



## Outsourcing and pass-through

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### ABSTRACT

A large share of international trade occurs through intra-firm transactions. We show that this common cross-border organization of the firm has implications for the well-documented incomplete transmission of shocks across such borders. We present new evidence of an inverse relationship between a firm's outsourcing of inputs and its rate of exchange-rate pass-through. We then develop a structural econometric model with final assemblers and upstream parts suppliers to quantify how firms' organization of their activities across national borders affects their pass-through behavior.

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### 1. Introduction

In recent years, the trade literature has produced several important new insights into the international organization of production. First, firms that engage in foreign trade are not a random sample of firms operating in the domestic economy but are larger, more productive, and more likely to be multinationals (see Helpman, 2006, for a review). Second, over the half-century of globalization dominated by multinationals (Bordo et al., 1999), trade in intermediate inputs has risen dramatically (Hummels et al., 2001). Third, over the past two decades, spurred by advances in computer-aided manufacturing, outsourcing has expanded both domestically and abroad.<sup>1</sup> A natural question, then, is, how do these stylized facts help us better understand some of the pricing puzzles in international macroeconomics, such as the incomplete transmission of exchange-rate shocks to domestic prices? This paper analyzes the extent to which how firms organize their production activities across borders affects their pass-through of exchange-rate shocks to their prices.

Although a substantial theoretical and empirical literature has made progress explaining *how* firms do not fully adjust their import prices following an exchange-rate shock, much less is understood about *why*. Yet assumptions about the *why* of this inertia shape economists' policy recommendations on some of the most basic issues in international goods and financial markets. Current research (most

notably, Engel, 2002) points to three overarching sources of incomplete pass-through: the importance of local nontraded costs in the total costs of imported goods; markup adjustment by firms along the distribution chain; and the costs of nominal price adjustment.<sup>2</sup> Evidence on the relative importance and underlying drivers of these sources remains mixed as the most important variables identified by theory—such as markups, nontraded costs, or vertical contracts—generally remain unobservable in practice, particularly in aggregate data sets. Before macroeconomic models can grapple with the implications of each of these potential sources of incomplete transmission, they need stylized facts from the microeconomic literature about their relative importance and underlying drivers.

To identify the relative importance and underlying drivers of each potential source of incomplete transmission, a recent literature has drawn on new data sets for modeling the microeconomics of incomplete pass-through by exploiting the structural approach common to industrial organization (IO) models. The unique advantages of IO studies enable them to provide insights unattainable through other common approaches in the literature. First, IO studies use microeconomic data sets that generally have higher quality data than aggregate data sets, with more precise estimates of both prices and quantities. Although quantities are rarely available in aggregate data, they are needed to observe or derive variables of interest to pass-through studies, such as markups. Second, IO studies draw on industry lore to

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<sup>1</sup> Helpman (2006) reviews the relevant literature.

<sup>2</sup> See Burstein et al. (2003), Campa and Goldberg (2005), Corsetti and Dedola (2005), Corsetti et al. (2010), Gopinath et al. (2010), Gopinath and Rigobon (2008), Gron and Swenson (2000), and Krugman (1987).

inform modeling assumptions, which, together with their higher quality microeconomic data, can deliver credible estimates of markups, local costs, and the like. Third, regarding the sources of markup adjustment, IO studies provide possible mechanisms for formalizing the reasons that price does not equal costs and thus for why changes in costs may not be passed through into prices. These mechanisms may include long-term contracts (Bettendorf and Verboven, 2000) or the possibility of strategic markup adjustment along the supply distribution chain (Goldberg and Verboven, 2001; Bonnet et al., 2009). Finally, IO studies generally use structural models that allow counterfactual experiments for testing the various hypotheses about why pass-through is low and thus enable researchers to ask deeper questions than are possible in modeling approaches that rely exclusively on aggregate data. Examples include Hellerstein (2008), Goldberg and Hellerstein (2008), and Nakamura and Zerom (2009), which all use structural models to decompose the relative importance of various sources of incomplete pass-through. This paper, based on the IO approach, analyzes the impact of vertical relationships on firms' markup adjustment—and the consequent incomplete pass-through. The disadvantage of IO studies is that to be generalizable, the results require confirmation from work on other industries. That said, the literature so far has begun to identify stylized microeconomic facts that are remarkably robust across markets and modeling assumptions.

Our first goal in this paper is to present evidence of a positive relationship between a firm's degree of vertical integration and its pass-through of foreign cost shocks. The second goal is to look more deeply at the sources of incomplete transmission by using a structural model to run counterfactual experiments which simulate variations in firm boundaries across national borders. For the structural model, our empirical approach has two components: estimation and simulation of counterfactuals. At the estimation stage, we estimate the demand parameters and then the marginal costs and markups of the original equipment manufacturer (OEM) and what in industry parlance is known as a tier-one parts supplier (TOPS) for each vertical contractual model. To assess the overall impact of each vertical contract on firms' pass-through behavior, we employ simulation.

A cross-border contract is by definition a vertical contract between an upstream (foreign) and a downstream (domestic) firm. Our structural model studies a continuum of contracts with two extreme points of integration: vertically integrated and outsourced supply chains. In a vertically integrated supply chain, all transactions are conducted in-house, within the boundaries of the firm. In an outsourced supply chain, all transactions are conducted at arm's length between firms with no formal ownership ties or control rights over one another's production and pricing decisions. In the structural model, we begin by computing the industry equilibrium that emerges if firms experience a 10-percent cost increase in the outsourced model and compare it to the equilibrium that prevails when one firm, a multinational, controls pricing along the distribution chain. We interpret the different response of prices across the two models as a measure of the overall impact of firms' cross-border organization on their pass-through of shocks. We find that, on average, following a 10-percent cost increase, firms pass through 54% of a foreign cost shock to their retail prices in a vertically integrated supply chain and only 13% in an outsourced supply chain, a 40 percentage-point difference. Next, we compute pass-through with a structural model calibrated to the average degree of vertical integration observed in the auto industry. We then compare the results to the outcome given a one standard deviation increase in the share of outsourced production. We find that a one standard deviation increase in outsourcing is associated with a 12 percentage-point decline in firms' average pass-through to prices. The counterfactual experiments thus confirm that pass-through is much higher in a vertically integrated than in an outsourced production chain.

The empirical pass-through literature generally attributes some part of local-currency price inertia to firms' markup adjustment but without analyzing its drivers, such as the role of different vertical

contracts between suppliers and final-goods producers. An early paper by Rangan et al. (1993) argues that U.S. multinationals pass-through exchange-rate shocks to export prices at a higher rate than do vertically separated firms.<sup>3</sup> Several more recent papers, including Clausing (2003) and Neiman (2010), examine the empirical relationship between the boundaries of the firm and the transmission of shocks across national borders. Using the microeconomic price data used to construct the U.S. Bureau of Labor Statistics' international price indexes, Clausing (2003) and Neiman (2010) estimate pass-through elasticities for intra-firm and market transactions for U.S. imports and exports. Clausing (2003) finds a higher rate of pass-through for U.S. imports traded in market transactions than in intra-firm transactions, while Neiman (2010) finds a higher rate of pass-through for differentiated goods traded in intra-firm transactions than for those traded in market transactions, a very similar result to our findings. Our study is different from this previous work in several important respects. Although the microdata used in previous work encompass a number of industries, the intra-firm data are transfer prices, whose variation may not fully reflect variation in transaction prices because of firms' incentives to transfer income across borders to minimize taxes, a fact established by Clausing (2003).<sup>4</sup> While our microdata cover only the auto industry, we are able to use quantity data to derive intra-firm markups. We do not use transfer prices in our structural analysis.

We study the auto industry in our structural analysis for several reasons. First, because prices of manufactured goods tend to exhibit dampened responses to foreign shocks in aggregate data, autos are an appropriate choice to investigate the puzzling phenomenon of incomplete pass-through. Second, trade in autos and auto parts is quite large for most countries, which gives our empirical results direct policy relevance. For example, trade in autos and auto parts makes up 25 to 40% of U.S. goods imports in any given year, depending on how one concords the industry's input-output tables with import data. Third, we have a rich panel data set with monthly transaction prices for 24 models from six major manufacturers over a period of 37 months, as well as the share of inputs sourced from abroad by model. We focus on the top-selling models and thus have a limited number of car models in our sample, each with a very large U.S. market share. This approach enables us to use product fixed effects to control for product-specific, time-invariant characteristics in our structural demand model, as we discuss further in the estimation section. These 24 models comprise roughly one-third of U.S. sales of passenger cars and sports utility vehicles (SUVs). Our sample includes models assembled in the United States with a significant share of parts sourced from abroad.

The next section outlines our conceptual framework, while Section 3 presents stylized facts about the relationship between exchange-rate pass-through and intra-firm trade. Section 4 sets out our structural model, and Section 5 discusses the estimation methodology and demand results. Section 6 presents results from the counterfactual experiments, and Section 7 concludes.

## 2. Vertical integration and pass-through: conceptual framework

The goal of this paper is to investigate the relationship between a firm's degree of vertical integration and its pass-through of exchange-rate-induced cost shocks. While aware that a firm's pass-through may

<sup>3</sup> Bernard et al. (2006) find in U.S. census data that multinationals adjust arm's length prices by more than intra-firm prices after an exchange-rate shock, though in a very limited sample.

<sup>4</sup> Roughly half of the intra-firm prices included in the BLS's import-price samples are cost-based rather than market-based: They are not set with reference to market trends but instead are constructed as a markup over the exporting subsidiary's observable costs. A study by Alterman (1997) finds that, for particular industries, cost-based prices change less frequently than market-based prices and, in particular, fluctuate less than market-based prices following macroeconomic shocks such as exchange-rate changes.

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