



# Generalized linear competition: From pass-through to policy

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Economic policy and shifts in input market prices often have significant effects on the marginal costs of firms and can prompt strategic responses that are hard to predict. Changing costs may be a direct objective of regulation, for example, when it puts a price on an externality such as carbon emissions or introduces a minimum wage. In other cases, like the emergence of fracking technology that has reduced energy costs for many US companies, the shift is market-driven. Such cost shifts can have important—and potentially highly heterogeneous—impacts on the profitability of firms. An *ex ante* understanding of these profit implications can be critical to the evaluation and successful implementation of policy on one hand and to the formulation of corporate strategy on the other.

However, estimating the firm-level profit impacts of a cost shift is not straightforward. In general, its profit impact will depend on the firm's own production technology, the structure of demand, and its rivals' strategic responses. The last factor is particularly challenging in that modelling it usually requires information on the identities of all firms, each of their production technologies, the nature of product differentiation, what variables the firms compete on, the intensity of competition in the market, and so forth. Our aim here is to present an approach that radically simplifies this problem.

In the first part of the paper, we introduce a new reduced-form model: “generalized linear competition” (GLC). We developed GLC to respond to the call for economists to derive “predictions which are robust across a range of model specifications which are deemed reasonable.” GLC makes weaker assumptions than typical models of imperfect competition. GLC makes no assumptions about the consumer demand system, on the technologies and strategies of rivals, or about “equilibrium”. In this sense, our approach is consistent with notions of bounded rationality of firms and/or consumers.

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We use GLC to quantify the impacts of a cost shift and its winners and losers. The cost shift raises a firm's unit cost and affects those of its rivals in an arbitrary way. We show how firm-level cost pass-through, i.e., the fraction of its cost increase that is passed onto its price, is a sufficient statistic for the profit impact. That is, all relevant information on the firm's demand and supply conditions is contained in this single metric. We show that higher pass-through implies a more favourable profit impact; a firm's profit falls with the cost shift if and only if its pass-through is below 100%.

The second part of the paper illustrates the usefulness of the GLC framework by estimating the profit impacts of introducing carbon pricing in the domestic US airline market. This setting is important in its own right: emissions from airline travel are projected to grow well into the 21st century and economic regulation is likely as countries seek to implement internationally-agreed climate targets in a cost-effective manner. At a price of \$30 per ton of carbon dioxide, the annual "value" of US airlines' total carbon emissions is around \$4 billion. Like many other industries, aviation is characterized by important demand, cost and conduct heterogeneities between firms.

Leveraging GLC, we estimate the firm-level profit impacts of carbon pricing in three steps. Using quarterly ticket price data for 1,334 domestic US carrier-routes over the period 2004–2013, we estimate pass-through of fuel costs utilizing plausibly exogenous variation in fuel prices as an instrument. Our baseline specification is a standard unbalanced panel with fixed effects for each carrier-route and year-quarter; we also control for variation in demand conditions, non-fuel costs and proxies for competition. Our results show significant intra-industry heterogeneity in pass-through: the large legacy carriers (American, Delta, United and US Airways) have pass-through that is significantly smaller than 100%; by contrast, thanks to its more fuel-efficient planes, the major low-cost carrier Southwest has pass-through above 100%.

At a \$30/tCO<sub>2</sub> carbon price, reflecting differences in pass-through, legacy carriers' profits fall by \$234 million while Southwest is a winner with a profit increase of \$98 million. decline due to climate regulation, albeit only modestly. Overall, the industry's profits decline, albeit only modestly. Finally, we also show how GLC's structure can be used for welfare analysis and to endogenize the extent of regulation.

We developed GLC with the objective of a simple yet robust modelling approach that can be put to use on a range of policy issues across different industries. GLC's comparative advantage lies in lower complexity in conducting *ex ante* policy evaluations, rooted in the theory of imperfect competition, but without requiring commitment to a particular model or notion of equilibrium.