

*The Impact of Innovation, Regulation,  
and Market Power on Economic Development:  
Evidence from the American West*

This dissertation is an empirical analysis of how the interaction between innovation, market power, and regulation reshaped the American West between the late nineteenth and early twentieth centuries. American agricultural production experienced drastic technological change and regulatory shifts during this period. I focus on the long-term effect of mechanical refrigeration on agriculture productivity, how this innovation influenced market power in the meatpacking industry, and finally, the influence of liability rules on agricultural land use and livestock production. The evolution of technology, market structure, and legal frameworks in the past century provides a valuable angle to understand current policy challenges.

LONG-TERM EFFECT OF MECHANICAL REFRIGERATION  
ON U.S. AGRICULTURAL PRODUCTION

Despite the historical importance of refrigeration, few studies have empirically analyzed its long-term impact on American agriculture. Prior to refrigerated rail cars, livestock needed to be transported alive from farms to urban markets to be slaughtered and sold. The transportation process was costly and risked animals losing weight or dying on the trip. In 1880, meat packers in the Midwest acquired the patent to build the first refrigerated rail car. The invention significantly reduced the shipping cost of beef: carcasses could be shipped for one-third the cost of shipping live cattle. Within ten years, from 1880 to 1890, the number of cattle slaughtered in Chicago more than quadrupled, and the meatpacking industry became the second-largest manufacturing sector in terms of output value.

The research design exploits the variation in relative natural suitability for livestock versus grain production across counties to capture the impact of refrigeration. Perishable goods, such as beef, experienced a drastic reduction in transportation costs after 1880. Meanwhile, this change did not influence other non-perishable products, such as wheat. In other words, counties more suitable for livestock production were more influenced by the new technology, thus allowing an event-study analysis that compares changes in counties more or less suitable for livestock production before and after 1880.

The event study shows that after 1880, when refrigeration was commercially adopted in the meatpacking industry, counties that were relatively more suitable for ranching than farming witnessed more farmland development and higher output value. For every percentile increase in the relative suitability ranking, counties experienced a 0.1 percentage point increase in the share of land areas being developed as farmland and a

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0.5 percent increase in output value and land value. The effects also differ for counties across the range of relative suitability but persist over time. The results were driven primarily by the top two quartiles, but the impact on output and land value persisted until 1960.

#### MONOPSONY, CARTELS, AND MARKET MANIPULATION: EVIDENCE FROM THE U.S. MEATPACKING INDUSTRY

In addition to shifting upstream agricultural production, how does the new technology affect market power and the competition structure in the manufacturing sector? In this chapter, I answer this question by analyzing the American meatpacking industry in the early twentieth century.

Due to the high fixed costs, mechanical refrigeration created a few firms with unprecedented market power in the meatpacking industry. By the early twentieth century, five firms dominated the meatpacking industry. Under weak antitrust enforcement, they formed a monopsonistic cartel to manipulate the wholesale cattle market. The cartel dominated both the input market (cattle) and product market (beef): the five packers purchased 95 percent of cattle sold at the ten largest stockyards and produced more than 80 percent of refrigerated beef for urban markets. In an era of weak antitrust enforcement, they openly colluded to manipulate the wholesale cattle market from 1893 to 1920.

Standard monopsony models focus primarily on static and immediate responses to cartel strategies. However, for markets with substantial time to ship or time to build, current market outcomes may influence future supply decisions and thus make sellers vulnerable to a more complex form of dynamic manipulation. Because sellers must make future production or shipment decisions based on current market information, they must commit to the market before observing the realized spot market price at the time of delivery. If a monopsonistic cartel incorporates the delayed supply responses in the collusive strategy, the canonical static model may fail to properly assess the cartel damage on the market.

Two factors make this historical case particularly well suited to examining the effect of a dynamic monopsonistic cartel strategy. First, because the cartel was eventually challenged in court, the resulting litigation created detailed documentation on the cartel's manipulation strategies. The court found that the cartel members were guilty of "bidding up through their agents, the prices of livestock for a few days at a time, to induce large shipments, and then ceasing from bids, to obtain livestock thus shipped at prices much less than it would bring in the regular way." Second, exogenous changes in the regulatory environment forced the cartel to switch from the aforementioned dynamic strategy to a static, fixed market share agreement in 1913, while other features of the market remained unchanged. Thus, I observe the market outcomes under both dynamic and static strategies, but with the same market participants. This allows me to compare the empirical outcomes under the dynamic strategy to counterfactuals suggested by the well-understood static monopsony model.

The main analyses leverage exogenous regulatory changes that forced the cartel to switch from dynamic to static strategies. I first construct and estimate a static model of the cattle wholesale market using data after 1913, when the cartel strategy coincided with the static model. I then use the estimated static model to solve for market outcomes for the dynamic period *before* 1913. This recovers the counterfactual cattle wholesale prices and cartel quantities as well as downstream wholesale beef prices. The difference

between the observed market outcomes under the dynamic strategy and the counterfactuals suggested by the static model is, therefore, the “additional” damage of the dynamic cartel strategy not captured by standard models.

I find two sets of key results. First, regarding the wholesale cattle market, the dynamic strategy causes more damage to small sellers than what is suggested by the standard model. Without cartel manipulation, the average cattle wholesale price would increase by 23.4 percent, which would increase the profit margin by 57 percent for the sellers. The average total quantity purchased by the cartel would also increase by 14 percent, or 15,000 more heads of cattle per week sold at the four stockyards. Second, regarding the downstream wholesale beef market, the dynamic strategy hurts urban consumers by reducing the beef supply and increasing household food expenditure. However, the effects are much smaller: without cartel manipulation, downstream wholesale beef prices would reduce by 6 percent, and total household food expenditures would reduce by \$3.6 per year.

#### FENCE LAWS: LIABILITY RULES AND AGRICULTURAL PRODUCTIVITY

This chapter uses the historical evolution of fence laws in the American West to analyze the long-term effect of liability rules on resource allocation and productivity. In his seminal article, Coase (1960) uses an example between a farmer and a cattle-raiser adjacent to each other to illustrate that the assignment of property damage liability does not affect the allocation of resources. Cattle may stray and destroy the crops on the farmer’s land. Regardless of whether the farmer or the cattle-raiser is legally liable for the trespassing damage, the land allocation between the two types of production should reach the same equilibrium, as long as the liability is well-defined and enforced, and the transaction is costless. However, despite the wide application, most research focuses on the effects of establishing and enforcing property rights. Few empirical works study how the assignment of property damage liability may influence resource allocation.

In the American West, counties assign the liability of protecting against animal trespassing to either farmers or ranchers. Under the “fence-out” rule, farmers can claim damage from owners of the trespassing animals *only if* they have enclosed the land with fences that satisfy specific regulatory requirements. Meanwhile, under the “fence-in” rule, farmers can claim damage from livestock owners *regardless* of whether the farms are enclosed with fences. In other words, the liability for livestock trespassing is assigned to farmers in some areas and livestock owners in others. Ranchers and farmers have long contested fence regulations. Prolonged public debates and occasional violent conflicts between farmers and ranchers suggest that this supposedly innocuous rule had profound economic implications.

I compiled data on all county-level fence-related regulation changes from the first state (or territorial) legislature until 1930. To the best of my knowledge, this is the first dataset that fully captures the legal environment for property rights protection during this period. I combine the fence law data with the decennial censuses, measuring land use, land value, output value, and productivity over the past century. This data provides a comprehensive legislative history of liability rules for the western states.

The analysis exploits the county-level fence laws variation over time to quantify the effects of liability rules on agricultural productivity. Consistent with historical accounts, the baseline difference-in-differences results show that fence-in rules incentivized

agricultural development. Compared to fence-out counties that required farmers to construct fences, the fence-in law increased the density of farmland and the share of improved farmland. By making ranchers liable for trespassing damages, the fence-in rule also increased grain cultivation area. This eventually translates to a higher total value of farm output for fence-in counties, although the higher productivity was not reflected in land values.

#### CONCLUSIONS

With newly constructed historical data and clear identification strategies, this dissertation provides new causal evidence on the persistent impact of innovation and regulation. It quantifies the long-term economic impact of some of American history's most important technological and regulatory changes. The results also expand our understanding of the interaction between innovation and regulation and how they can influence market structure and economic development. First, mechanical refrigeration benefited upstream agricultural production, especially in places relatively more suitable for ranching. Meanwhile, the high fixed cost of the new technology also created a highly concentrated market, resulting in welfare losses for both small suppliers and consumers. Finally, while antitrust laws improved welfare by restricting market manipulation, other seemingly innocuous regulations, such as the fence laws, created persistent resource misallocation.

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### *Financial Crises and Economic Growth: U.S. Cities, Counties, and School Districts during the Great Depression*

I study the impact of financial frictions on local public good provision and economic activity during the Great Depression in the United States. To date, research has shown that the fragility of households and firms during crises is an important determinant of their outcomes: highly indebted households and firms with fractured creditor relationships seem to bear the brunt of recessions (Chodorow-Reich 2014; Mian, Rao, and Sufi 2013). Yet, leveraged local governments have received much less attention, despite the vast size of the municipal bond market and the economic importance of local public services.

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