wholesale Hubs

Notes: Teal states are the five largest broiler-producing states in 2017 by live weight (Georgia, Arkansas, North Carolina, Alabama, and Mississippi; 58 percent of the U.S. total), from USDA NASS (U.S. Department of Agriculture, National Agricultural Statistics Service, 2018). Indigo states are the ten largest destination states by disclosure-cleared model-implied baseline inside sales in the estimation sample, summed over 2007, 2012, and 2017 (Georgia, Texas, California, Arkansas, Florida, Virginia, New York, Alabama, Illinois, and Pennsylvania; 66 percent of inside sales including the Rest of America aggregate). Hatched states belong to both groups. Dots mark eight USDA Agricultural Marketing Service terminal-market cities: New York (Hunts Point), Philadelphia, Atlanta, Miami, Chicago, Dallas, Los Angeles, and San Francisco (U.S. Department of Agriculture, Agricultural Marketing Service, n.d.). The map shows the contiguous United States in an Albers equal-area projection. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

sales, 50–70 percent as sales under customer contracts, and 17–20 percent as exports (In re Broiler Chicken Antitrust Litigation, 2016, para. 84). Because this paper studies domestic transactions, a midpoint normalization within the first two categories gives a rough spot-to-nonspot volume benchmark of 15 : 60, or approximately 1 : 4. This is a range-based calibration rather than an official national time series, and "nonspot" is used here as an umbrella for recurring customer agreements, whether short- or long-term. The thinner spot layer chiefly covers surplus commodity loads sold for prompt delivery; wholesalers and traders participating in that layer can redirect purchases across suppliers on short notice. In the paper's channel notation, this price-discovery layer is represented primarily by PW transactions, without implying that every PW shipment is spot or every PR shipment is nonspot.

The small volume of the spot layer does not imply a small pricing role, and nonspot does not mean fixed-price. Sanderson Farms reported that prices under many long-term customer contracts fluctuated with quoted commodity prices, that realized prices commonly incorporated customer-specific discounts to those quotations, and that the choice of pricing benchmark was largely customer driven; it also reported that these agreements generally did not commit either party to a fixed quantity (Sanderson Farms, 2017). Wayne Farms similarly reported that most of its revenue arose under agreements whose formulas referenced Urner Barry prices, with fresh-chicken prices linked to daily, weekly, or monthly quotations plus or minus a negotiated adjustment (Wayne Farms, 2015). Urner Barry is therefore a price-reporting benchmark rather than a trading exchange: quotations formed in the spot layer provide price discovery, while indexation and recurring bids or negotiations transmit that signal into a much larger nonspot segment. At the annual frequency used below, a buyer's transaction price is not predetermined merely because the purchase occurs under a supply agreement; it can move with the benchmark and with renegotiated discounts or markups. This is a substantive contrast with beef, where mandatory livestock price reporting underpins both the public price series and the recent structural literature on packer conduct (Adjemian et al., 2016; Garrido et al., 2024). Poultry is thus a test case for measuring market power in a major meat industry without mandatory reporting, and the restricted-use shipment microdata provide transaction-level geographic detail absent from public aggregate series. Section 4 returns to these institutions when motivating the model's conduct assumption.

2.3 Structural Procurement Markets

The structural model defines products as establishment–commodity pairs and markets as destination-county-year procurement markets. This market definition differs from the descriptive ZIP-code network. The ZIP-code network is used to document the upstream shipment structure, classify PR and PW channels, and construct network-based variables such as ToW. The BLP demand and supply model then aggregates to destination counties because the structural choice set must contain multiple competing processor-origin products serving the same downstream procurement market.

This distinction is important for interpretation. The descriptive network asks how poultry shipments are organized across ZIP-code links and downstream channels. The structural model asks how destination-county buyers substitute among competing establishment–commodity products and how firms price those products under common ownership. The two pieces are therefore complementary: the network provides channel and geography information, while the BLP model turns that information into demand, markup, and welfare objects.

The poultry industry is organizationally distinctive. Broiler production has long relied on vertical coordination between growers, integrators, and processing establishments, and processing firms often operate multiple establishments (Martinez, 1999; Vukina, 2001; MacDonald, 2008). Concentration has also risen steadily: in Census of Manufactures data, the four-firm concentration ratio of broiler processing climbed from 44 to 59 percent between 1992 and 2007 (Weng, Vukina, and Zheng, 2015), and the 2022 Sanderson–Wayne transaction subsequently combined the industry's third-largest producer with a mid-sized rival (U.S. Department of Justice, 2022). Poultry nevertheless remains the least concentrated of the major U.S. meat industries—four-firm ratios in beef packing exceed 80 percent—which makes it a setting where market power must be measured rather than presumed from structure alone. More broadly, modern agricultural markets often combine product differentiation, vertical coordination, and concentration, so market power cannot be evaluated from atomistic textbook assumptions alone (Sexton, 2013). These features imply that pricing incentives may depend on both plant-level cost conditions and firm-level ownership links. A multi-plant firm selling more than one poultry product into the same destination market internalizes some substitution across its own products when setting prices, while rival-owned plants do not.

The upstream grow-out side is also not a spot market for live birds. Broiler production is organized through production contracts in which integrators supply chicks, feed, veterinary services, technical assistance, catching, and live-haul services, while growers provide housing capital, labor, utilities, and day-to-day husbandry (MacDonald, 2014; Vukina, 2001). USDA survey evidence reports that 97 percent of broilers were raised on contract operations in 2011. The same evidence shows that grower–plant geography is highly local: the mean distance from a grower to the integrator's processing plant was 34 miles, and 90 percent of birds were produced within 60 miles of the plant (MacDonald, 2014). Because growers make long-lived, specialized investments in poultry houses and usually face only a few nearby integrators, upstream supply is better viewed as a governed contractual relationship than as an unconstrained spot market. This relationship is itself an active regulatory margin: recent Packers and Stockyards Act rulemaking targets tournament-payment disclosure and grower compensation (U.S. Department of Agriculture, Agricultural Marketing Service, 2023), and the Sanderson–Wayne transaction closed under a consent decree addressing grower pay (U.S. Department of Justice, 2022). Those instruments regulate the upstream boundary of the markets studied here; the downstream sales side, by the USDA's own account, has seen decades of little enforcement attention (U.S. Department of Agriculture, Agricultural Marketing Service, 2024). This institutional structure motivates the focus on weather-exposed poultry-processing and production counties in the plant-unavailability counterfactual: a local disruption can interrupt nearby grower relationships and live-bird flows as well as downstream shipments, although the simulation in Section 6 models only the downstream choice-set consequences.

3 Data

This section describes the linked shipment, establishment, and manufacturing data used to construct the estimation sample. I first define CFS-expanded shipment weights and values. I then describe how processor-origin shipments are assigned to downstream channels, and how these assignments provide the wholesale-channel share used later in estimation. The section then defines products, markets, FOB-plant unit values, quantities, shipment distances, shares, market size, and downstream buyer-composition measures. Appendix B reports additional construction details.

3.1 CFS Shipments and Census Microdata

The Commodity Flow Survey (CFS) is a shipper-based survey conducted jointly by the U.S. Census Bureau and the Bureau of Transportation Statistics. The survey is conducted every five years and provides repeated cross-sectional information on freight shipments originating from selected business establishments. The sampling frame covers establishments in manufacturing, mining, wholesale trade, and selected retail and service industries, together with auxiliary establishments such as warehouses and distribution centers, while excluding several important categories such as farm-origin shipments and imports. Sampled establishments report outbound shipments for assigned one-week periods in each calendar quarter of the survey year, allowing the CFS to capture seasonal variation in freight flows. For each reported shipment, the CFS records commodity type, shipment value, weight, transportation mode, origin, destination, distance shipped, and related shipment characteristics (U.S. Census Bureau, 2025, 2017).

I focus on poultry-related commodities and conduct the analyses using the 2007, 2012, and 2017 waves of the CFS. Poultry shipments are identified using the Standard Classification of Transported Goods (SCTG) commodity codes for fresh or chilled poultry and frozen poultry; live-poultry shipments do not enter the descriptive network or the estimation sample. I use these repeated cross sections to construct poultry shipment networks and compare the geographic structure of poultry flows across survey years.

The CFS reports two distinct weight concepts: the physical shipment weight reported for shipment record s from establishment e, w_{se}^{ship}, and the within-establishment annualization weight used in this paper, $\kappa_{se}^{\text{plant}}$. The latter is the product of five CFS component weights,

$$\kappa_{se}^{\text{plant}} = \kappa_{se}^{\text{ship}} \kappa_{se}^{\text{shipNR}} \kappa_{se}^{\text{quarter}} \kappa_{e}^{\text{quarterNR}} \kappa_{e}^{\text{estAdj}}.$$

The first four components expand usable records to shipments made by the same establishment during its reporting week, quarter, and survey year; the fifth calibrates that establishment's annual estimate to its CFS stratification measure. I do not apply the establishment first-stage sample weight or the nonresponse post-stratification adjustment, both of which would make responding establishments represent other establishments. Thus the expanded quantities retain the identity of the observed establishment. I use "CFS-expanded shipment weight" to mean $\tilde{w}_{se} = \kappa_{se}^{\text{plant}} w_{se}^{\text{ship}}$. Similarly, v_{se} is the reported shipment value, and $\tilde{v}_{se} = \kappa_{se}^{\text{plant}} v_{se}$ is the CFS-expanded shipment value. These expanded weights and values are the building blocks for product-market quantities, FOB-plant unit values, weighted distances, and channel shares below.

I link the CFS shipment records to establishment-level businesses through the Longitudinal Business Database (LBD). The LBD is an annual, longitudinal establishment database constructed from the Census Bureau's Business Register and related administrative records. It covers private, nonfarm employer establishments in the United States and provides longitudinal establishment identifiers, firm identifiers, establishment location, employment, payroll, and industry classification using the North American Industry Classification System (NAICS) (Jarmin and Miranda, 2002). These NAICS codes help identify processors, wholesalers, retailers, and other downstream establishment types.

I use the longitudinal establishment identifiers to follow plants over time and connect CFS shipment records to plant-level characteristics. Firm identifiers group establishments under common ownership and distinguish single-plant firms from multi-establishment firms. For manufacturing establishments, I further merge plant-level information from the Census of Manufactures (CMF) and the Annual Survey of Manufactures (ASM), which provide measures of employment, payroll, inventories, assets, capital expenditures, materials costs, fuel and electricity expenditures, and detailed product-line shipments. Together, these linked datasets characterize poultry shipments by plant scale, input use, cost shifters, product specialization, and firm ownership structure. They also identify when multiple products or shipments in the same destination market are supplied by establishments under common ownership, which is central for modeling multi-product pricing incentives.

On the demand side, I use LBD establishments in destination counties to describe the local downstream business environment, including food-service, retail, and wholesale establishments. Later subsections use these records to measure downstream buyer composition and to help distinguish retail-oriented from wholesale-oriented shipment destinations. I also use county-level wholesale and retail activity from the Annual Wholesale Trade Survey (AWTS) and Annual Retail Trade Survey (ARTS) as auxiliary information on local downstream market capacity (U.S. Census Bureau, 2024a,b). These linked shipment, establishment, and firm records support a demand-and-supply framework with endogenous FOB-plant unit values, plant-level marginal-cost heterogeneity, multi-product ownership, and market-specific downstream buyer composition.

3.2 Classifying Downstream Shipment Channels

Conditional on the maintained two-channel topology, processor-origin shipments are assigned processor-to-retailer labels (PR) or processor-to-wholesaler labels (PW). These are inferred destination-channel labels, not observed receiver identities or unrestricted national channel shares. This distinction matters because PR shipments represent direct service from processors to retail destinations, while PW shipments route product through wholesale intermediaries before reaching downstream markets. The main classification challenge arises because the CFS identifies the destination ZIP code of each shipment but does not report the receiver's establishment identifier. If a destination ZIP code contains both retail and wholesale establishments in the LBD, the shipment cannot be assigned mechanically to either the PR or PW channel.

The PR–PW channel can be assigned mechanically only when the destination ZIP code contains a single eligible downstream establishment type in the LBD. I use these unambiguous cases to construct a labeled sample for classifying ambiguous processor-origin shipments. Specifically, a processor-origin shipment is labeled PW if the destination ZIP contains eligible wholesalers but no eligible retailers in the LBD. Conversely, it is labeled PR if the destination ZIP contains eligible retailers but no eligible wholesalers. This rule yields about 17,000 labeled shipments. I partition these labeled shipments 90–10 into an initial training set and a validation set. On the 90 percent training set, I use ten-fold cross-validation to compare candidate random-forest specifications (Breiman, 2001); I then use the 10 percent validation set to select the hyperparameter specification. After selecting the specification, I refit the final random forest on all labeled shipments and apply it to processor-origin shipments whose destination ZIP codes contain both downstream types. The predictors include shipment weight, shipment value, shipment distance, survey year, shipper NAICS, SCTG code, frozen status, transportation mode, an intrastate indicator, origin state, and destination state.

The classifier is used as a data-construction tool rather than a standalone economic model. Its purpose is to assign ambiguous processor-origin shipments to economically meaningful downstream channels. Following the distinction emphasized by Mullainathan and Spiess (2017), this step is a supervised prediction and measurement exercise: the random forest constructs the shipment-channel variable, while the structural parameters are estimated only after this variable has been assigned. The rounded confusion matrix in Table A1 reports fitted classifications from the final random forest after it has been refit on the full labeled sample. It is therefore not a held-out confusion matrix. The matrix implies approximately 99 percent fitted accuracy and a true-positive rate for PW links of about 92 percent. Accuracy on the 10 percent validation set used during specification selection was about 96 percent, and the other validation-set classification metrics were comparable. The validation cases are shipments to mechanically separable destination ZIP codes; the true labels for ambiguous ZIPs are not observed directly. Applying the fitted classifier to ambiguous destinations therefore assumes that the mapping from observable shipment characteristics to the PR–PW channel is stable between mechanically separable and mixed ZIP codes. The matrix reports approximate, disclosure-rounded counts and is not intended to reconcile exactly with the approximate labeled-shipment total. Wholesaler-origin shipments are assigned the pooled legacy label WR by construction; here WR includes possible retail and food-service destinations and is not the separately calibrated $W \to R$ edge in Figure 1.

The PR–PW classification is aggregated to the product-market level to construct ToW, which measures the importance of the wholesale channel in a given product-market cell. Specifically, ToW_{jm} is defined as the share of CFS-expanded processor-origin shipment weight in product j and market m that is classified as processor-to-wholesaler:

$$ToW_{jm} = \frac{\sum_{s\in(j,m)} \tilde{w}_{se} \mathbf{1}\{s \in PW\}}{\sum_{s\in(j,m)} \tilde{w}_{se}}. \tag{1}$$

Here, $\tilde{w}_{se}$ is the CFS-expanded shipment weight for shipment s. The denominator sums over all processor-origin shipments in the product-market cell, while the numerator restricts the sum to PW shipments. Higher values of ToW_{jm} indicate that a product-market is served more heavily through wholesale intermediaries, whereas lower values indicate greater reliance on direct processor-to-retailer shipments.

In the demand model, ToW_{jm} enters mean utility directly and through an interaction with log distance. The direct term captures differences in downstream buyer composition across markets. The distance interaction allows wholesaler-oriented shipment flows to face a different distance penalty than direct processor-to-retailer flows, reflecting the role of wholesalers in consolidation, inventory holding, and distribution-route networks.

3.3 Poultry Shipment Network

Before estimating the structural model, I construct a descriptive ZIP-code poultry shipment network from CFS shipment records and LBD establishment information. The network documents the spatial organization of poultry flows and summarizes the conditional PR and PW labels together with the pooled wholesaler-origin WR label. It is distinct from the public-source physical-flow calibration in Figure 1 and is not the maintained BLP market definition; the structural model aggregates processor-origin products to destination-county-year procurement markets.

The variable carried from the network into the structural model is the product-market wholesale-channel share ToW_{jm} from (1); the product-market shipment distance d_{jm} is constructed directly from CFS records in Subsection 3.4. Network density, the Herfindahl–Hirschman index (HHI), and directed-edge counts are descriptive statistics only. Appendix B.1 reports the full ZIP-code network construction, and Table A2 reports the disclosure-cleared network summary.

3.4 Products, Markets, Unit Values, and Quantities

The structural estimation retains shipments with SCTG code 05121, poultry fresh or chilled, and SCTG code 05122, poultry frozen. A product j is an establishment–commodity pair: an establishment interacted with one of these two SCTG codes. A market is a destination-county-year cell, indexed by m, with choice set $\mathcal{J}_m$. This definition treats a plant shipping fresh poultry and the same plant shipping frozen poultry as two separate products while preserving the plant identity needed for ownership and cost controls. Only processor-origin shipments enter the estimation sample; wholesaler-origin (WR) shipments appear in the descriptive network but not in the structural choice set, and their volume is part of the residual outside option defined in Subsection 3.5.

Physical shipment weight and the within-establishment annualization weight are distinct variables. For each shipment record, I first multiply the reported shipment weight by $\kappa_{se}^{\text{plant}}$ and then aggregate within product-market cells. Thus product-market quantity, q_{jm}, is measured as expanded shipment weight,

$$q_{jm} = \sum_{s\in(j,m)} \tilde{w}_{se} = \sum_{s\in(j,m)} \kappa_{se}^{\text{plant}} w_{se}^{\text{ship}}. \tag{2}$$

As a scale check, I compare the within-establishment annualized CFS shipment total $\sum_s \kappa_{se}^{\text{plant}} w_{se}^{\text{ship}}$ for the retained poultry scope with the USDA production benchmark for the matched survey years and poultry classes. The retained expanded CFS total is about 85 percent of that benchmark (USDA NASS, various years). This comparison is used only to assess scale: the model quantities remain annualized shipments from observed establishments, not a complete production census.

The CFS instructs respondents to report shipment value net of freight charges and excise taxes, on a free-on-board (FOB) plant basis (U.S. Census Bureau, 2017). Accordingly, the product-market FOB-plant unit value is the expanded-value-to-expanded-weight ratio,

$$p_{jm} = \frac{\sum_{s\in(j,m)} \tilde{v}_{se}}{\sum_{s\in(j,m)} \tilde{w}_{se}}. \tag{3}$$

Equivalently, this is $\sum_s \kappa_{se}^{\text{plant}} v_{se} / \sum_s \kappa_{se}^{\text{plant}} w_{se}^{\text{ship}}$ within the product-market cell. I refer to p_{jm} throughout as the FOB-plant unit value. The structural model treats this measure as the product price, but it does not include separately billed freight charges. The within-establishment annualization weights enter at the shipment level before aggregation, and all monetary variables are converted to constant 2017 dollars before estimation. Shipment distance is aggregated with the same expanded shipment weights,

$$d_{jm} = \frac{\sum_{s\in(j,m)} \text{distance}_s \times \tilde{w}_{se}}{\sum_{s\in(j,m)} \tilde{w}_{se}}. \tag{4}$$

The estimation uses $\log(d_{jm})$.

Plant-level product categories are constructed from CMF product-line information rather than from shipment temperature status. The CMF reports establishment output using detailed NAICS product codes. For poultry processing, these codes distinguish young chickens, processed poultry and small-game products containing at least 20 percent poultry or meat, turkeys, hens and fowl, and other poultry and small game (Weng, Vukina, and Zheng, 2015). In my sample, poultry establishments are highly specialized, so the detailed CMF product code uniquely identifies each establishment's underlying product category. I assign each establishment to one mutually exclusive plant-level category: broiler, processed poultry, or other poultry. This assignment is the source of the broiler and processed-poultry dummy variables used in the demand and supply equations. An establishment can still ship both fresh or chilled and frozen forms of its underlying product. The SCTG code determines only the frozen indicator: code 05122 is frozen and code 05121 is fresh or chilled. Additional plant-level controls include production employment, asset stock, hourly production-worker pay, capital expenditure rate, materials unit cost, supplemental input unit cost, labor unit cost, inventory-to-assets ratio, and indicators for own-slaughter and external-slaughter processing plants. The three unit-cost variables are reported in constant 2017 dollars per pound. Appendix C provides variable definitions.

3.5 Market Size and Shares

Market size converts CFS-expanded inside shipments into product shares and an outside option. Four objects enter the demand model: observed inside shipments R_m, final market size M_m, product shares s_{jm}, and the outside share s_{0m}. The construction starts from observed CFS inside shipments, uses county population and national poultry availability to form a baseline capacity measure, and then adjusts that scale using downstream retail and wholesale activity from ARTS/AWTS and LBD. Appendix B.3 gives the exact market-size formula and small-area construction.

Observed inside shipments in destination-county-year market m are

$$R_m = \sum_{j \in \mathcal{J}_m} q_{jm}. \tag{5}$$

Here R_m is the total CFS-expanded quantity of retained poultry products shipped into market m. It is not total county poultry consumption and not total poultry sales by all suppliers. I use it as the dependent variable in the auxiliary market-size regression and as a lower bound on final market size. The fitted market-size proxy should therefore be read as a capacity measure for potential poultry procurement in a destination-county-year market, not as a census of realized poultry consumption. Product and outside shares are

$$s_{jm} = \frac{q_{jm}}{M_m}, \qquad s_{0m} = 1 - \sum_{j \in \mathcal{J}_m} s_{jm}. \tag{6}$$

The outside option is a residual normalization rather than an observed choice. It can be interpreted as covering procurement from establishments or sourcing arrangements not included in the estimation sample, including shipments excluded by the sample restrictions in Subsection 3.7 and substitution toward other meat products, although these flows are not separately observed or modeled. Because the market-size proxy is calibrated to downstream meat retail and wholesale capacity rather than to poultry shipments alone, it deliberately leaves room for this residual, and the counterfactual welfare comparisons hold the resulting normalization fixed.

3.6 Market-Specific Buyer-Type Distribution

The economic motivation is that food-service, retail, and wholesale buyers may not respond to price changes in the same way. Restaurants, grocery retailers, and wholesale distributors differ in scale, inventory needs, and substitution opportunities. I therefore allow price sensitivity to vary with the downstream buyer type represented in each destination market.

The difficulty is that the CFS records the shipment destination but not the receiving establishment. I use the LBD to approximate the local buyer mix. In each destination-county-year market m, I identify eligible downstream establishments and classify them as food service, retail, or wholesale. Let $\mathcal{A}_m$ be this set of establishments, and let $T_{am} \in \{F, R, W\}$ denote the type of establishment a. To convert local establishments into buyer-type demand weights, I combine establishment employment, emp_{am}, with a buyer-type throughput-per-employee factor, $\tau_{T_{am}}$. The resulting market-specific buyer-type distribution is

$$\phi_{gm} = \frac{\sum_{a \in \mathcal{A}_m} \text{emp}_{am} \tau_{T_{am}} \mathbf{1}\{T_{am} = g\}}{\sum_{a \in \mathcal{A}_m} \text{emp}_{am} \tau_{T_{am}}}, \qquad g \in \{F, R, W\}. \tag{7}$$

Conceptually, ϕ_{gm} is the constructed probability that one representative unit of poultry demand in market m is associated with buyer type g. A high value of ϕ_{Wm} means that the market has a large wholesale presence after accounting for both employment and poultry throughput per worker. These probabilities are not directly observed shipment-level buyer identities; they are an empirical proxy built from local business records and the throughput calibration.

For estimation, I represent this distribution with 1,000 representative buyer records drawn with replacement. The probability of drawing establishment a is proportional to $\text{emp}_{am}\tau_{T_{am}}$, so the simulated shares of food-service, retail, and wholesale records approximate ϕ_{Fm}, ϕ_{Rm}, and ϕ_{Wm}. These records are representative LBD establishment records, not household consumers and not an additional survey. Appendix B.4 gives the NAICS mapping, throughput calibration, and sampling equations.

The estimation file keeps these representative buyer records so that the demand specification can use the local buyer-type mix. For each representative buyer record, I retain the market identifier and two buyer-type indicators,

$$D_{im}^{R} = \mathbf{1}\{T_{im} = R\}, \qquad D_{im}^{W} = \mathbf{1}\{T_{im} = W\}. \tag{8}$$

Here retail and wholesale records are measured relative to food service, the omitted buyer type. Section 4 shows how these indicators allow price sensitivity to differ across buyer types. I do not include establishment employment or payroll as separate buyer characteristics because employment already affects the representative-buyer sampling probability, and payroll is mechanically related to employment.

3.7 Sample Restrictions and Descriptive Statistics

The estimation sample excludes establishments with internal plant transfers greater than 30 percent of total shipment value, trims product-market observations outside the 5th and 95th percentiles of the FOB-plant unit-value distribution, drops product-market observations with shares below 0.1 percent, and removes markets with fewer than four inside products. Shipment volume excluded by these restrictions is not reassigned to retained products; under the market-size construction in Subsection 3.5, it falls into the residual outside option as a matter of normalization rather than as an observed reallocation. The final sample contains 700 destination-county-year markets, 6,500 product-market observations, 400 establishment–commodity products, and 700,000 representative buyer records.

Table A3 reports descriptive statistics for the estimation variables. The average FOB-plant unit value is 1.423 dollars per pound ($/lb), and the average product share is 0.046. The mean log distance is 6.09, with substantial dispersion across product-market cells. The sample is concentrated in broiler products but still contains meaningful frozen and processed-poultry variation: broiler, frozen, and processed-poultry indicators have means of 0.600, 0.277, and 0.246, respectively. The mean of the cell-level wholesale-channel share ToW is 0.093, with a standard deviation of 0.282. This is a simple mean across retained product-market observations, not the ratio of nationally aggregated PW weight to total processor-origin weight. Likewise, the confusion matrix and the shipment column in Table A2 count records rather than tons. These objects therefore do not identify the national PW–PR physical-volume split. The large cross-cell standard deviation documents substantial heterogeneity in wholesale reliance but does not by itself establish an aggregate share. Accordingly, the external 52:48 calibration in Figure 1 is neither estimated from nor contradicted by these CFS summaries.

Because the CFS is a sample of shipments rather than a census, each product-market cell aggregates a finite number of sampled shipment records, and the choice set in each market is defined by sampled positive flows. Table A4 reports the resulting sampling depth. Thin cells are common but economically small: cells built from one or two sampled shipments account for 29.5 percent of observations but only 4.5 percent of CFS-expanded shipment weight, cells with five or more shipments carry 83 percent of expanded weight, and the weight-weighted median cell is built from about 12 shipments, so sampling noise in shares and unit values is concentrated where the welfare stakes are smallest.

I assess destination-set coverage directly using a plant-level occupancy diagnostic. For each plant–survey-year observation, I use the number of sampled shipment records and the number of distinct destination counties among those records to estimate the plant's potential county destinations under an equal-probability occupancy model. The disclosure-rounded average ratio of observed counties to estimated potential counties is about 95 percent. Thus county aggregation appears to recover nearly all of the effective plant-level destination support implied by this benchmark; Appendix B.2 gives the estimator and its assumptions. The diagnostic cannot rule out rare, low-probability links, and the cells retained after the share restrictions are still selected partly on realized demand, as emphasized by Gandhi, Lu, and Shi (2023). The plant–county availability component of the positive-flow choice set is therefore well covered empirically, without implying that every technically feasible link is observed. Unsampled and excluded flows fall into the residual outside option as a matter of normalization (Subsection 3.5), and the estimates should be read as conditional on the retained choice sets.

4 Model and Estimation

The structural model is based on the shipment-network variables and market-specific buyer-type distribution constructed in Section 3. The channel classification produces product-market variables such as ToW; the LBD sampling procedure produces representative buyer records that approximate the local food-service, retail, and wholesale mix. Conditional on these objects, the model estimates demand, recovers marginal costs from firms' pricing first-order conditions, and supplies the primitives for the counterfactuals.

The modeling approach follows the random-coefficients logit tradition introduced by Berry (1994) and Berry, Levinsohn, and Pakes (1995) and used in supply-side markup estimation by Nevo (2001). The paper also follows practical estimation guidance in Nevo (2000a), Dubé, Fox, and Su (2012), and Conlon and Gortmaker (2020). Identification with market-level data follows the logic in Berry and Haile (2014); the use of local representative-buyer information is related to work on incorporating micro data into differentiated-products demand estimation (Berry and Haile, 2024; Conlon and Gortmaker, 2025). Here, the representative records describe local establishment composition rather than individual purchase histories.

4.1 Demand

Demand is modeled using a random-coefficients nested logit model with the market-specific buyer-type distribution represented by LBD representative buyer records. For representative buyer record i, product j, and destination-county-year market m, let $f(j,m)$ denote the product's LBD firm owner, $o(j)$ the origin state of its producing establishment, $r(m)$ the destination state containing the market, and $t(m)$ the survey year. Indirect utility is

$$u_{ijm} = \delta_{jm} + \mu_{ijm} + \varepsilon_{ijm}, \tag{9}$$

where ε_{ijm} has the nested extreme-value structure. Mean utility is

$$\delta_{jm} = x'_{jm}\beta + \phi_{f(j,m)} + \lambda_{o(j),t(m)} + \eta_{r(m),t(m)} + \xi_{jm}, \tag{10}$$

where x_{jm} collects observed product-market demand characteristics, β is the corresponding vector of mean-utility coefficients, $\phi_{f(j,m)}$ is a firm fixed effect, $\lambda_{o(j),t(m)}$ is an origin-state-by-survey-year fixed effect, $\eta_{r(m),t(m)}$ is a destination-state-by-survey-year fixed effect, and ξ_{jm} is unobserved demand quality. The buyer-specific component is

$$\mu_{ijm} = -\alpha_{im} p_{jm}. \tag{11}$$

Here p_{jm} is the FOB-plant unit value defined in Subsection 3.4, which the structural model treats as the product price. The price-sensitivity parameter is positive and lognormally distributed conditional on buyer type:

$$\log \alpha_{im} = \pi_F + \pi_R D^R_{im} + \pi_W D^W_{im} + \sigma v_{im}, \qquad v_{im} \sim \mathcal{N}(0,1). \tag{12}$$

Equivalently, $\alpha_{im} = \exp(\pi_F + \pi_R D^R_{im} + \pi_W D^W_{im} + \sigma v_{im})$, so price has a negative utility effect for every simulated buyer. The food-service type is omitted, so π_F is the food-service baseline log price sensitivity, while π_R and π_W measure retailer and wholesaler differences relative to food service. Beyond enriching substitution patterns, this price-coefficient heterogeneity matters for the counterfactuals: multinomial and nested logit constrain demand to be log-concave, which mechanically caps cost pass-through below one, whereas random coefficients on price let the demand curvature that governs pass-through and merger effects be determined by the data (Miravete, Seim, and Thurk, 2023).

Products are partitioned into three nests, $\mathcal{G} = \{B, P, O\}$, using broiler, processed-poultry, and other-poultry product categories:

$$g(j) = \begin{cases} B, & broiler_{jm} = 1, \\ P, & processed_{jm} = 1, \\ O, & broiler_{jm} = 0 \text{ and } processed_{jm} = 0. \end{cases} \tag{13}$$

The frozen indicator remains an observed product characteristic in mean utility rather than a nest definition. Let $\mathcal{J}_{g,m}$ denote products in nest g in market m, and let $\rho \in [0, 1)$ be the nesting parameter. With the outside option normalized to zero, define the agent-specific inclusive value

$$I_{igm}(\theta) = \sum_{k \in \mathcal{J}_{g,m}} \exp\left(\frac{\delta_{km} + \mu_{ikm}}{1 - \rho}\right). \tag{14}$$

Agent i's probability of choosing product j is the product of the conditional within-nest probability and the nest probability:

$$P_{ij|g(j),m}(\theta) = \frac{\exp\left((\delta_{jm} + \mu_{ijm})/(1 - \rho)\right)}{I_{ig(j),m}(\theta)}, \tag{15}$$

$$P_{ig,m}(\theta) = \frac{I_{igm}(\theta)^{1-\rho}}{1 + \sum_{h \in \mathcal{G}} I_{ihm}(\theta)^{1-\rho}}, \tag{16}$$

$$P_{ijm}(\theta) = P_{ij|g(j),m}(\theta) P_{ig(j),m}(\theta). \tag{17}$$

When $\rho = 0$, these probabilities collapse to the standard random-coefficients logit probabilities. Positive ρ allows substitution to be stronger within the broiler, processed-poultry, and other-poultry nests than across nests. Model-implied product shares average these probabilities over the representative LBD buyer records in each market:

$$s_{jm}(\theta) = \sum_{i=1}^{1{,}000} \psi_{im} P_{ijm}(\theta), \qquad \psi_{im} = \frac{1}{1{,}000}. \tag{18}$$

Observed shares are inverted into mean utilities using the BLP contraction mapping (Berry, 1994; Berry, Levinsohn, and Pakes, 1995).

In the empirical specification, x_{jm} includes the frozen-shipment indicator, plant product-category indicators, the private-carriage share, the wholesale-channel share ToW, log shipment distance, and interactions between log distance and the product or shipment attributes. Standalone survey-year indicators are absorbed by the state-by-survey-year fixed effects. The firm effects absorb persistent firm-level demand quality, the origin-state-by-survey-year effects absorb shocks common to plants in the same producing state and survey year, and the destination-state-by-survey-year effects absorb demand conditions common to destinations in the same state and survey year. These controls do not absorb plant-product-specific composition, county-level demand shocks, destination-specific matching, or other product-market shocks, which remain part of ξ_{jm}. This specification lets geography and the predicted wholesale-channel share enter demand directly, and it lets the distance penalty differ by product and shipment type. Buyer type does not enter δ_{jm} because it is an agent characteristic rather than a product-market characteristic; instead, buyer type shifts the price coefficient through (12).

4.2 Supply

The model treats the observed FOB-plant unit value as the product price set in a static Bertrand–Nash equilibrium. Let $\mathcal{H}_{jk,m} = 1$ if products j and k in market m are owned by the same firm and zero otherwise. The market-level first-order conditions can be written as

$$\mathbf{p}_m = \mathbf{mc}_m + \Delta_m^{-1} s_m(\theta), \tag{19}$$

where

$$\Delta_{jk,m} = -\mathcal{H}_{jk,m} \frac{\partial s_{km}(\theta)}{\partial p_{jm}}. \tag{20}$$

Ownership is measured with the LBD firm identifier, and the implied markup for product j is $p_{jm} - mc_{jm}$.

Marginal cost is parameterized in levels with a linear regression,

$$mc_{jm} = w_{jm}'\gamma + \omega_{jm}, \tag{21}$$

where w_{jm} includes plant-level unit costs, input-mix variables, shipment characteristics, plant-type indicators, year indicators, destination population, and rival-count controls. The firm, origin-state-by-survey-year, and destination-state-by-survey-year fixed effects in mean utility apply to the demand side only; they are not imposed on this supply equation. This specification relates recovered marginal cost in levels to supply-side shifters; its parameters are estimated jointly with the demand parameters through the supply-side moment condition below.

The static Bertrand–Nash assumption warrants discussion, and the pricing institutions documented in Subsection 2.2 help motivate it. The rough 1 : 4 spot-to-nonspot volume benchmark does not imply that four-fifths of transaction prices are predetermined: contract status and price fixity are distinct. Because many nonspot prices are indexed to current quotations or re-set through recurring negotiations, competitive conditions can transmit into transaction prices within the model's annual time unit. The FOB-plant unit value used in estimation aggregates a product's transactions within a market and survey year, so it may average over contract and spot executions, which the CFS does not distinguish. These institutions suggest one reason wholesale-oriented markets may exhibit different price sensitivity: wholesalers and traders can monitor quotations and redirect purchases more readily than buyers operating retail programs or food-service menus. The CFS does not observe contract-level benchmark choice, bargaining, or switching, however, so the demand estimates in Section 5 are consistent with this mechanism rather than identifying it.

The frequency of the model matters for how the conduct assumption should be read. The model's time unit is the survey year: the price entering the pricing first-order conditions is a product's CFS-expanded average transaction price over the year, not a posted weekly quote. At that frequency, formula indexation and periodic renegotiation allow the prices faced by buyers to respond to annual market conditions, while negotiated discounts, markups, and product mix leave processors pricing discretion over their average transaction values. I therefore use static Nash pricing as a maintained annual-frequency benchmark—the same interpretation under which posted-price competition is applied to averaged transaction prices in other differentiated-products settings (Nevo, 2001; Miller and Osborne, 2014). It does not model contract-specific bargaining, benchmark selection, or quantity commitments. Retail evidence from another heavily benchmarked food-and-beverage category shows that discrete price points can remain consequential even at six-month and one-year horizons (Conlon and Rao, 2020); annual aggregation may attenuate, but does not necessarily eliminate, higher-frequency pricing frictions. Poultry procurement is also a repeated flow purchase with limited storability outside frozen product, so the dynamic considerations that complicate static pricing in durable- or storable-goods markets are muted.

The two leading deviations from the unilateral benchmark move the recovered objects in opposite directions, although their magnitudes are unknown and cannot be presumed to cancel. Bilateral bargaining by the largest retail and food-service buyers would place transaction prices below sellers' unilateral best responses; the first-order conditions would then attribute those discounts to lower marginal cost, and the Bertrand margins would overstate the surplus sellers actually retain from such buyers. Conversely, the sample period overlaps the conduct period alleged in private and federal antitrust litigation concerning coordinated supply restrictions among broiler producers (In re Broiler Chicken Antitrust Litigation, 2016); to the extent conduct was more accommodating than unilateral pricing, the first-order conditions attribute the coordinated component of prices to marginal cost, and the reported margins understate market power. The same direction of bias applies to the information-exchange conduct alleged in the Department of Justice's suit against Agri Stats, which concerns processors' benchmarking of prices charged to downstream buyers

(U.S. Department of Justice, 2023). The unilateral benchmark therefore carries evidentiary value of its own: the recovered margins measure the pricing incentives that annual-frequency competition would generate absent coordination, a structural reference point that the litigation record otherwise lacks. Holding bargaining behavior fixed, they are conservative relative to a coordinated-pricing counterfactual; they are not an unconditional lower bound on market power. Estimating either alternative directly would require downstream resale prices, contract terms, or bilateral transaction data that the CFS does not provide (Villas-Boas, 2007; Bonnet and Dubois, 2010). I therefore hold the unilateral benchmark fixed and read the recovered margins as summarizing average pricing incentives rather than transaction-level conduct.

4.3 Instruments, Identification, and Estimation

FOB-plant unit values are endogenous because unobserved product quality and cost shocks may be correlated with the observed unit value. The excluded demand instruments combine plant-level cost and scale shifters, market-structure measures, and local differentiation instruments. Appendix B.5 lists the variables in the instrument set. Plant cost and scale shifters move unit values through supply-side cost and capacity conditions, while local differentiation instruments shift markups through exogenous crowding in product-characteristic space. These instruments are valid under the maintained assumption that, after the observed controls, firm fixed effects, origin-state-by-survey-year fixed effects, destination-state-by-survey-year fixed effects, and market construction are conditioned on, they are not correlated with unobserved demand quality. The fixed effects remove persistent firm-level quality, common origin-state-year shocks, and common destination-state-year demand conditions from the identifying variation, but they do not by themselves eliminate time-varying plant-product composition, county-specific demand shocks, product-specific destination selection, or buyer–supplier matching. The local differentiation instruments are constructed from frozen status, distance, broiler status, turkey status, and processed-poultry status, following the logic that exogenous crowding in product-characteristic space shifts substitution patterns and pricing incentives (Gandhi and Houde, 2019). The efficiency of random-coefficients demand estimates also depends on the choice of excluded instruments (Reynaert and Verboven, 2014); I use a fixed set of excluded instruments rather than iterating to approximate optimal instruments.

Shipment distance therefore has two roles in the empirical specification. The product's own log distance enters mean utility as an included, conditionally exogenous product characteristic and serves as its own instrument. The differentiation instruments built from distance, frozen status, and product category are excluded instruments for the endogenous FOB-plant unit value. The own-distance coefficient is identified under the maintained condition

$\mathbb{E}[\log(d_{jm})\,\xi_{jm} \mid f(j,m), o(j) \times t(m), r(m) \times t(m)] = 0$: after conditioning on observed controls, the three sets of demand fixed effects, and market construction, shipment distance is uncorrelated with unobserved demand quality.

The identifying assumptions are the standard BLP orthogonality conditions,

$$\mathbb{E}[z^d_{jm}\xi_{jm}(\theta)] = 0, \tag{22}$$

$$\mathbb{E}[z^s_{jm}\omega_{jm}(\theta,\gamma)] = 0, \tag{23}$$

where z^d_{jm} and z^s_{jm} denote demand- and supply-side instruments. Here $\theta = (\beta', \pi_F, \pi_R, \pi_W, \sigma, \rho)'$ collects the demand-side parameters, and γ is the cost-coefficient vector in (21); the supply residual evaluates (21) at the marginal costs recovered from the first-order conditions (19). On the demand side, the moment condition is implemented after absorbing firm, origin-state-by-survey-year, and destination-state-by-survey-year fixed effects from the included regressors and instruments. These assumptions require the excluded instruments to shift the FOB-plant unit value or cost without being correlated with unobserved demand quality, after conditioning on observed controls, demand fixed effects, and market construction. Product-count instruments are therefore interpreted conditional on the maintained market definition and sample restrictions, not as a model of endogenous entry.

The parameters are estimated by two-step GMM (Hansen, 1982),

$$(\hat{\theta}, \hat{\gamma}) = \arg\min_{\theta,\gamma} \hat{g}(\theta,\gamma)'\,\Omega\,\hat{g}(\theta,\gamma), \tag{24}$$

where $\hat{g}(\theta,\gamma)$ stacks the demand- and supply-side sample moments and Ω is the two-step GMM weighting matrix, so the demand and cost parameters are estimated jointly. The numerical implementation uses L-BFGS-B optimization, 1,000 representative LBD buyer records per market, and `pyblp` routines for BLP estimation and post-estimation analysis (Conlon and Gortmaker, 2020). Each representative record contains the buyer-type indicators in Subsection 3.6 and one standard-normal simulation node for the lognormal price coefficient. Standard errors clustered by destination county are reported throughout; clustering at the county level allows for correlation across products within a market and across survey years within the same county, including the market-level variation in the rival-count instruments. Instrument relevance is supported by released weak-instrument diagnostics in addition to the OLS–IV unit-value contrast in Section 5. The first-stage projections absorb the same firm, origin-state-by-survey-year, and destination-state-by-survey-year fixed effects as the demand equations. Conditional on those fixed effects, the cluster-robust Montiel Olea–Pflueger effective first-stage F statistic is 77.62 for the IV logit, far above the critical value of about 23 associated with a worst-case bias of 10 percent (Montiel Olea and Pflueger, 2013). For the nested-logit specification, which instruments both the unit value and the within-nest share, the corresponding Kleibergen–Paap rk Wald F statistic is 58.19 (Kleibergen and Paap, 2006); because formal critical values for robust statistics with multiple endogenous variables are not established, this statistic is reported as a descriptive diagnostic. Disclosure constraints limit other auxiliary estimation output, such as full first-stage coefficient vectors.

5 Results

5.1 Preliminary Logit Benchmarks

The diagnostic OLS, IV, and nested-logit estimates in Table 1 support the structural specification. Instrumenting the FOB-plant unit value moves its coefficient from -1.062 to -1.898, consistent with favorable unobserved demand shocks biasing OLS toward zero. The nested-logit estimate, $\rho = 0.448$, indicates stronger substitution within poultry categories. These diagnostics motivate instrumenting unit value and retaining product-category nesting in the main demand model; random coefficients separately allow price sensitivity to vary with the LBD buyer-type distribution. Appendix F gives the benchmark equations, while Section 4 and Appendix E discuss first-stage relevance and identification.

5.2 BLP Demand Estimates

Table 2 reports the nonlinear price-sensitivity parameters from the demand specification with firm, origin-state-by-survey-year, and destination-state-by-survey-year fixed effects. The baseline food-service log price-sensitivity parameter π_F is 1.138 and is precisely estimated. The retailer increment π_R is 0.686, and the wholesaler increment π_W is 1.202; both are positive and statistically significant at the 1 percent level. Under the lognormal specification, holding the idiosyncratic normal draw fixed, retailer agents have price sensitivity about $\exp(0.686) = 1.99$ times the food-service baseline, while wholesaler agents have price sensitivity about $\exp(1.202) = 3.33$ times the food-service baseline. The wholesaler effect is the largest buyer-type difference. The within-type dispersion parameter σ, 0.364, shows that meaningful residual heterogeneity remains even after conditioning on buyer type.

The LBD buyer distribution supplies market-specific probability weights on food-service, retail, and wholesale establishments. The coefficients π_R and π_W are therefore demographic interactions in the random-coefficients demand system, not product-level demand shifters or reduced-form effects of selling through a particular channel. They are identified from how

Table 1: Logit, IV Logit, and Nested-Logit Demand Estimates with Fixed Effects

Variable	Logit	IV logit	Nested logit
FOB-plant unit value	-1.0620***	-1.8980***	-2.7150***
	(0.0823)	(0.2929)	(0.2821)
Frozen-shipment indicator	0.0954	0.2397	0.0136
	(0.2446)	(0.2469)	(0.2287)
Broiler product indicator	-0.7386**	-0.5744*	-0.3506
	(0.3156)	(0.3147)	(0.3046)
Processed-poultry indicator	-0.3529	-0.2270	0.1925
	(0.3492)	(0.3477)	(0.3337)
private	-0.1365	-0.1248	-0.1786
	(0.2471)	(0.2484)	(0.2209)
ToW	0.9309**	1.1370***	0.6115
	(0.4132)	(0.4280)	(0.3963)
Log shipment distance	-0.2131***	-0.1851***	-0.1956***
	(0.0469)	(0.0466)	(0.0453)
Frozen × log distance	-0.0219	-0.0355	-0.0390
	(0.0386)	(0.0388)	(0.0359)
Broiler × log distance	0.1839***	0.1550***	0.2184***
	(0.0491)	(0.0491)	(0.0475)
Processed poultry × log distance	0.0741	0.0615	0.0646
	(0.0546)	(0.0547)	(0.0523)
private × log distance	0.0264	0.0247	0.0369
	(0.0431)	(0.0434)	(0.0384)
ToW × log distance	-0.1184*	-0.1439**	-0.0685
	(0.0647)	(0.0669)	(0.0617)
Nested-logit parameter (ρ)	–	–	0.4480***
	–	–	(0.0216)
Firm fixed effects	Yes	Yes	Yes
Origin-state-by-survey-year fixed effects	Yes	Yes	Yes
Destination-state-by-survey-year fixed effects	Yes	Yes	Yes

Notes: The estimation sample contains 6,500 product-market observations in 700 destination-county-year markets with 400 products. Standard errors clustered by destination county are in parentheses. Every column absorbs LBD firm, producing-establishment origin-state-by-survey-year, and destination-state-by-survey-year fixed effects. The IV logit instruments the FOB-plant unit value. The nested-logit column also instruments the within-nest share. The fixed-effect-adjusted first-stage statistics are 77.62 for the IV logit and 58.19 for the nested logit. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table 2: Random-Coefficients Price Sensitivity by Buyer Type

Parameter	Interpretation	Estimate
π_F	Food-service baseline log price sensitivity	1.1380^{***}
		(0.1244)
π_R	Retailer increment relative to food service	0.6862^{***}
		(0.2195)
π_W	Wholesaler increment relative to food service	1.2020^{***}
		(0.1109)
σ	Within-type lognormal dispersion	0.3644^{***}
		(0.0441)

Notes: The estimation sample contains 6,500 product-market observations in 700 destination-county-year markets with 400 products. Standard errors clustered by destination county are in parentheses. The BLP demand specification absorbs firm, producing-establishment origin-state-by-survey-year, and destination-state-by-survey-year fixed effects; these effects apply to demand, not to the supply equation. Parameter notation follows (12). Food-service agents are the omitted buyer type. Positive retailer and wholesaler increments raise log price sensitivity relative to food-service agents. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

market demand responses covary with the calibrated local buyer distribution, conditional on the throughput weights described in Appendix B.4. Because the CFS does not reveal the identity or choice of each receiver, the buyer-type estimates should be read as model-based heterogeneity, and their uncertainty is conditional on that calibrated distribution.

Table A5 reports the mean-utility coefficients. Log distance enters at -0.210, and the BLP nesting parameter is 0.323 with a standard error of 0.034. The positive nesting parameter confirms stronger substitution within the broiler, processed-poultry, and other-poultry groups. The wholesale-channel share has a positive level coefficient and a negative distance interaction, so its fitted association with mean utility weakens with route length. These estimates preserve the geographic demand pattern found in the simpler benchmarks while adding local buyer-type heterogeneity.

The product-category distance interactions clarify one part of the mechanism. Holding the other distance-interacted characteristics fixed, the base other-poultry slope is -0.210; the processed-poultry interaction offsets part of it, and the broiler interaction, $+0.216$, almost fully offsets it. The estimates therefore indicate a much weaker category-specific non-price distance friction for broilers. Total demand and cost slopes vary with the remaining interactions reported in Table A5 and Table A6.

5.3 Supply-Side Estimates

Table A6 reports the cost estimates, where marginal cost is recovered from the demand system and the multi-product Bertrand first-order conditions. Average recovered marginal cost is 0.966 \$/lb, within about 4 percent of the independently observed materials, supplemental-input, and labor cost total of roughly 1.00 \$/lb in Table A3. Because marginal cost and average accounting cost are distinct objects, this comparison is an order-of-magnitude check rather than a test of equality. Separately, the model implies an average unit-value–cost margin of about 33 percent; this is not an accounting profit rate.

The frozen level coefficient is 0.082 \$/lb; after including the frozen-by-distance term, the point-implied frozen differential at the sample mean log distance of 6.09 is about 0.023 \$/lb. The baseline log-distance coefficient is 0.028 \$/lb per log point, while total distance slopes vary with the reported product, shipment, and year interactions. Since the FOB-plant unit value excludes separately billed freight, the baseline gradient reflects distance-related costs borne by the plant rather than separately invoiced freight. The processed-poultry level and distance terms nearly offset one another at the sample mean route length.

Plant unit costs for materials, supplemental inputs, and labor are positively associated with recovered marginal cost, as are capital expenditures and inventories. External-slaughter plants also have higher recovered costs than the omitted plant group. These coefficients should be read as conditional associations, not as an accounting decomposition or as causal technology effects. The rival-count variables likewise serve as controls for local market conditions rather than standalone effects of rivals on cost.

5.4 Economic Magnitudes

The estimates imply an average own-price elasticity of -3.1 and an average unit-value–cost margin of 33 percent. Because this elasticity is defined for an establishment–commodity option within a destination-county market, its magnitude need not match category-level poultry elasticities.

The demand and supply estimates also identify distinct adjustment margins. Buyer composition shifts price sensitivity, product category governs within-group substitution, distance enters both utility and marginal cost, and ownership determines which substitution effects a firm internalizes. The counterfactuals use these margins jointly rather than treating each disruption as a reduced-form quantity shock.

6 Counterfactual Simulations

The four counterfactuals change one primitive at a time—plant availability, effective distance, raw-poultry cost, or ownership—and recompute equilibrium while holding the estimated behavioral parameters fixed.

6.1 Benchmark and Welfare Aggregation

Table 3 reports the common baseline and the four counterfactual equilibria.

Table 3: Aggregate Counterfactual Outcomes by Scenario

Scenario	FOB-plant unit value	Cost	Elas.	Inside	Producer	Buyer	Total	ΔTS	ΔTS (%)
Model-implied baseline	1.443	0.966	-3.135	63.56	34.39	55.36	89.75	0.00	0.00
Plant unavailability	1.448	0.967	-3.118	61.08	33.04	52.38	85.43	-4.32	-4.81
Effective distance +20%	1.469	0.990	-3.158	60.98	33.18	52.41	85.60	-4.15	-4.62
Raw-poultry cost +20%	1.558	1.085	-3.515	54.27	27.28	46.58	73.85	-15.90	-17.72
Merger of third- and fourth-largest firms	1.542	0.966	-3.276	57.70	37.09	48.83	85.92	-3.83	-4.27

Notes: Unit values and costs are in \$/lb; elasticity is unitless; inside sales are in billion lb; surplus is in billions of dollars. Quantity and surplus sum annual model-implied outcomes for 2007, 2012, and 2017. Unit values, costs, and elasticities are averages across disclosure-cleared state rows. ΔTS is relative to the common baseline. Producer and buyer surplus may not sum exactly to total surplus because entries are rounded separately from the underlying state rows. Firms in the merger scenario are ranked by CFS-expanded shipment value. Counterfactual outcomes are model-implied point values evaluated at the estimated parameters; see Appendix E.
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

In the baseline, average own-price elasticity is -3.135, average unit value is 1.443 \$/lb, and average marginal cost is 0.966 \$/lb, implying a 33 percent margin. The state-row unit-value average differs from the 1.423 product-market mean in Table A3 because the aggregation levels differ. Baseline total surplus is 89.75 billion dollars when the three survey-year outcomes are summed. These levels depend on the market-size normalization, but every scenario is evaluated against the same baseline. The main objects are therefore changes in quantities and surplus rather than their absolute levels. Table A7 and Figure A1 report state-level heterogeneity; Table A8 shows that alternative market-size normalizations preserve every scenario's sign and ranking. Appendix F gives the elasticity and aggregation formulas.

6.2 Counterfactual Procedure and Shock Design

For each scenario, I hold the estimated demand and cost parameters and fitted unobservables fixed, change the relevant primitive, and solve the multi-product Bertrand pricing conditions for a new equilibrium. Products that remain available retain their baseline unobservables, and market size remains fixed. Producer surplus is the sum of product markups times model-implied quantities; downstream-buyer surplus is the integrated nested-logit log-sum. Appendix F reports the formulas and computational details. Because the shocks are not normalized to a common primitive scale, the results compare scenario-specific outcomes rather than elasticities to standardized shocks.

The distance scenario raises every route's effective distance by 20 percent. It affects both demand and cost but leaves the choice set intact, representing detours or an equivalent network-wide increase in logistics frictions rather than plant relocation. The raw-poultry scenario raises the raw-poultry input-cost component by 20 percent and adds the resulting dollar increase one-for-one to marginal cost. This accounting experiment differs from the cross-sectional materials coefficient, which mixes input prices with plant and product composition; Appendix F gives the distinction and historical scale comparison.

The plant-unavailability scenario removes products from a confidential set of weather-exposed southeastern counties fixed before the equilibria were solved. Appendix D.1 documents the selection rule and public analogues. Surviving plants can expand at constant marginal cost, so the exercise abstracts from binding short-run capacity and contracting frictions. The merger assigns the products of the third- and fourth-largest firms to one owner while holding costs and offerings fixed. It therefore isolates short-run pricing incentives rather than efficiencies, entry, or product repositioning.

6.3 Counterfactual Results

Figure 3 maps the state-level percentage change in total surplus. The raw-poultry cost shock is broad-based; the distance shock is more diffuse than plant unavailability, while plant unavailability and the merger produce more spatially concentrated losses. Detailed state rows appear in Table A7; the remaining outcome maps appear in Figure A2 through Figure A7.

Plant unavailability works mainly through the choice set. Unit value and recovered cost barely move, but inside sales fall from 63.56 to 61.08 billion lb and total surplus falls by 4.32 billion dollars, or 4.81 percent. The loss comes from removing nearby or otherwise attractive products rather than from a uniform cost increase.

The distance shock leaves all products available but makes every route less attractive or more costly. Average cost rises to 0.990 \$/lb and average unit value to 1.469 \$/lb; inside sales fall to 60.98 billion lb. Producer and buyer surplus decline by 1.21 and 2.95 billion dollars, respectively, for a total-surplus loss of 4.15 billion dollars, or 4.62 percent. Its aggregate loss is close to that from plant unavailability, but the mechanism and spatial footprint differ: the closure removes discrete options, while greater distance degrades the full network.

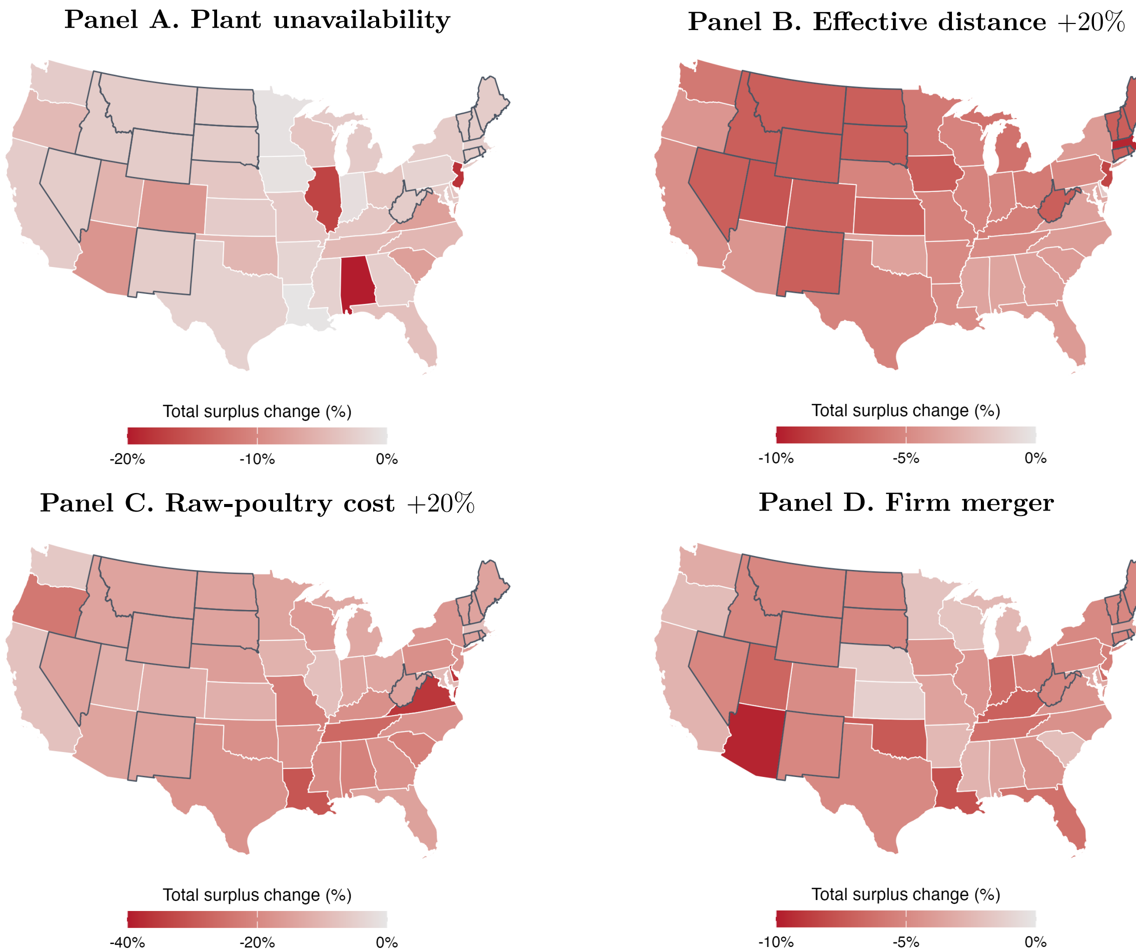

Figure 3: State-Level Total-Surplus Percentage Changes Relative to the Baseline

Notes: Total surplus equals producer surplus plus downstream-buyer surplus. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent; because every state loses surplus in all four scenarios, each panel uses a single-hue sequential scale from light gray (no change) to dark red (largest loss). Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

The 20 percent raw-poultry cost increase produces the largest contraction. Average cost rises to 1.085 \$/lb and unit value to 1.558 \$/lb, while inside sales fall to 54.27 billion lb. Producer surplus drops by 7.11 billion dollars and buyer surplus by 8.78 billion dollars. Total surplus falls by 15.90 billion dollars, or 17.72 percent. The cost shock does not merely transfer surplus through higher prices; it compresses margins and quantities enough that both sides of the market lose.

The merger changes ownership but not marginal-cost primitives. Average unit value rises from 1.443 to 1.542 \$/lb and inside sales fall to 57.70 billion lb. Producer surplus rises by 2.70 billion dollars because the merged firm internalizes substitution between the parties' products, while downstream-buyer surplus falls by 6.53 billion dollars. Total surplus falls by 3.83 billion dollars. Thus 59 percent of the buyer loss is deadweight loss rather than a transfer to producers.

Similar aggregate losses from plant unavailability and distance conceal different price, cost, and substitution responses, while the merger highlights redistribution that a total-surplus measure alone would miss.

7 Conclusion

This paper links CFS shipments to Census establishment data to study processor sales to wholesalers, retailers, and food-service buyers. The estimated random-coefficients demand system shows that wholesale buyers are 3.3 times and retail buyers about twice as price sensitive as food-service buyers. Distance raises marginal cost for all poultry and also lowers demand for differentiated products. Recovered marginal cost aligns closely with independent plant accounting costs, and the average markup is about one-third of unit value.

The counterfactuals show why the source of a disruption matters. A 20 percent raw-poultry cost increase reduces total surplus by 17.7 percent and lowers both producer and buyer surplus. Plant unavailability and a 20 percent increase in effective distance each reduce total surplus by roughly 5 percent, but closures remove options while distance raises network-wide frictions. A merger of the third- and fourth-largest firms raises producer surplus but reduces buyer and total surplus; 59 percent of the buyer loss is deadweight loss.

These are short-run partial-equilibrium estimates: they hold entry, capacity, contracts, and product locations fixed, and receiver-level choices are inferred from establishment composition rather than observed directly. Even within those limits, the results show that buyer composition, geography, and ownership jointly determine who bears supply-chain shocks. The linked-shipment approach can be applied to other manufacturing and agricultural markets where plant location and business-to-business trade shape competition.

Data Availability and Disclosure Statement

The empirical analysis relies on restricted-use Census microdata and linked establishment identifiers. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2521 and was reviewed for release under Disclosure Clearance Numbers CBDRB-FY25-0219 and CBDRB-FY26-0215. Public documentation for the CFS and Census business surveys is available from the U.S. Census Bureau and the Bureau of Transportation Statistics. The restricted microdata cannot be redistributed by the author. The replication package will contain code, synthetic or public-use examples where feasible, and disclosure-cleared tables and figures. All tables, figures, and other reported statistics in the public manuscript are subject to Census Bureau disclosure review and should be cited with the project and disclosure clearance numbers reported in this manuscript.

Required Census Bureau disclaimer. Any views expressed are those of the authors and not those of the U.S. Census Bureau. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2521. (CBDRB-FY25-0219; CBDRB-FY26-0215)

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A Tables and Figures

A.1 Tables

Table A1: Full-Sample Fitted Confusion Matrix for Final PR–PW Classifier

	Reference label	
Prediction	PW label	PR label
PW label	∼1,200	∼80
PR label	∼100	∼15,500

Notes: Entries are rounded, disclosure-cleared fitted counts from the final random forest after refitting on the full mechanically labeled sample. This is not a held-out confusion matrix. Subsection 3.2 describes the 90–10 training-validation procedure used to select the specification and the subsequent full-sample refit. Accuracy on the 10 percent validation set used during specification selection was about 96 percent. Class frequencies are record counts in the mechanically labeled sample, not national physical-flow shares.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY25-0219.

Table A2: Descriptive ZIP-Code Poultry Network Counts and Statistics by Link Type and Year

		Counts						Statistics			
Link	Year	Firms	Plants	Shipments	Src. ZIPs	Dest. ZIPs	Edges	Dist. wt.	Dist. val.	Density	Mean HHI
PR	2007	100	250	15,000	250	2,000	5,100	400	403	1.02%	0.266
PR	2012	70	150	9,000	150	1,700	3,200	408	430	1.25%	0.256
PR	2017	70	200	20,000	200	2,000	5,700	481	502	1.43%	0.203
PW	2007	60	150	1,000	150	150	350	370	392	1.56%	0.740
PW	2012	40	90	600	90	100	250	542	534	2.78%	0.680
PW	2017	60	200	2,600	150	350	900	586	577	1.71%	0.495
WR	2007	200	300	6,000	250	2,400	2,900	513	437	0.48%	0.133
WR	2012	100	200	3,800	150	1,600	1,800	370	361	0.75%	0.197
WR	2017	150	200	5,400	150	2,600	3,100	565	462	0.79%	0.315

Notes: PR and PW are conditional labels assigned to processor-origin records for the retailer and wholesaler channels, respectively; WR is a pooled label for wholesaler-origin retail or other downstream-distribution records. Counts are rounded, disclosure-cleared descriptive network objects constructed before aggregation to the destination-county-year BLP estimation sample. The Shipments column counts sampled records, not physical quantity or national flow shares. Distances are miles and report shipment-distance averages weighted by shipment weight and shipment value. Network density is the number of observed directed edges divided by the product of source ZIPs and destination ZIPs. Mean HHI is computed across destination-ZIP shipment-weight shares for each source ZIP and then averaged using source-ZIP shipment weight.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY25-0219.

Table A3: Descriptive Statistics for Estimation Variables

Variable	Mean	Std. dev.
FOB-plant unit value	1.4230	0.177
Share	0.0458	0.073
Log distance	6.0900	1.113
Frozen-shipment indicator	0.2769	0.451
Broiler indicator	0.6000	0.492
Processed-poultry indicator	0.2462	0.427
Private-carriage share (private)	0.1739	0.363
Wholesale-channel share (ToW)	0.0931	0.282
Log total production workers	7.9740	0.669
Log asset stock	10.7500	1.161
Materials unit cost ($/lb)	0.6860	0.395
Supplemental unit cost ($/lb)	0.1677	0.153
Labor unit cost ($/lb)	0.1500	0.097
Capital expenditure rate	0.2434	0.242
Production-worker hourly pay	13.5000	3.136
Inventory-to-assets ratio	0.0309	0.040
Own-slaughter plant	0.6000	0.492
External-slaughter plant	0.1308	0.339
Rival product count	11.8500	10.521
Rival frozen-product count	4.7080	6.990
Rival broiler count	6.1320	6.023
Rival processed-product count	4.2940	7.861

Notes: The sample contains 6,500 product-market observations, 700 markets, and 400 products. Reported statistics are rounded in accordance with Census Bureau disclosure review, so distinct variables can display identical rounded values. The FOB-plant unit value and unit-cost variables are in constant 2017 dollars per pound; production-worker hourly pay is in constant 2017 dollars per hour. Means are simple across product-market observations; in particular, mean ToW is not a nationally aggregated PW weight share.
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A4: Sampled Shipments per Product-Market Cell

Shipments per cell	Share of cells	Mean shipments	Share of CFS-expanded weight
1–2	29.5%	1.5	4.5%
3–4	25.4%	3.6	12.4%
5–9	23.7%	6.7	26.2%
10–19	12.9%	13.0	24.6%
20 or more	8.5%	23.7	32.3%

Notes: The table reports the distribution of sampled CFS shipment records underlying the 6,500 product-market cells in the estimation sample. Across cells, the mean is about 6.6 shipments, the median is 4, the 90th and 95th percentiles are 15 and 22, and the maximum is about 55; the weight-weighted median cell is built from about 12 shipments. Shares and counts are rounded in accordance with Census Bureau disclosure review.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A5: BLP Mean Utility and Nested-Logit Parameters with Fixed Effects

Variable	Estimate
Frozen-shipment indicator	0.3272
	(0.2842)
Broiler product indicator	-0.9779***
	(0.3638)
Processed-poultry indicator	-0.3449
	(0.3992)
private	-0.1787
	(0.2856)
ToW	1.1660**
	(0.4908)
Log shipment distance	-0.2103***
	(0.0536)
Frozen × log distance	-0.0420
	(0.0446)
Broiler × log distance	0.2164***
	(0.0568)
Processed poultry × log distance	0.0919
	(0.0628)
private × log distance	0.0345
	(0.0500)
ToW × log distance	-0.1433*
	(0.0766)
Nested-logit parameter (ρ)	0.3229***
	(0.0335)
Firm fixed effects	Yes
Origin-state-by-survey-year fixed effects	Yes
Destination-state-by-survey-year fixed effects	Yes

Notes: The estimation sample contains 6,500 product-market observations in 700 destination-county-year markets with 400 products. Standard errors clustered by destination county are in parentheses. The BLP demand specification absorbs LBD firm, producing-establishment origin-state-by-survey-year, and destination-state-by-survey-year fixed effects; the intercept and standalone year indicators are therefore not separately reported. These effects apply to demand, not to the supply equation. The BLP nesting parameter ρ is reported with the demand-side parameters because it governs within-nest substitution rather than marginal cost. It uses the same broiler, processed-poultry, and other-poultry nests as the preliminary nested-logit model. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A6: Supply-Side Cost Parameters

Variable	Estimate	Variable	Estimate
Constant	0.6170*** (0.1060)	Log shipment distance	0.0280*** (0.0087)
Log total production workers	-0.0146** (0.0061)	Frozen × log distance	-0.0097 (0.0059)
Log asset stock	-0.0111*** (0.0042)	Broiler × log distance	-0.0027 (0.0079)
Materials unit cost ($/lb)	0.0885*** (0.0083)	Processed poultry × log distance	0.0238*** (0.0090)
Supplemental unit cost ($/lb)	0.1902*** (0.0202)	private × log distance	-0.0078 (0.0066)
Labor unit cost ($/lb)	0.1893*** (0.0331)	ToW × log distance	0.0082 (0.0087)
Capital expenditure rate	0.0693*** (0.0167)	2012 indicator	0.0087 (0.0456)
Production-worker hourly pay	0.0003 (0.0013)	2017 indicator	0.2036*** (0.0385)
Inventory-to-assets ratio	0.5900*** (0.1002)	2012 indicator × log distance	0.0047 (0.0073)
Own-slaughter plant	-0.0122* (0.0071)	2017 indicator × log distance	-0.0239*** (0.0059)
External-slaughter plant	0.1076*** (0.0102)	Log destination-county population	0.0195*** (0.0034)
Frozen-shipment indicator	0.0821** (0.0375)	Rival product count	0.0015* (0.0009)
Broiler product indicator	-0.0509 (0.0494)	Rival frozen-product count	0.0024** (0.0010)
Processed-poultry indicator	-0.1453** (0.0567)	Rival broiler count	0.0023* (0.0013)
private	0.0442 (0.0377)	Rival processed-product count	-0.0026** (0.0011)
ToW	-0.0297 (0.0552)		

Notes: The estimation sample contains 6,500 product-market observations in 700 destination-county-year markets with 400 products. Standard errors clustered by destination county are in parentheses. The dependent variable is marginal cost in levels recovered from the supply-side first-order conditions; the cost parameters are estimated jointly with the demand parameters in the GMM system. The firm, origin-state-by-survey-year, and destination-state-by-survey-year fixed effects used in demand are not imposed on this supply equation. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A7: State-Level Counterfactual Results by Scenario: Panel A. Baseline
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

State	FOB	Cost	Elas.	Mkt.	Inside	PS	BS	TS
Alabama	1.426	0.9439	-3.063	6.465	2.806	1.567	2.525	4.092
Arizona	1.429	0.9961	-3.443	1.754	0.9064	0.4206	0.7731	1.194
Arkansas	1.416	0.9202	-3.377	21.25	5.808	3.504	4.893	8.397
California	1.436	0.9876	-3.199	12.45	5.809	2.922	5.119	8.041
Colorado	1.472	1.032	-3.33	1.099	0.4725	0.2199	0.4068	0.6267
Delaware	1.378	0.8349	-3.03	1.874	1.001	0.6699	0.917	1.587
Florida	1.444	0.9838	-3.388	7.924	3.838	1.977	3.357	5.334
Georgia	1.413	0.9164	-3.195	16.61	6.421	3.292	5.403	8.695
Illinois	1.5	1.042	-3.378	5.137	2.552	1.196	2.31	3.506
Indiana	1.436	0.9509	-3.073	0.8793	0.3923	0.2107	0.353	0.5637
Iowa	1.468	0.9756	-3.148	0.7941	0.4317	0.2497	0.4182	0.6679
Kansas	1.451	0.9696	-3.283	1.167	0.4553	0.2502	0.4062	0.6564
Kentucky	1.504	1.01	-3.088	1.144	0.6234	0.3201	0.554	0.8741
Louisiana	1.379	0.8809	-2.842	1.817	0.8343	0.492	0.7206	1.213
Maryland	1.418	0.9756	-3.244	2.362	1.348	0.6568	1.257	1.914
Massachusetts	1.495	1.079	-3.275	0.6518	0.3645	0.1646	0.3382	0.5028
Michigan	1.489	1.024	-3.194	2.72	1.246	0.6153	1.139	1.754
Minnesota	1.398	0.9422	-3.116	1.943	0.7739	0.3493	0.6316	0.9809
Mississippi	1.415	0.9023	-3.055	4.636	1.859	0.986	1.605	2.591
Missouri	1.421	0.917	-3.071	2.098	1.033	0.6326	0.9284	1.561
Nebraska	1.477	0.9665	-3.321	0.3374	0.1827	0.1218	0.1726	0.2944
New Jersey	1.429	0.9899	-3.081	1.673	0.7796	0.3709	0.6595	1.03
New York	1.422	0.9719	-3.142	6.686	3.026	1.388	2.564	3.952
North Carolina	1.408	0.9215	-2.99	4.412	2.267	1.202	1.999	3.201
Ohio	1.446	0.977	-3.061	2.608	1.336	0.6985	1.206	1.905
Oklahoma	1.45	0.9356	-3.065	0.6162	0.2857	0.171	0.2512	0.4222
Oregon	1.469	1.014	-2.753	0.8007	0.4284	0.2621	0.3756	0.6377
Pennsylvania	1.433	0.9741	-3.074	6.04	2.449	1.216	2.071	3.287
South Carolina	1.442	0.9649	-2.863	1.421	0.7128	0.3824	0.6252	1.008
Tennessee	1.451	0.9185	-2.932	2.246	1.077	0.6501	0.9306	1.581
Texas	1.397	0.9138	-3.318	14.8	6.018	3.225	5.115	8.34
Utah	1.506	1.062	-3.257	0.9695	0.5153	0.2391	0.4481	0.6872
Virginia	1.418	0.9137	-2.535	10.43	3.52	2.711	3.099	5.81
Washington	1.478	1.02	-3.432	1.122	0.6144	0.2815	0.5487	0.8302
Wisconsin	1.478	0.9795	-2.966	1.548	0.8063	0.4583	0.7324	1.191
Rest of America	1.472	0.9683	-3.287	1.169	0.5678	0.3156	0.5066	0.8222

Table A7: State-Level Counterfactual Results by Scenario: Panel B. Plant unavailability
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

State	FOB	Cost	Elas.	Mkt.	Inside	PS	BS	TS
Alabama	1.412	0.9364	-2.985	6.465	2.471	1.274	2.008	3.282
Arizona	1.429	0.9923	-3.368	1.754	0.85	0.3966	0.6936	1.09
Arkansas	1.419	0.9181	-3.365	21.25	5.668	3.455	4.78	8.235
California	1.443	0.9903	-3.183	12.45	5.63	2.863	4.949	7.812
Colorado	1.493	1.045	-3.325	1.099	0.427	0.202	0.3718	0.5738
Delaware	1.398	0.8573	-2.901	1.874	0.9796	0.6492	0.8797	1.529
Florida	1.453	0.9885	-3.375	7.924	3.697	1.926	3.192	5.118
Georgia	1.417	0.9156	-3.164	16.61	6.253	3.25	5.214	8.464
Illinois	1.511	1.058	-3.572	5.137	2.248	0.9421	1.971	2.913
Indiana	1.442	0.9542	-3.075	0.8793	0.3874	0.2087	0.3499	0.5586
Iowa	1.476	0.9871	-3.107	0.7941	0.4304	0.2476	0.4164	0.664
Kansas	1.457	0.9708	-3.268	1.167	0.4413	0.2469	0.3907	0.6376
Kentucky	1.501	1.011	-3.047	1.144	0.6068	0.3091	0.5356	0.8447
Louisiana	1.372	0.8733	-2.839	1.817	0.8328	0.4915	0.7188	1.21
Maryland	1.427	0.9795	-3.191	2.362	1.317	0.6458	1.21	1.856
Massachusetts	1.48	1.061	-3.201	0.6518	0.3586	0.1629	0.3271	0.49
Michigan	1.486	1.02	-3.178	2.72	1.217	0.5974	1.105	1.702
Minnesota	1.397	0.9403	-3.107	1.943	0.7705	0.3491	0.6271	0.9762
Mississippi	1.408	0.8914	-3.017	4.636	1.815	0.9809	1.552	2.533
Missouri	1.424	0.9117	-3.073	2.098	1.002	0.6216	0.8903	1.512
Nebraska	1.477	0.94	-3.324	0.3374	0.1733	0.1192	0.1651	0.2843
New Jersey	1.434	0.9956	-3.323	1.673	0.6832	0.3035	0.5377	0.8412
New York	1.427	0.9748	-3.127	6.686	2.944	1.363	2.47	3.833
North Carolina	1.424	0.9299	-2.956	4.412	2.156	1.173	1.867	3.04
Ohio	1.449	0.9773	-3.006	2.608	1.28	0.6956	1.141	1.837
Oklahoma	1.456	0.937	-3.001	0.6162	0.2719	0.1673	0.2332	0.4005
Oregon	1.492	1.025	-2.7	0.8007	0.4073	0.2582	0.3487	0.6069
Pennsylvania	1.438	0.9776	-3.043	6.04	2.395	1.201	2.017	3.218
South Carolina	1.469	0.9798	-2.844	1.421	0.6638	0.3629	0.568	0.9309
Tennessee	1.429	0.8916	-2.835	2.246	1.029	0.6412	0.8643	1.506
Texas	1.392	0.9102	-3.295	14.8	5.904	3.18	4.973	8.153
Utah	1.507	1.062	-3.223	0.9695	0.4932	0.2304	0.4192	0.6496
Virginia	1.422	0.9235	-2.597	10.43	3.357	2.487	2.885	5.372
Washington	1.487	1.028	-3.412	1.122	0.5984	0.2776	0.5289	0.8065
Wisconsin	1.488	0.978	-2.946	1.548	0.7789	0.453	0.6945	1.147
Rest of America	1.494	0.9668	-3.288	1.169	0.5467	0.3112	0.4882	0.7994

Table A7: State-Level Counterfactual Results by Scenario: Panel C. Effective distance +20%
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

State	FOB	Cost	Elas.	Mkt.	Inside	PS	BS	TS
Alabama	1.449	0.966	-3.086	6.465	2.723	1.521	2.428	3.949
Arizona	1.467	1.03	-3.459	1.754	0.87	0.4063	0.7355	1.142
Arkansas	1.439	0.9431	-3.398	21.25	5.55	3.349	4.636	7.985
California	1.469	1.017	-3.214	12.45	5.541	2.851	4.816	7.667
Colorado	1.507	1.064	-3.358	1.099	0.444	0.2077	0.3751	0.5828
Delaware	1.395	0.8505	-3.049	1.874	0.9859	0.663	0.8989	1.562
Florida	1.474	1.011	-3.411	7.924	3.688	1.921	3.198	5.119
Georgia	1.436	0.9384	-3.217	16.61	6.225	3.191	5.18	8.371
Illinois	1.528	1.066	-3.397	5.137	2.436	1.153	2.172	3.325
Indiana	1.464	0.9756	-3.099	0.8793	0.3738	0.2035	0.3314	0.5349
Iowa	1.49	0.997	-3.194	0.7941	0.4094	0.2347	0.3841	0.6188
Kansas	1.483	0.9996	-3.33	1.167	0.4271	0.2358	0.3739	0.6097
Kentucky	1.53	1.037	-3.119	1.144	0.5963	0.3061	0.5198	0.8259
Louisiana	1.403	0.9029	-2.881	1.817	0.8028	0.471	0.6835	1.155
Maryland	1.446	1	-3.281	2.362	1.309	0.6428	1.209	1.852
Massachusetts	1.517	1.096	-3.247	0.6518	0.3377	0.154	0.3004	0.4544
Michigan	1.52	1.051	-3.24	2.72	1.188	0.5861	1.06	1.646
Minnesota	1.415	0.958	-3.157	1.943	0.7355	0.334	0.59	0.924
Mississippi	1.432	0.9195	-3.073	4.636	1.802	0.9579	1.542	2.5
Missouri	1.448	0.9419	-3.097	2.098	0.9886	0.6041	0.8731	1.477
Nebraska	1.503	0.9885	-3.337	0.3374	0.1752	0.1171	0.1619	0.279
New Jersey	1.442	1.001	-3.083	1.673	0.7275	0.3454	0.5983	0.9437
New York	1.45	0.9966	-3.171	6.686	2.922	1.345	2.448	3.793
North Carolina	1.428	0.9405	-3.007	4.412	2.198	1.168	1.908	3.076
Ohio	1.472	1.001	-3.106	2.608	1.275	0.6682	1.127	1.795
Oklahoma	1.477	0.9607	-3.066	0.6162	0.2757	0.1667	0.2401	0.4068
Oregon	1.499	1.041	-2.789	0.8007	0.4112	0.2552	0.355	0.6102
Pennsylvania	1.458	0.9967	-3.085	6.04	2.346	1.165	1.956	3.121
South Carolina	1.461	0.9832	-2.892	1.421	0.6914	0.3688	0.5985	0.9673
Tennessee	1.479	0.9468	-2.952	2.246	1.037	0.6214	0.8828	1.504
Texas	1.427	0.9414	-3.349	14.8	5.704	3.109	4.789	7.898
Utah	1.541	1.092	-3.264	0.9695	0.4814	0.2271	0.4076	0.6347
Virginia	1.443	0.9371	-2.541	10.43	3.414	2.621	2.973	5.594
Washington	1.509	1.045	-3.476	1.122	0.5822	0.272	0.5099	0.7819
Wisconsin	1.5	1.001	-2.986	1.548	0.7706	0.4388	0.6892	1.128
Rest of America	1.49	0.9857	-3.289	1.169	0.5352	0.3004	0.463	0.7634

Table A7: State-Level Counterfactual Results by Scenario: Panel D. Raw-poultry cost +20%
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

State	FOB	Cost	Elas.	Mkt.	Inside	PS	BS	TS
Alabama	1.566	1.088	-3.522	6.465	2.312	1.184	2.029	3.213
Arizona	1.524	1.087	-3.795	1.754	0.7978	0.3545	0.6696	1.024
Arkansas	1.556	1.054	-3.623	21.25	4.916	2.804	4.086	6.89
California	1.507	1.058	-3.353	12.45	5.353	2.61	4.804	7.414
Colorado	1.546	1.106	-3.668	1.099	0.4226	0.184	0.3656	0.5496
Delaware	1.654	1.132	-3.773	1.874	0.7095	0.41	0.5964	1.006
Florida	1.548	1.091	-3.68	7.924	3.403	1.606	2.947	4.553
Georgia	1.566	1.071	-3.564	16.61	5.402	2.638	4.487	7.125
Illinois	1.521	1.063	-3.6	5.137	2.403	1.09	2.126	3.216
Indiana	1.556	1.065	-3.414	0.8793	0.3431	0.1802	0.308	0.4882
Iowa	1.553	1.081	-3.417	0.7941	0.3994	0.2031	0.3905	0.5936
Kansas	1.594	1.101	-3.507	1.167	0.3948	0.2218	0.3577	0.5795
Kentucky	1.562	1.077	-3.508	1.144	0.5285	0.2641	0.4498	0.7139
Louisiana	1.563	1.063	-3.522	1.817	0.6208	0.3367	0.5062	0.8429
Maryland	1.533	1.086	-3.416	2.362	1.218	0.6028	1.129	1.732
Massachusetts	1.507	1.094	-3.583	0.6518	0.3435	0.1478	0.3133	0.4611
Michigan	1.547	1.091	-3.562	2.72	1.123	0.5088	1.012	1.521
Minnesota	1.548	1.086	-3.468	1.943	0.6665	0.301	0.5404	0.8414
Mississippi	1.604	1.092	-3.545	4.636	1.51	0.7989	1.292	2.091
Missouri	1.577	1.082	-3.456	2.098	0.8444	0.4905	0.7282	1.219
Nebraska	1.563	1.076	-3.605	0.3374	0.1616	0.1001	0.1484	0.2485
New Jersey	1.544	1.099	-3.576	1.673	0.6618	0.2909	0.5575	0.8484
New York	1.544	1.091	-3.511	6.686	2.562	1.138	2.141	3.279
North Carolina	1.551	1.075	-3.408	4.412	1.923	0.9464	1.689	2.635
Ohio	1.535	1.073	-3.42	2.608	1.188	0.5906	1.055	1.646
Oklahoma	1.542	1.05	-3.447	0.6162	0.2551	0.1329	0.2117	0.3446
Oregon	1.555	1.102	-3.111	0.8007	0.3539	0.1894	0.2985	0.4879
Pennsylvania	1.555	1.091	-3.464	6.04	2.059	0.9839	1.696	2.68
South Carolina	1.597	1.12	-3.379	1.421	0.5878	0.289	0.4997	0.7887
Tennessee	1.59	1.086	-3.557	2.246	0.8522	0.4507	0.7105	1.161
Texas	1.567	1.083	-3.648	14.8	5.075	2.543	4.312	6.855
Utah	1.538	1.1	-3.544	0.9695	0.4663	0.2122	0.3937	0.6059
Virginia	1.574	1.077	-3.43	10.43	2.615	1.582	2.138	3.72
Washington	1.572	1.112	-3.65	1.122	0.5764	0.2617	0.5149	0.7766
Wisconsin	1.556	1.076	-3.38	1.548	0.7198	0.3659	0.6324	0.9983
Rest of America	1.567	1.075	-3.446	1.169	0.506	0.2636	0.4406	0.7042

Table A7: State-Level Counterfactual Results by Scenario: Panel E. Firm merger
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

State	FOB	Cost	Elas.	Mkt.	Inside	PS	BS	TS
Alabama	1.512	0.9439	-3.14	6.465	2.591	1.686	2.264	3.95
Arizona	1.583	0.9961	-3.799	1.754	0.7304	0.4908	0.5875	1.078
Arkansas	1.452	0.9202	-3.463	21.25	5.492	3.642	4.549	8.191
California	1.506	0.9876	-3.28	12.45	5.437	3.106	4.718	7.824
Colorado	1.546	1.032	-3.505	1.099	0.426	0.244	0.3526	0.5966
Delaware	1.567	0.8349	-3.248	1.874	0.8619	0.7342	0.7497	1.484
Florida	1.568	0.9838	-3.602	7.924	3.338	2.201	2.8	5.001
Georgia	1.493	0.9164	-3.308	16.61	5.828	3.579	4.733	8.312
Illinois	1.569	1.042	-3.525	5.137	2.312	1.334	2.021	3.355
Indiana	1.568	0.9509	-3.28	0.8793	0.3408	0.2349	0.2922	0.5271
Iowa	1.58	0.9756	-3.265	0.7941	0.39	0.2721	0.3659	0.638
Kansas	1.49	0.9696	-3.326	1.167	0.4408	0.255	0.3935	0.6485
Kentucky	1.675	1.01	-3.283	1.144	0.5301	0.3599	0.4525	0.8124
Louisiana	1.497	0.8809	-3.097	1.817	0.6995	0.5466	0.571	1.118
Maryland	1.514	0.9756	-3.355	2.362	1.249	0.7153	1.135	1.85
Massachusetts	1.628	1.079	-3.432	0.6518	0.3323	0.1833	0.2998	0.4831
Michigan	1.538	1.024	-3.283	2.72	1.178	0.6536	1.058	1.712
Minnesota	1.419	0.9422	-3.19	1.943	0.7433	0.3669	0.5952	0.9621
Mississippi	1.482	0.9023	-3.142	4.636	1.746	1.036	1.485	2.521
Missouri	1.495	0.917	-3.165	2.098	0.9487	0.6725	0.8318	1.504
Nebraska	1.569	0.9665	-3.364	0.3374	0.1764	0.1241	0.1659	0.29
New Jersey	1.5	0.9899	-3.304	1.673	0.6935	0.4093	0.5643	0.9736
New York	1.548	0.9719	-3.3	6.686	2.719	1.529	2.227	3.756
North Carolina	1.523	0.9215	-3.108	4.412	2.044	1.304	1.752	3.056
Ohio	1.579	0.977	-3.227	2.608	1.185	0.7707	1.029	1.8
Oklahoma	1.625	0.9356	-3.302	0.6162	0.2427	0.1883	0.2026	0.3909
Oregon	1.544	1.014	-2.811	0.8007	0.4045	0.2723	0.3512	0.6235
Pennsylvania	1.516	0.9741	-3.219	6.04	2.202	1.332	1.794	3.126
South Carolina	1.521	0.9649	-2.898	1.421	0.6787	0.3969	0.589	0.9859
Tennessee	1.615	0.9185	-3.067	2.246	0.9323	0.7075	0.7747	1.482
Texas	1.492	0.9138	-3.484	14.8	5.342	3.486	4.44	7.926
Utah	1.637	1.062	-3.556	0.9695	0.4438	0.2723	0.3681	0.6404
Virginia	1.514	0.9137	-2.545	10.43	3.173	2.868	2.683	5.551
Washington	1.56	1.02	-3.561	1.122	0.5699	0.3021	0.502	0.8041
Wisconsin	1.53	0.9795	-3.02	1.548	0.7706	0.4744	0.6945	1.169
Rest of America	1.571	0.9683	-3.486	1.169	0.503	0.3447	0.4358	0.7805

Table A8: Sensitivity to the Market-Size Normalization

κ	Mkt.	Inside share	Elas.	Margin (%)	PS	BS	TS	ΔTS (%) by scenario: Plant	Distance	Raw cost	Merger
0.6	176.93	0.359	-3.180	32.8	34.12	54.74	88.86	-4.57	-4.54	-17.13	-4.02
0.7 (baseline)	151.65	0.419	-3.135	33.1	34.39	55.36	89.75	-4.81	-4.62	-17.72	-4.27
0.8	132.69	0.479	-3.041	33.7	34.73	58.24	92.97	-5.02	-4.71	-18.17	-4.41

Notes: Each row re-estimates the full model and re-solves all four counterfactual scenarios with the outside-option normalization in Appendix B.3 set to κ in place of the baseline 0.7. Mkt. is aggregate market size in billion lb and Inside share is aggregate inside sales divided by market size; both follow mechanically from the normalization. Elas. is the average own-price elasticity; Margin is the average unit-value–cost difference as a percent of the FOB-plant unit value. PS, BS, and TS are baseline producer, downstream-buyer, and total surplus in billions of dollars under each normalization. The ΔTS columns report each scenario's total-surplus change relative to that row's baseline, in percent. Scenario rankings and signs are unchanged across normalizations.

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A9: Public Examples of Weather-Disrupted Poultry-Processing and Production Counties

County	FIPS	Poultry-processing anchor	Weather or disruption motivation
Blount County, AL	01009	Tyson Blountsville chicken-processing plant.	April 2011 tornado outbreak: Tyson reported that the Blountsville plant was idled after losing power.
Marshall County, AL	01095	Tyson Albertville chicken-processing plant and Wayne Farms Albertville processing facilities.	April 2011 tornado outbreak: Tyson reported that Albertville was idled after losing power; Wayne Farms reported Albertville-area processing facilities idled for seven days.
Morgan County, AL	01103	Wayne Farms Decatur processing facilities.	April 2011 tornado outbreak: Wayne Farms reported that Decatur-area processing facilities were idled for seven days by widespread power outages.
Tuscaloosa County, AL	01125	Peco Foods Tuscaloosa poultry facility.	April 2011 tornado outbreak: Meat+Poultry reported that the Tuscaloosa facility was heavily damaged.
Forsyth County, GA	13117	Tyson Cumming chicken plant.	Hurricane Irma in September 2017: Tyson shut down the Cumming chicken plant in response to the storm.
Terrell County, GA	13273	Tyson Dawson chicken plant.	Hurricane Irma in September 2017: Tyson shut down the Dawson chicken plant in response to the storm.
Dooly County, GA	13093	Tyson Vienna chicken plant.	Hurricane Irma in September 2017: Tyson shut down the Vienna chicken plant in response to the storm.
Lenoir County, NC	37107	Sanderson Farms Kinston poultry-processing facility.	Hurricane Matthew in October 2016: Reuters reported severe North Carolina poultry losses, including about 250,000 Sanderson broilers lost in the state.
Lexington County, SC	45063	House of Raeford West Columbia poultry plant and South Carolina grower region.	Hurricane Matthew in October 2016: House of Raeford reported partial contract-farm flock losses and weather-related road-access problems.
Jasper County, MS	28061	Peco Foods Bay Springs poultry-processing and slaughter facility.	April 2011 tornado outbreak: the National Weather Service reported significant poultry-farm damage along the Smith–Jasper–Clarke tornado track.

Notes: The table reports public examples of southeastern counties that combine poultry-processing capacity or upstream poultry production with documented weather-related disruption. It does not disclose the confidential county set used in the plant-unavailability simulation. The examples illustrate the type of geography used to motivate the stylized choice-set shock: counties where storms, flooding, power outages, road-access problems, or live-bird losses plausibly interrupted poultry production or processing. Sources: Tyson Foods (2011), MEAT+POULTRY (2011), Powder & Bulk Solids (2017), AgCanada/Reuters (2016), WATTAgNet (2016), National Weather Service Jackson (2011), FSIS (n.d.a), FSIS (n.d.b), and FSIS (n.d.c).

Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Table A10: Main Variables Used in Estimation
Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

Variable	Definition
FOB-plant unit value	CFS-expanded shipment value divided by expanded shipment weight, using the within-establishment annualization weight and aggregated to the product-market-year level in constant 2017 dollars per pound. CFS shipment value excludes freight charges and excise taxes.
Share	Product-market quantity divided by adjusted market size.
Log distance	Log of shipment distance weighted by CFS-expanded shipment weight.
Frozen	Indicator equal to one for SCTG 05122 and zero for SCTG 05121.
Broiler	Indicator for plants assigned to the broiler product category using manufacturing product-line information.
Processed poultry	Indicator for plants assigned to the processed-poultry product category; the omitted category is other poultry plants.
private	Private-carriage share: the share of shipments transported using shipper-owned trucks.
ToW	Product-market CFS-expanded weight share of processor-origin shipments classified as processor-to-wholesaler (PW) using the PR–PW classifier.
type_R	Sampled-record indicator equal to one for retail representative buyer records; food service is the omitted buyer type.
type_W	Sampled-record indicator equal to one for wholesale representative buyer records; food service is the omitted buyer type.
sampling_weight	LBD representative-buyer sampling size equal to establishment employment times the buyer-type throughput ratio.
tpw	Total production workers.
tae	Plant asset stock measure.
wp	Production-worker payroll per production-worker hour.
te	Capital expenditures divided by plant assets.
mc	Materials unit cost, equal to materials cost divided by CFS-expanded shipment weight and reported in $/lb.
sc	Supplemental input unit cost, equal to supplemental input cost divided by CFS-expanded shipment weight and reported in $/lb.
wc	Labor unit cost, equal to labor cost divided by CFS-expanded shipment weight and reported in $/lb.
tie	Total inventories divided by ending total assets.
Packaging input intensity	CMF materials-detail packaging cost divided by CFS-expanded shipment weight ($/lb); enters the excluded demand instruments.
Raw-poultry input intensity	CMF materials-detail raw-poultry cost divided by CFS-expanded shipment weight ($/lb); enters the excluded demand instruments and is the cost term raised by 20 percent in the raw-poultry counterfactual.
Poultry-parts input intensity	CMF materials-detail processed-poultry cost divided by CFS-expanded shipment weight ($/lb); enters the excluded demand instruments.
TYPOP104	Indicator for poultry or meat products processed chiefly from animals slaughtered in the same establishment.
TYPOP106	Indicator for poultry or meat products processed chiefly from animals slaughtered elsewhere.
Turkey indicator	Indicator equal to one for plants whose CMF product line is turkey; used only in constructing the local differentiation instruments (turkey plants belong to the other-poultry category).
Log destination-county population	Log of population in the market's destination county and year; a supply-side control in the marginal-cost equation.
n_rival	Number of competing products in the same destination-county-year market.
n_rival_frozen	Number of competing frozen products in the same market.
n_rival_broiler	Number of competing broiler products in the same market.
n_rival_processed	Number of competing processed-poultry products in the same market.

A.2 Figures

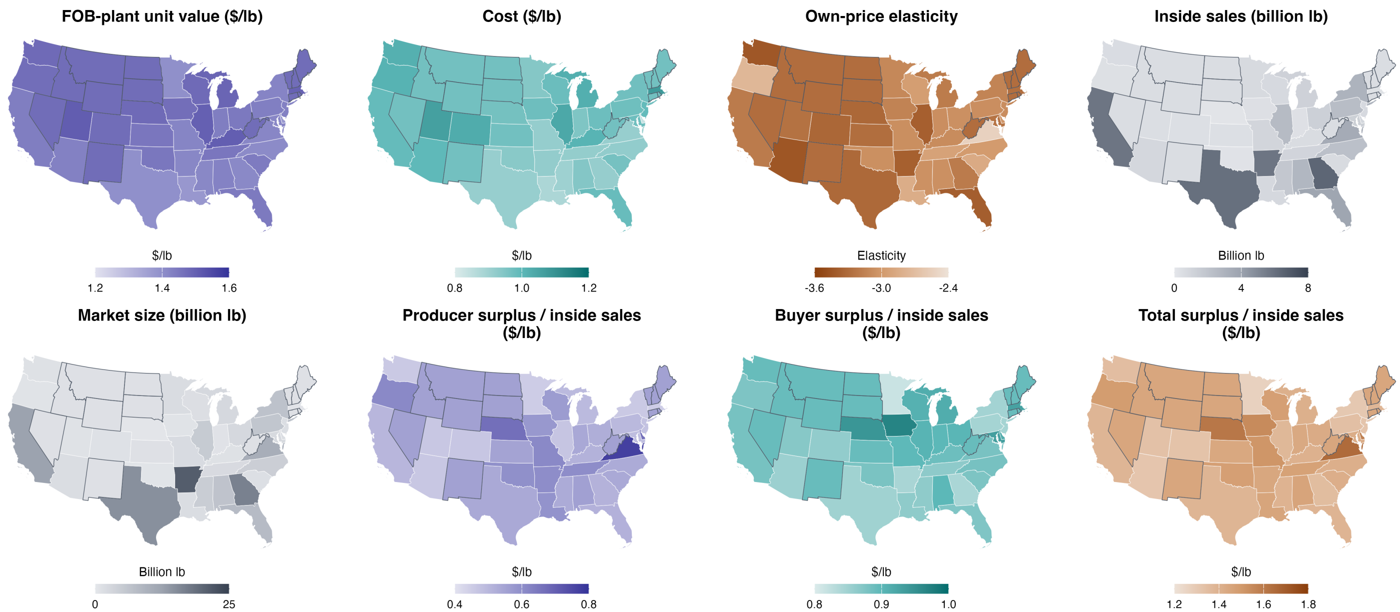

Figure A1: Model-Implied Baseline State-Level Distributions

Notes: Panels map the model-implied baseline levels of the FOB-plant unit value, recovered cost, own-price elasticity, inside sales, market size, and the three surplus measures normalized by inside sales. The FOB-plant unit value, recovered cost, and the three surplus-per-inside-sales measures are reported in $/lb; inside sales and market size are reported in billion lb. The total-surplus-per-pound panel equals total surplus divided by inside sales, where total surplus is producer surplus plus downstream-buyer surplus. Each panel uses its own sequential color scale, with limits snapped outward to multiples of 0.2 ($/lb and elasticity), 2 billion lb (inside sales), or 5 billion lb (market size); darker shades indicate larger values, except that darker shades in the elasticity panel indicate more elastic (more negative) demand. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

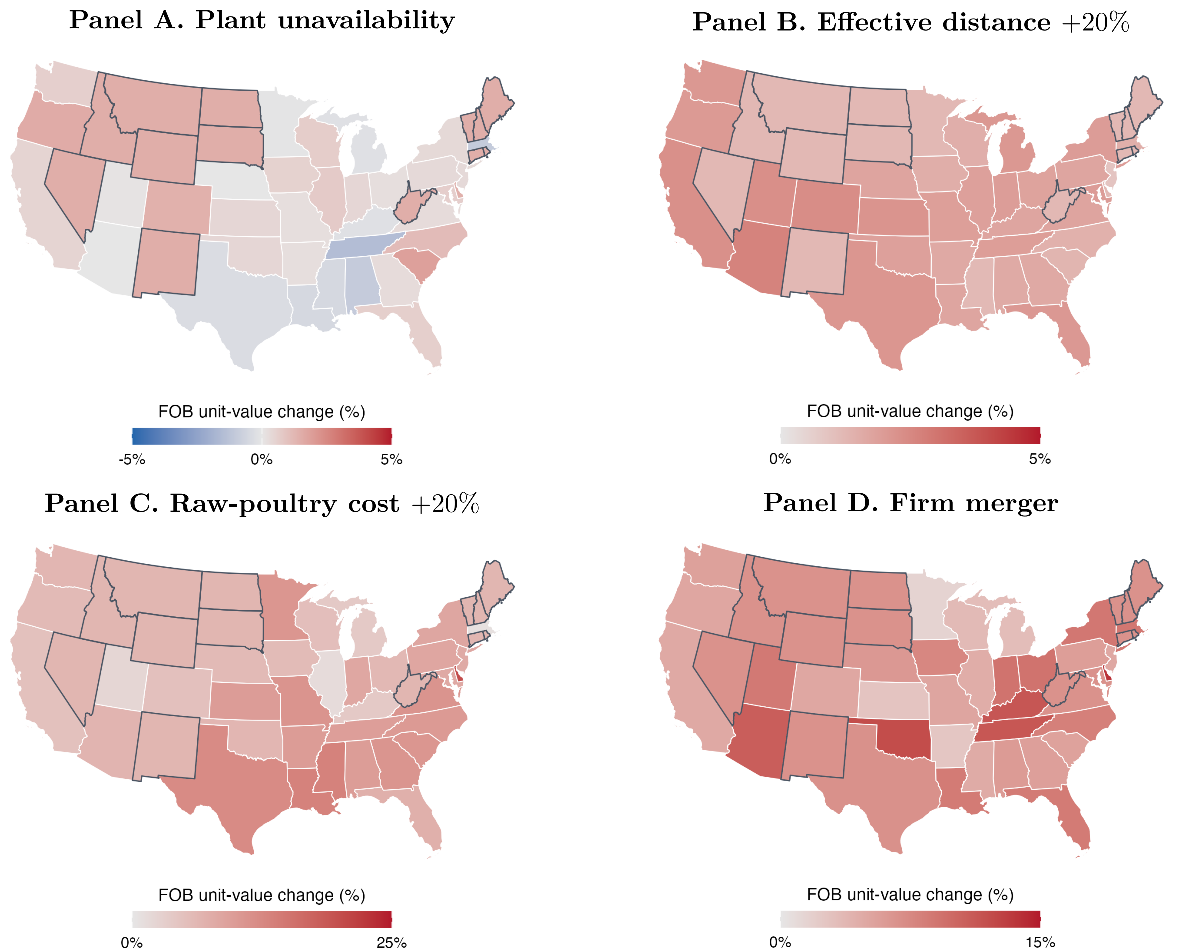

Figure A2: State-Level FOB-Plant Unit-Value Percentage Changes Relative to the Baseline
Notes: The FOB-plant unit value is the average equilibrium unit value in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

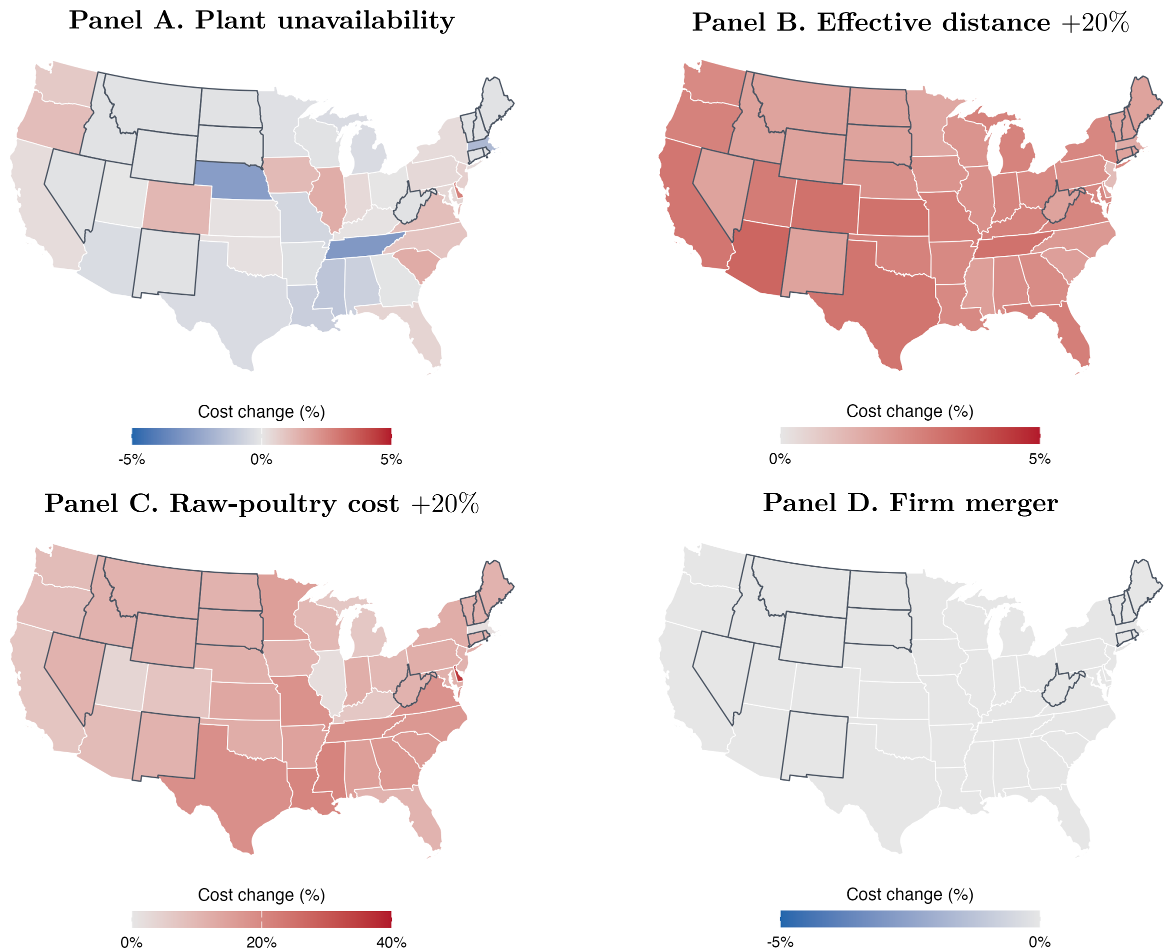

Figure A3: State-Level Cost Percentage Changes Relative to the Baseline

Notes: Cost is the recovered average marginal-cost measure in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

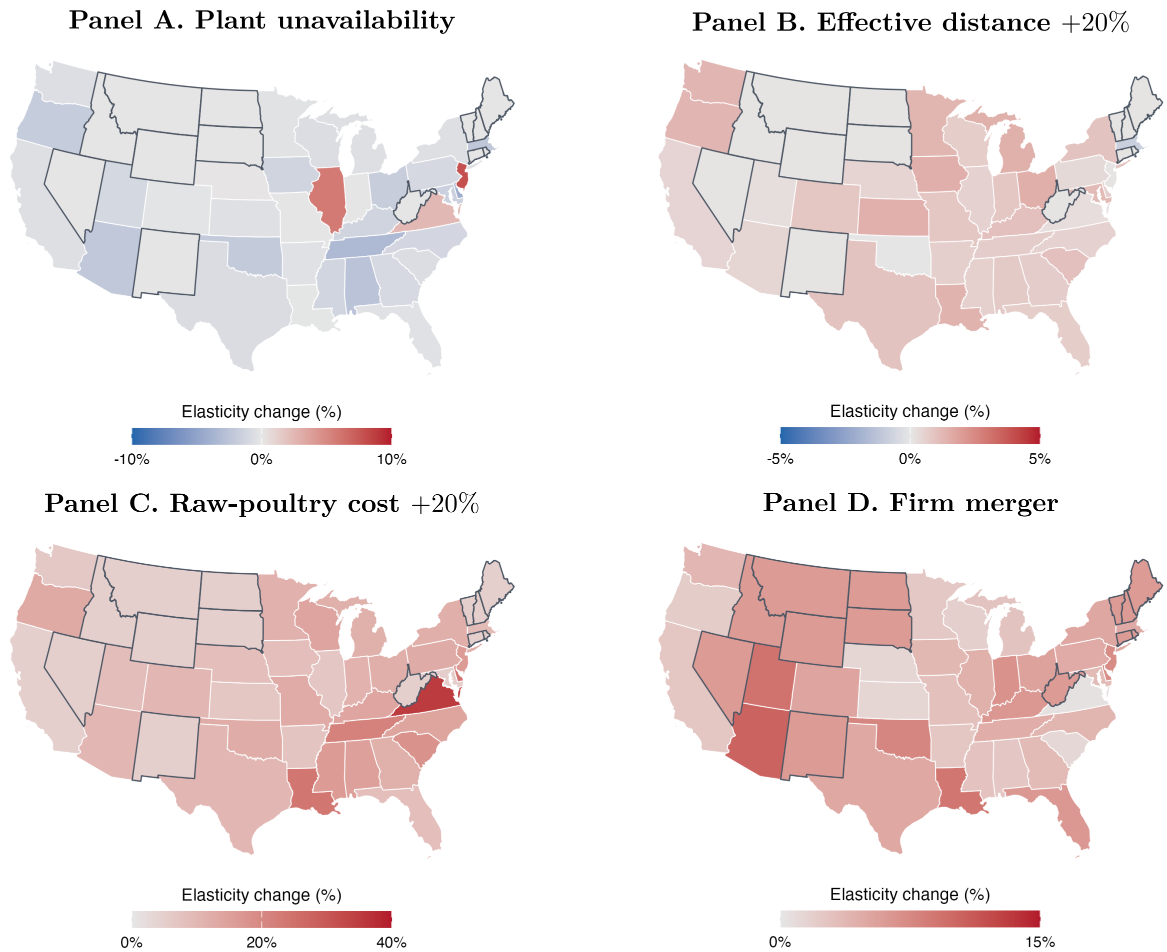

Figure A4: State-Level Own-Price Elasticity Percentage Changes Relative to the Baseline

Notes: Elasticity is the average own-price elasticity in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

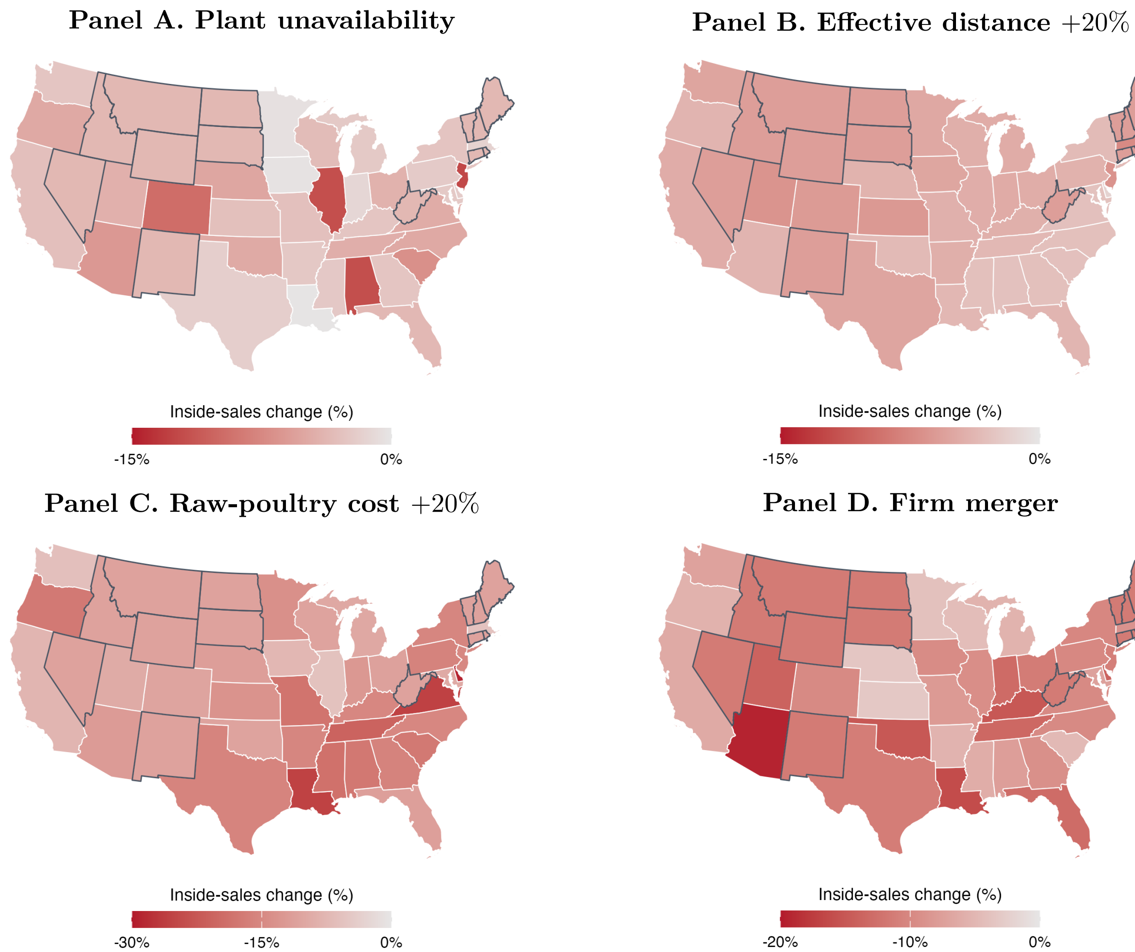

Figure A5: State-Level Inside-Sales Percentage Changes Relative to the Baseline

Notes: Inside sales aggregate the equilibrium inside quantity measure in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

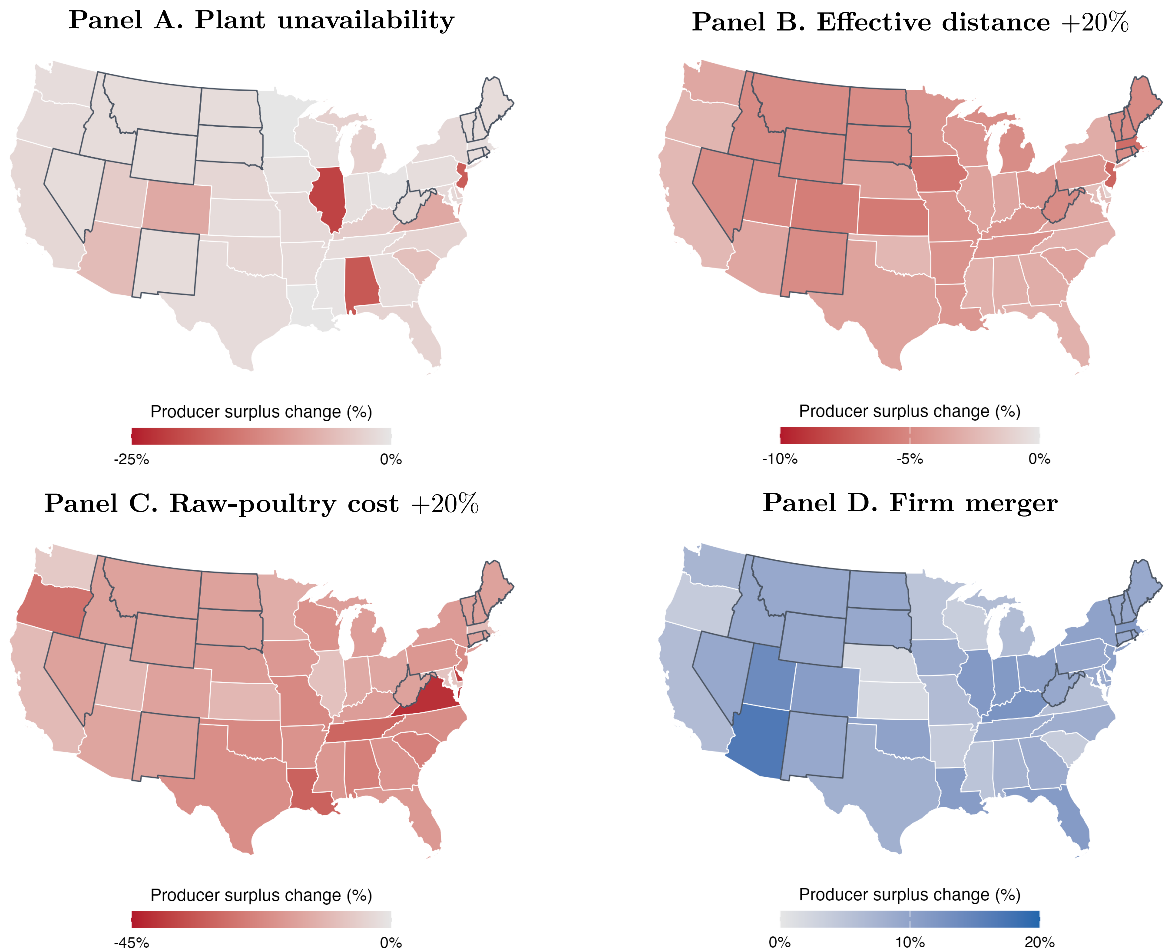

Figure A6: State-Level Producer-Surplus Percentage Changes Relative to the Baseline
Notes: Producer surplus is the model-implied producer surplus in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

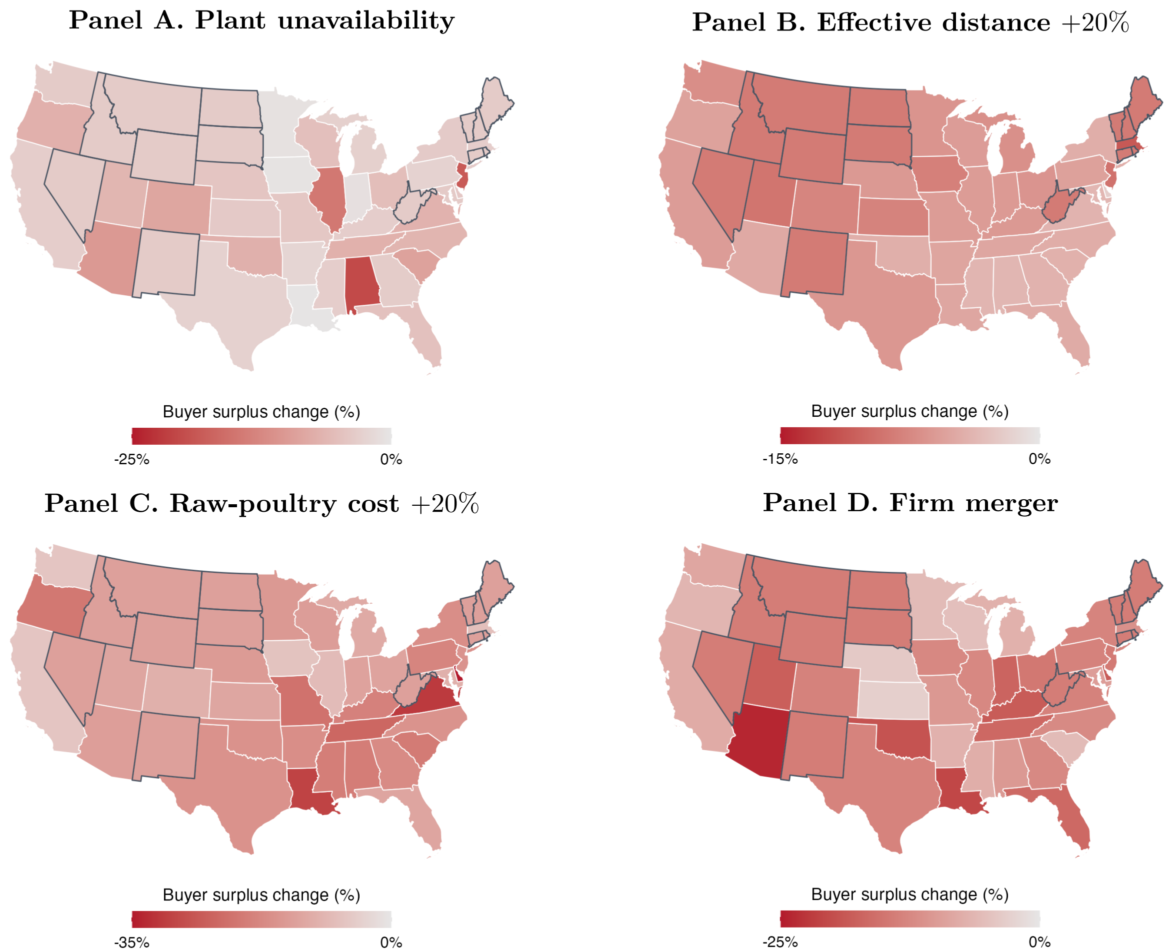

Figure A7: State-Level Downstream-Buyer-Surplus Percentage Changes Relative to the Baseline

Notes: Downstream-buyer surplus is the BLP log-sum surplus measure in the state row. Panels A–D show percentage changes relative to the model-implied baseline under plant unavailability in the confidential weather-exposed county set, a 20 percent increase in effective shipment distance, a 20 percent increase in raw-poultry cost, and a merger of the third-largest and fourth-largest firms, respectively. Each panel uses its own color scale with limits rounded outward to multiples of 5 percent. Panels in which all states move in the same direction use a single-hue sequential scale from light gray (no change) to dark red (an increase in the unit value, cost, or elasticity magnitude, or a decrease in inside sales or surplus) or dark blue (the opposite movement); panels with changes of both signs use a diverging scale centered at light gray. The two inside-sales panels for plant unavailability and the distance shock share one scale. Maps display the contiguous United States. States without separate state rows are colored with the Rest of America aggregate value and outlined in dark gray. Disclosure: FSRDC Project Number 2521; Disclosure Clearance Number CBDRB-FY26-0215.

B Data Construction Details

This appendix reports implementation details for the descriptive shipment network, market-size proxy, and LBD representative-buyer sample. These objects support the variables defined in Section 3, but the structural model uses the product-market variables and representative buyer records described in the main text.

B.1 Descriptive Poultry Shipment Network

This appendix records the construction of the descriptive ZIP-code poultry shipment network summarized in Subsection 3.3, using the channel assignments produced in Subsection 3.2. Unlike the destination-county-year markets maintained in the structural model, the descriptive network keeps origin and destination ZIP codes so that shipment links can be characterized before aggregation.

The network uses the same poultry SCTG codes as the structural sample: 05121 for fresh or chilled poultry and 05122 for frozen poultry. I begin with poultry shipment records originating from meat processors and grocery-related wholesalers. The descriptive extract contains roughly 63,000 poultry shipments across the 2007, 2012, and 2017 CFS waves. In a typical wave, about 200 processors and 200 wholesalers appear as CFS shippers. Because the CFS is a shipment survey rather than a census of all poultry establishments, the network objects should be interpreted as disclosure-cleared descriptive summaries of observed shipment links rather than as the universe of all poultry flows.

Shipments are organized into three directed link types. Processor-origin shipments use the PR and PW classification described in Subsection 3.2. Wholesaler-origin shipments are classified under the pooled legacy label WR, covering retail or other downstream-distribution destinations. This empirical label is not the separately calibrated $W \to R$ edge in Figure 1. After assigning shipment channels, I aggregate records to directed origin-ZIP–destination-ZIP edges by survey year and link type. Let $L \in \{PR, PW, WR\}$ index the link type and let t index the survey year. Table A2 reports the number of firms, plants, shipment records, source ZIP codes, destination ZIP codes, unique directed edges, weighted distances, density, and HHI for each (L, t) cell. For link type L in year t, network density is computed as

$$\text{Density}_{Lt} = \frac{E_{Lt}}{S_{Lt} D_{Lt}},$$

where E_{Lt} is the number of observed directed ZIP-to-ZIP edges, S_{Lt} is the number of source ZIPs, and D_{Lt} is the number of destination ZIPs. The HHI statistic is first computed within each source ZIP using destination-ZIP shipment-weight shares,

$$\mathrm{HHI}_{zLt} = \sum_d \left(\frac{\tilde{w}_{zdLt}}{\sum_{d'} \tilde{w}_{zd'Lt}} \right)^2,$$

where $\tilde{w}_{zdLt}$ is the CFS-expanded shipment weight on directed edge $z \to d$. The HHI is then averaged across source ZIPs using source-ZIP CFS-expanded shipment weight.

The descriptive network shows that distance patterns differ by link type. Processor-origin links become longer on average, especially PW links, while WR distances are more volatile. These patterns motivate the model's use of shipment distance, downstream channel exposure, and local buyer composition, but the descriptive ZIP network is not itself the maintained BLP market definition.

B.2 Destination-Set Coverage Diagnostic

The structural choice sets use positive processor-origin flows observed in the CFS. I assess how completely the sampled records recover each plant's set of destination counties with a finite-category occupancy model. For plant–survey-year observation e, let n_e denote the number of sampled shipment records used in the diagnostic, let k_e denote the number of distinct destination counties observed among those records, and let $M_e \geq k_e$ denote the number of potential destination counties. The calculation treats the sampled destination labels as independent draws and, as a benchmark, assigns each of the M_e counties probability $1/M_e$. Under this model,

$$\Pr(K_e = k_e \mid M_e, n_e) = \frac{(M_e)_{k_e}\, S(n_e, k_e)}{M_e^{n_e}}, \tag{25}$$

where $(M_e)_{k_e} = M_e(M_e - 1)\cdots(M_e - k_e + 1)$ is the falling factorial and $S(n_e, k_e)$ is a Stirling number of the second kind. Because $S(n_e, k_e)$ does not depend on M_e, the integer maximum-likelihood estimator is

$$\widehat{M}_e = \arg \max_{M \in \{k_e, k_e+1, \ldots\}} \frac{(M)_{k_e}}{M^{n_e}}. \tag{26}$$

I measure count coverage as $C_e = k_e/\widehat{M}_e$. Across plant–survey-year observations with a finite estimate, the disclosure-rounded mean of C_e is about 0.95. This result indicates that, at the county level, sampled shipment records recover nearly all of the effective plant-level destination support implied by the benchmark model.

The equal-probability assumption is useful for making M_e identifiable from (n_e, k_e), but it gives the diagnostic a specific interpretation. If true destination probabilities are unequal, rarely served counties are less likely to appear, and the equal-probability estimate can be smaller than the nominal number of counties with positive probability. At the same time, the observed counties are disproportionately likely to include high-volume destinations. I therefore interpret $k_e/\widehat{M}_e$ as evidence on coverage of the plant's effective county support, not as proof that every low-probability feasible link is observed. The diagnostic supports defining county-level availability from positive flows while preserving the residual limitation stated in Subsection 3.7.

B.3 Market-Size Construction

The final market-size measure in Subsection 3.5 combines CFS inside shipments, population-based poultry availability, and downstream retail and wholesale activity from ARTS/AWTS. The ARTS/AWTS variables are scale proxies for potential downstream poultry demand; they do not replace the CFS quantities used to form product-level inside shares. I first construct a population-based scale,

$$M_m^{\text{pop}} = \text{pop}_m \times \overline{\text{consumption}}_{t(m)},$$

where $\overline{\text{consumption}}_{t(m)}$ is national annual per-capita poultry availability in the CFS survey year of market m, measured in pounds and constructed from public chicken and turkey availability series (National Chicken Council, n.d.).

Because market m is a destination-county-year cell, let $c(m)$ denote its destination county and let $t(m)$ denote its year. I use county c and year y to describe the auxiliary ARTS/AWTS estimates before mapping them back to market m. For each ARTS/AWTS establishment record i, let w_i denote the survey weight WGT, and let z_i be one of total sales CSAL, total inventories CTINV, or operating expenses COPEX. Records are assigned to counties using reported FIPS codes or a ZIP-to-county crosswalk and are retained for the meat and poultry retail/wholesale NAICS cells used in the downstream calibration. The direct county-year survey estimate for variable z is

$$\widehat{Z}_{cy}^{\text{dir}}(z) = \sum_{i \in \mathcal{S}_{cy}} w_i z_i, \qquad z \in \{\text{CSAL}, \text{CTINV}, \text{COPEX}\}.$$

Annual ARTS/AWTS samples are sparse at the county level, so I stabilize the direct estimates using a five-year window around the year of market m, $\mathcal{W}(t(m)) = \{t(m)-2, t(m)-1, t(m), t(m)+1, t(m)+2\}$. The market year receives weight 3, adjacent years receive weight 2, and the two outer years receive weight 1. Let a_y denote this time weight and let $r_{c(m)y}$ be a reliability weight based on the number of usable survey observations in county $c(m)$ and year y. The pooled direct estimate assigned to market m is

$$\bar{Z}_m^{\text{dir}}(z) = \frac{\sum_{y \in \mathcal{W}(t(m))} a_y r_{c(m)y} \widehat{Z}_{c(m)y}^{\text{dir}}(z)}{\sum_{y \in \mathcal{W}(t(m))} a_y r_{c(m)y}}.$$

For counties with little or no direct survey support, I use the LBD county-year universe to construct small-area predictions. The auxiliary LBD variables are total employment, total payroll, and the number of downstream establishments in the same county-year. On county-years with usable ARTS/AWTS direct estimates, I fit log per-worker outcomes of the form

$$\log\left(\frac{\widehat{Z}_{cy}^{\text{dir}}(z) + 1}{\text{EMP}_{cy}^{\text{LBD}} + 1}\right) = X_{cy}'\beta_z + \mu_c + \eta_y + \varepsilon_{cy},$$

where X_{cy} contains LBD employment, payroll-per-worker, and establishment-count controls, and μ_c and η_y are county and year effects. The fitted values generate model-based county-year predictions that I map back to each market as $\bar{Z}_m^{\text{model}}(z) = \bar{Z}_{c(m),t(m)}^{\text{model}}(z)$. I combine direct and model-based information with an empirical shrinkage weight,

$$\bar{Z}_m(z) = \lambda_m \bar{Z}_m^{\text{dir}}(z) + (1 - \lambda_m)\bar{Z}_m^{\text{model}}(z), \qquad \lambda_m = \frac{n_m^{\text{win}}}{n_m^{\text{win}} + 10},$$

where n_m^{win} is the number of usable survey observations in the five-year window. Finally, I benchmark the county estimates so that their state-year, or national-year when state support is insufficient, totals match the corresponding pooled ARTS/AWTS survey totals. For state $s(m)$,

$$Z_m^{\text{bench}}(z) = \bar{Z}_m(z) \frac{\sum_{c \in s(m)} \bar{Z}_{c,t(m)}^{\text{dir}}(z)}{\sum_{c \in s(m)} \bar{Z}_{c,t(m)}(z)}.$$

The variables in the market-size regression are then

$$\begin{aligned} \text{meat\_sales}_m &= Z_m^{\text{bench}}(\text{CSAL}), \\ \text{meat\_inventories}_m &= Z_m^{\text{bench}}(\text{CTINV}), \\ \text{operating\_expenses}_m &= Z_m^{\text{bench}}(\text{COPEX}). \end{aligned}$$

The adjusted market-size proxy is obtained by regressing observed inside shipments on the population and downstream-scale variables,

$$\begin{aligned} R_m = \zeta_0 + \zeta_1 M_m^{\text{pop}} + \zeta_2 \text{meat\_sales}_m + \zeta_3 \text{meat\_inventories}_m \\ + \zeta_4 \text{operating\_expenses}_m + \nu_m, \end{aligned} \tag{27}$$

and denoting the fitted value by $\widehat{M}_m^{\text{adj}}$. The final baseline market-size proxy is

$$M_m = \frac{\max\{\widehat{M}_m^{\text{adj}}, R_m\}}{0.7}. \tag{28}$$

The max operator ensures that market size is not smaller than observed CFS-expanded inside shipments R_m. The denominator is a baseline normalization that leaves room for an outside option, since the retained CFS scope is not a complete census of poultry procurement. I use this market-size proxy to form product shares and the outside share in Subsection 3.5.

B.4 LBD Buyer-Agent Sampling

The random-coefficients model integrates over a market-specific sample of downstream buyers. In this paper, a representative buyer record is a numerical integration node drawn from LBD establishments in a destination-county-year market. It is not an individual household consumer and it is not an additional raw data source.

Let a index LBD establishments located in market m. I first classify each eligible establishment into one of three mutually exclusive buyer types using harmonized NAICS codes in the LBD extract:

$$T_{am} = \begin{cases} W, & \text{if NAICS is } 424410, 424420, 424470, \text{ or } 424440, \\ R, & \text{if NAICS is } 445110, 455211, \text{ or } 445240, \\ F, & \text{if NAICS begins with } 7225. \end{cases} \tag{29}$$

Here F denotes food-service establishments, R denotes retailers, and W denotes wholesalers. Food service is the omitted buyer type in the demand specification.

The LBD contains many small establishments in each county-year. Treating each establishment as equally representative would overstate the role of small restaurants and convenience stores relative to large retailers and wholesale distributors. I therefore use a probability-proportional-to-size (PPS) sampling weight that combines establishment employment with a buyer-type-specific measure of poultry throughput per employee. The throughput ratios are normalized so that food service equals one:

$$\tau_F = 1, \qquad \tau_R = 2.89, \qquad \tau_W = 38.12. \tag{30}$$

These ratios are calibration inputs for sampling representative buyer records; they are not estimated demand parameters. They enter the model only through the sampling probabilities in (35) below, so they shape the market-specific buyer-type distribution rather than the demand coefficients directly; Appendix E lists this calibration among the constructed inputs on which the reported standard errors condition. The numerical ratios are constructed from public national throughput-per-worker benchmarks. For buyer type $g \in \{F, R, W\}$, let $\widetilde{\tau}_g = Q_g/E_g$, where Q_g is annual poultry pounds handled and E_g is employment in the corresponding public NAICS industries. Food-service and retail pounds use 2017 chicken and turkey per-capita availability, together with ERS away-from-home shares of 47 percent for chicken and 30 percent for turkey (U.S. Department of Agriculture, Economic Research Service, 2021; National Chicken Council, n.d.). This broad away-from-home allocation is used only to scale PPS throughput per worker. It is distinct from the narrower restaurant-plus-fast-food terminal split in Figure 1 and does not calibrate that figure's edges:

$$Q_F = N^{\mathrm{US}}(92.1 \times 0.47 + 16.4 \times 0.30) \approx 15.67 \text{ billion lb}, \tag{31}$$

$$Q_R = N^{\mathrm{US}}(92.1 \times 0.53 + 16.4 \times 0.70) \approx 19.60 \text{ billion lb}, \tag{32}$$

where $N^{\mathrm{US}} = 325$ million approximates the 2017 U.S. population. Dividing by 2017 Economic Census employment gives $\widetilde{\tau}_F = 15.67$ billion lb/10,717,088 $\approx$ 1,462 lb per employee for food service (NAICS 7225) and $\widetilde{\tau}_R = 19.60$ billion lb/4,630,685 $\approx$ 4,232 lb per employee for the retail NAICS set used in the public calibration. For wholesale, I sum Economic Census poultry product-line sales across the relevant wholesale NAICS industries, 24.759 billion dollars, and convert dollars to pounds using \$1.498 per pound, a composite of the 2017 broiler wholesale and retail price composites:

$$Q_W = \frac{24.759 \text{ billion dollars}}{1.498 \text{ dollars/lb}} \approx 16.53 \text{ billion lb}. \tag{33}$$

With wholesale employment $E_W = 296{,}581$, this gives $\widetilde{\tau}_W = 16.53$ billion lb/296,581 $\approx$ 55,728 lb per employee (U.S. Census Bureau, 2024c). Normalizing by the food-service benchmark yields $\tau_R = 4{,}232/1{,}462 \approx 2.89$ and $\tau_W = 55{,}728/1{,}462 \approx 38.12$.

For establishment a in market m, the sampling size is

$$A_{am} = \mathrm{emp}_{am} \times \tau_{T_{am}}, \tag{34}$$

where emp_{am} is LBD employment and $\tau_{T_{am}}$ is the relative throughput per employee for the establishment's buyer type. This weighting scheme makes a wholesale employee represent substantially more potential poultry flow than a retail or food-service employee, while still allowing local employment to determine how much mass each establishment receives within its type.

For each market m, I draw 1,000 representative buyer records with replacement from the eligible establishment set $\mathcal{A}_m = \{a : T_{am} \in \{F, R, W\}\}$. The probability that establishment a is selected on any draw is

$$\Pr(i = a \mid m) = \frac{A_{am}}{\sum_{b \in \mathcal{A}_m} A_{bm}}. \tag{35}$$

The draw is therefore a probability-proportional-to-size approximation to the local buyer distribution. After sampling, the 1,000 representative buyer records are used as the numerical integration nodes in the BLP demand system. Because the sampling probabilities already incorporate employment and throughput differences, the integration weights are equal within a market:

$$\psi_{im} = \frac{1}{1{,}000}, \qquad i = 1, \ldots, 1{,}000. \tag{36}$$

The 700 estimation markets therefore generate 700,000 representative buyer records.

B.5 Instrument Set

The demand system treats the FOB-plant unit value as endogenous. The excluded demand instruments used in Section 4 are built from three groups:

1. Plant cost and scale shifters: materials, supplemental-input, and labor unit costs; production-worker payroll per hour; production employment; plant asset stock; capital expenditure relative to assets; inventory relative to assets; input-intensity measures for packaging, raw poultry, and poultry parts, defined as the corresponding CMF materials-detail costs per pound of CFS-expanded shipment weight; and indicators for own-slaughter and external-slaughter processing plants.

2. Market-structure shifters: counts of rival products, rival frozen products, rival broiler products, rival processed-poultry products, and distinct firms in the destination-county-year market.

3. Local differentiation instruments: Gandhi–Houde local differentiation measures constructed from frozen status, shipment distance, broiler status, turkey status, and processed-poultry status (Gandhi and Houde, 2019).

The product's own log shipment distance is an included demand characteristic and therefore serves as its own instrument. The distance-based local differentiation measures are separate excluded instruments for the endogenous FOB-plant unit value. Turkey status is an indicator equal to one for plants whose CMF product line is turkey; because turkey plants belong to the other-poultry category in the demand and supply specifications, the indicator enters only the construction of the differentiation instruments. The supply-side moments use the exogenous cost shifters, product and plant-type indicators, shipment characteristics, year indicators, destination population, and rival-count variables in the marginal-cost specification.

The preliminary IV first stages and the BLP demand moments absorb LBD firm, producing-establishment origin-state-by-survey-year, and destination-state-by-survey-year fixed effects. Thus demand-side identification uses the component of each instrument remaining after persistent firm-level differences, shocks common to an origin state in a survey year, and demand conditions common to a destination state in a survey year are removed. The supply-side specification does not impose these demand fixed effects. This conditioning strengthens the interpretation of cost and scale shifters relative to specifications based only on cross-firm or common regional-year variation, but it does not rule out correlation with time-varying plant-product quality, product composition, county-specific demand shocks, product-specific destination selection, or buyer–supplier matching.

C Variable Definitions

Table A10 reports the main variables used in the demand, supply, and preliminary regression specifications. The table is intended as a compact dictionary for variables whose construction is described in Section 3 and Appendix B. It orders variables by their economic role rather than by source file: shipment-based variables, representative-buyer variables, plant characteristics, and market-structure instruments.

Several variables are defined at the product-market level. A product is an establishment–commodity pair defined by the establishment and its SCTG code, and a market is a destination-county-year cell. Product-market FOB-plant unit values, quantities, shares, shipment distance, private-carriage shares, and the wholesale-channel share ToW are all constructed from CFS records after multiplying shipment-level values and physical shipment weights by the within-establishment annualization weight defined in Subsection 3.1. This weight retains the identity of the observed establishment and excludes the first-stage establishment sample weight and nonresponse post-stratification adjustment. The product-level indicators Frozen, Broiler, and Processed poultry combine SCTG information with CMF product-line information, so temperature status and plant product specialization enter separately.

The preliminary demand regressions, their IV first-stage projections, and the BLP demand specification include LBD firm fixed effects, origin-state-by-survey-year fixed effects, and destination-state-by-survey-year fixed effects. Origin state is the state containing the producing establishment, while destination state is the state containing the destination county that defines the procurement market. The fixed effects are demand-side controls and are not imposed on the marginal-cost equation.

The representative-buyer variables are defined at the sampled-record level within each market. The indicators type_R and type_W identify sampled retail and wholesale representative buyer records, with food service as the omitted group. The sampling size combines LBD employment with the buyer-type throughput-per-employee calibration described in Appendix B.4; it affects which establishments are represented in the numerical integration sample but is not itself an estimated demand parameter.

The supply-side controls are plant-level characteristics merged from Census manufacturing records. The unit-cost variables mc, sc, and wc are reported in constant 2017 dollars per pound and correspond to materials, supplemental inputs, and labor, respectively; the mnemonic mc refers to materials cost and is distinct from the marginal cost mc_{jm} in the supply model. The rival-count variables summarize the composition of the choice set in each destination-county-year market and enter the preliminary and structural specifications as market-structure controls or instruments.

D State-Level Counterfactual Results

Figure A1 first displays the model-implied baseline state-level distributions of the FOB-plant unit value and cost (both in $/lb), own-price elasticity, inside sales and market size (both in billion lb), and producer, downstream-buyer, and total surplus normalized by inside sales (in $/lb). Table A7 reports the state-level rows underlying Figure 3 and the aggregate counterfactual summary in Table 3. As in Section 6, state-level quantity and surplus entries sum annual model-implied outcomes across the three CFS survey years (2007, 2012, and 2017) and are not cumulative 2007–2017 flows; unit values, costs, and elasticities are averages. The table reports destination states by name after converting the original destination-state FIPS codes; Rest of America corresponds to the original FIPS 99 aggregate. The table is organized by scenario so that each block can be compared directly with the model-implied baseline. Within a state, the relevant welfare comparison is the change in the TS (total-surplus) column relative to the baseline row for the same state; the main text summarizes these state-level changes in percentage and absolute terms.

In Table A7, FOB denotes the FOB-plant unit value and is reported in $/lb; cost is also reported in $/lb; Mkt. and Inside denote market size and inside sales in billion lb; and PS, BS, and TS denote producer surplus, downstream-buyer surplus, and total surplus in billions of dollars. Within each state row, FOB, cost, and elasticity are averages across product-market cells weighted by CFS-expanded quantity. The plant-unavailability scenario makes products from the confidential weather-exposed county set unavailable; the distance scenario increases effective shipment distance by 20 percent; the cost scenario raises raw-poultry cost by 20 percent; and the firm-merger scenario combines the third-largest and fourth-largest firms, ranked by total CFS-expanded shipment value in the estimation sample.

D.1 Public Examples for the Plant-Unavailability Scenario

Table A9 reports public examples of southeastern counties with poultry-processing capacity or upstream poultry production that experienced weather-related interruptions. The table is not the confidential county list used to run the plant-unavailability simulation. The examples clarify the type of county used to motivate the weather-exposed choice-set shock; the counterfactual itself remains a stylized simulation rather than an event-study estimate.

E Validation Under Disclosure Constraints

All analyses are conducted with restricted-use Census microdata inside a Federal Statistical Research Data Center. The validation strategy is therefore deliberately narrow: I report only checks that are essential for credibility and can be summarized in disclosure-cleared aggregate form. I do not present a broad grid of alternative specifications that would require many additional sample cells, state-by-industry cuts, or unpublished establishment-level diagnostics. The central question is not whether every plausible variant has been exhausted, but whether the two constructed ingredients that carry the empirical design—the PR–PW channel classifier and the unit-value-endogenous demand specification—have enough support to interpret the estimates.

The first check is PR–PW classifier assessment. Subsection 3.2 describes a 90–10 training-validation partition: candidate specifications are compared by ten-fold cross-validation within the training set, the validation set is used to select the hyperparameter specification, and the final random forest is then refit on the full labeled sample. The disclosure-cleared confusion matrix reports fitted classifications from this final refit and is not a held-out matrix. Accuracy on the 10 percent validation set was about 96 percent, with comparable values for the other validation-set metrics. This check is necessary because ToW and the descriptive shipment network depend on the classifier; in particular, it asks whether the classifier can recover the less frequent PW label in the mechanically labeled shipment-record sample rather than simply predict the more frequent PR label in that sample. This record-class balance has no interpretation as a national physical-flow share. The high fitted accuracy and meaningful recovery of the PW class support treating the random-forest assignment as a data-construction device rather than as a separately estimated economic mechanism, subject to the transferability assumption in Subsection 3.2.

The second check is demand-identification validation. The preliminary OLS, IV, and nested-logit estimates in Table 1 are used as diagnostics for the structural model: the IV coefficient on the FOB-plant unit value is more negative than OLS, the nested-logit parameter supports stronger within-nest substitution, and the excluded instruments enter through the same unit-value-endogeneity channel used in the BLP specification. The preliminary demand equations, their first-stage projections, and BLP mean utility all absorb firm, producing-establishment origin-state-by-survey-year, and destination-state-by-survey-year fixed effects. The released evidence on instrument relevance is therefore conditional on those effects: the OLS-to-IV movement together with the cluster-robust Montiel Olea–Pflueger effective first-stage F of 77.62 for the IV logit, well above its critical value, and the Kleibergen–Paap rk Wald F of 58.19 for the nested-logit benchmark, reported as a descriptive diagnostic. These diagnostics establish relevance after the fixed effects but do not by themselves test the exclusion restriction. They are more important than a large set of alternative counterfactuals because rejected demand identification would undermine every surplus calculation. Additional sensitivity analyses, such as alternative representative-buyer sampling rules, ownership groupings, and shock magnitudes, are better treated as limitations or future extensions unless disclosure-cleared aggregate versions are needed during review.

One additional limitation follows from the same disclosure-constrained design. Several inputs are constructed before structural estimation, including the wholesale-channel share ToW, the market-size proxy M_m, the throughput calibration used in representative-buyer sampling, and the PPS representative-buyer draws. Of these, the market-size normalization is examined directly: Table A8 re-estimates the model under outside-option normalizations of 0.6 and 0.8 and shows that scenario signs, rankings, and magnitudes are essentially unchanged. Table A4 similarly documents the sampling depth behind the product-market cells; thin cells carry little CFS-expanded weight. The reported standard errors condition on these constructed inputs rather than propagating all first-stage prediction, calibration, and sampling uncertainty. For the same reason, the counterfactual outcomes in Section 6 are reported as point values evaluated at the estimated parameters: simulation-based uncertainty measures would require many additional disclosure cells, and the scenario comparisons should be read as model-implied magnitudes rather than as estimates with released sampling intervals.

F Additional Model and Counterfactual Details

F.1 Preliminary Logit Benchmarks

Following the market-share inversion in Berry (1994), define

$$y_{jm} = \log(s_{jm}) - \log(s_{0m}), \tag{37}$$

where s_{jm} is product j's share in market m and s_{0m} is the outside-option share. The OLS and IV benchmarks estimate

$$y_{jm} = x'_{jm}\beta + \alpha p_{jm} + \phi_{f(j,m)} + \lambda_{o(j),t(m)} + \eta_{r(m),t(m)} + \xi_{jm}. \tag{38}$$

Here, x_{jm} contains the demand controls used in the structural specification, and the three sets of fixed effects are for the firm, origin state by survey year, and destination state by survey year. The IV model instruments the FOB-plant unit value with the excluded demand instruments described in Appendix B.5.

The nested-logit benchmark adds the within-nest share:

$$y_{jm} = x'_{jm}\beta + \alpha p_{jm} + \rho \log(s_{j|g(j),m}) + \phi_{f(j,m)} + \lambda_{o(j),t(m)} + \eta_{r(m),t(m)} + \xi_{jm}. \tag{39}$$

The nests are broiler, processed poultry, and other poultry; frozen status remains an observed characteristic. Both the unit value and the within-nest share are instrumented. Table 1 reports the full estimates. The unit-value coefficient becomes more negative under IV, the IV-logit effective first-stage F statistic is 77.62, and the nested-logit estimate of ρ is 0.448. Distance is negative across specifications, while the positive broiler interaction implies a weaker distance penalty for commodity-like broiler products.

F.2 Counterfactual Computation and Welfare Aggregation

For scenario c, I hold $(\hat{\theta}, \hat{\gamma})$ and the fitted demand and cost unobservables fixed for products that remain available. The counterfactual equilibrium solves

$$\mathbf{p}^c_m = \mathbf{mc}^c_m(\hat{\gamma}, \hat{\boldsymbol{\omega}}_m) + \Delta^c_m(\mathbf{p}^c_m; \hat{\theta})^{-1} s^c_m(\mathbf{p}^c_m; \hat{\theta}), \tag{40}$$

following standard differentiated-products counterfactual simulation (Nevo, 2000b). Producer surplus is

$$PS^c_m = \sum_{j \in \mathcal{J}^c_m} (p^c_{jm} - mc^c_{jm}) q^c_{jm}, \qquad q^c_{jm} = M_m s^c_{jm}(\mathbf{p}^c_m; \hat{\theta}), \tag{41}$$

with market size M_m fixed at its baseline value. For representative buyer i, the counterfactual inclusive value for nest g is

$$I^c_{igm}(\hat{\theta}) = \sum_{k \in \mathcal{J}^c_{g,m}} \exp\left(\frac{\delta^c_{km} + \mu^c_{ikm}}{1-\hat{\rho}}\right). \tag{42}$$

Downstream-buyer surplus and total surplus are

$$BS^c_m = M_m \sum_i \psi_{im} \frac{\log\left(1 + \sum_{g \in \mathcal{G}} [I^c_{igm}(\hat{\theta})]^{1-\hat{\rho}}\right)}{\hat{\alpha}_{im}}, \tag{43}$$

$$TS^c_m = PS^c_m + BS^c_m. \tag{44}$$

Price elasticities are

$$\epsilon_{jk,m} = \frac{\partial s_{jm}(\hat{\theta})}{\partial p_{km}} \frac{p_{km}}{s_{jm}}. \tag{45}$$

The diagonal terms are own-price elasticities, and the off-diagonal terms govern substitution toward rival products in the same market. Quantities and surplus in the aggregate table sum the three survey-year outcomes; unit values, costs, and elasticities are averages across disclosure-cleared state rows. All scenarios use the same market-size normalization. Appendix E reports the corresponding normalization sensitivity.

F.3 Shock Implementation and Interpretation

The logistics scenario applies the proportional route transformation

$$d^c_{jm} = 1.2 d_{jm}, \qquad \log d^c_{jm} = \log d_{jm} + \log(1.2). \tag{46}$$

All log-distance terms and their interactions are re-evaluated at the transformed distance. The scenario represents detours or an equivalent network-wide increase in shipping frictions; plants and destinations do not move.

The raw-poultry scenario raises by 20 percent the input-cost component constructed from CMF materials detail in constant 2017 dollars per pound of CFS-expanded shipment weight, and adds the resulting dollar increase one-for-one to marginal cost. This is distinct from the cross-sectional materials coefficient in Table A6, which is identified from cross-plant variation that also reflects product mix, slaughter arrangements, and measurement error. The shock magnitude is economically plausible: feed accounts for roughly two-thirds of live-broiler production cost, and historical corn and soybean-meal prices have exhibited changes of comparable scale (MacDonald, 2014; U.S. Department of Agriculture, Economic Research

Service, n.d.a). This comparison is a plausibility check, not a validation exercise.

The plant-unavailability scenario removes products from a confidential set of southeastern counties selected to represent weather-exposed processing capacity. The set was fixed before equilibrium outcomes were computed and was not chosen from simulated welfare effects. Appendix D.1 gives the selection rule and public analogues. The exercise is an unconstrained short-run spatial-reallocation benchmark: surviving plants can expand at constant marginal cost, and displaced volume can move to the residual outside option.

The merger scenario assigns products of the third- and fourth-largest firms, ranked by CFS-expanded shipment value, to one owner. It holds marginal-cost primitives and product offerings fixed. The exercise therefore isolates short-run pricing incentives and excludes efficiencies, entry, capacity changes, and product repositioning; these longer-run adjustments can moderate merger effects (Wollmann, 2018).