Online Appendices to: Multinationals, Intrafirm Trades, and International Macro Dynamics

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Abstract

These online appendices contain some work developed in response to questions about the paper. They are complementary, but in no way required to understand the key points in the paper itself. The primary appendices, which cover details on data, robustness, and methodology, appear in the main paper after the Figures and Tables.

Online Appendix 1: Intrafirm Adjustment Costs

This appendix discusses the notion that intrafirm price adjustment costs may differ from arm's length adjustment costs. One of the motivations for considering the prevalence of intrafirm trade for explaining pricing dynamics is the fairly intuitive notion that the information acquisition, process, and communication costs associated with a price change may be smaller when between related parties compared with arm's length firms. Further, in addition to causing different related party pricing dynamics itself, a reduced adjustment cost could theoretically produce different behavior from the arm's length competitors in that sector.

Unfortunately, it is difficult in my model to distinguish the impact of a smaller adjustment cost from, for example, a difference in productivity. Holding everything equal in the baseline simulation, for example, but halving the related party adjustment cost, leads to a moderate reduction in related party stickiness (for $\rho = 4$, for example, duration drops from 7.8 months to 5.4). The change in passthrough is far less pronounced. Increasing the size of the average related party sale would have essentially the same effect.

It would be possible in principle, however, to test the impact of this more flexible related party on arm's length pricing dynamics in the same industry. In particular, halved related party adjustment costs combined with a large value for ρ (and hence strong complementarities), one might look for the increased number of related party price changes to trigger more price changes from arm's length competitors. In fact, even when $\rho = 12$ in the model, halving the related party adjustment cost barely changes the pricing dynamics of the arm's length competitors. As shown in the paper, complementarities are indeed strong enough where a related party price change can itself cause an arm's length price change in response. In the simulation, however, such related party price changes are almost always large enough to warrant a price change under the original adjustment cost scheme. The price changes that only occur in the lower adjustment cost regime are, almost by definition, smaller changes and hence are generally not those that elicit a pricing response from competitors. Hence, it is unlikely that the potentially lower intrafirm adjustment costs themselves have an important impact on the price stickiness of arm's length firms.

Online Appendix 2: Comparison with Standard CES

This appendix gives intuition as to how the implications for duration of the demand structure in Section 6 differs from the more standard CES framework with monopolistic competition. Consider a shock to a firm's own cost and assume that competitor firms do not change their prices. Writing profits as the product of a firm's revenues and profit share, $\pi_j = R_j s_j^{\pi}$, and now using the notation $\widehat{x}$ to represent the size (in percent) of the discrete change in x, one sees that the change in one-period profits from adjusting prices compared to non-adjustment of prices can be written as $\Delta\pi^A - \Delta\pi^N = \pi^0 \left(\left[\widehat{R} + \widehat{s^{\pi}} \right]^A - \left[\widehat{R} + \widehat{s^{\pi}} \right]^N \right)$.[1] A and N denote values under adjustment and non-adjustment, respectively, π^0 is the level of profits prior to the shock, and aggregate prices and quantities are held fixed.

For the standard non-nested CES case with monopolistic competition, prices are set as a constant markup over marginal cost. If a firm starts at the flexible price equilibrium and then incurs a cost shock, any adjustment would set $\widehat{p} = \widehat{m}$, preserving the original profit share, $\widehat{s^{\pi}_{ces}}^A = 0$. Revenues, however, would be impacted, reflecting the change to price and resulting change in quantity: $\widehat{R}^A_{ces} = (\widehat{m} + 1)^{1-\varepsilon} - 1$. Alternatively, if the firm decides against adjustment, revenues remain fixed, $\widehat{R}^N_{ces} = 0$, while the profit share would change, $\widehat{s^{\pi}}^N_{ces} = (1 - \varepsilon)\, \widehat{m}$. Hence, for this simple case where a firm starts at its flexible price equilibrium and undergoes a cost shock $\widehat{m}$, we can express the one-period benefit of changing prices as:

$$\Delta\pi_{ces} = \pi^A_{ces} - \pi^N_{ces} = \pi^0 \left(\widehat{R}^A_{ces} - \widehat{s^{\pi}}^N_{ces} \right) = R^0 \frac{1}{\varepsilon} \left((\widehat{m} + 1)^{1-\varepsilon} - (1 - \varepsilon)\, \widehat{m} - 1 \right). \qquad \text{(OA1)}$$

[1] Note that $\widehat{x}$ here is defined slightly differently from in the main text, as $\frac{x^{t+1} - x^t}{x^t}$, rather than $\frac{dx}{x}$, where $\left(x^{t+1} - x^t\right)$ may not be small.

Firms with larger revenues (or equivalently, larger initial profits) have a larger incentive to adjust prices, $\frac{d(\Delta\pi_{ces})}{dR_0} > 0$, which implies lower price durations – they can, naturally, offset a fixed adjustment cost with a per unit benefit realized over a greater number of units. Additionally, fixing either π^0 or R^0, it is easily seen that higher elasticity goods will have less sticky prices, $\frac{d(\Delta\Pi_{ces})}{d\varepsilon} > 0$.[2] A price increase for a homogeneous good will decrease revenues more than for a heterogeneous good, but the larger decline in profit shares from non-adjustment for the homogeneous good compared to the heterogeneous good is even worse. Indeed, for this simple one-period case with constant markups, initial revenues (or profits) and the elasticity of demand are the only factors that determine duration.

I now consider the arm's length firm in the model with variable markups. Should the firm forgo adjustment, its profit share will be impacted identically as the constant markup firm: $\widehat{s_{AL}^{\pi}}^{N} = (1-\varepsilon)\,\widehat{m}$. The impact of adjustment is different, however, because only a portion α of the cost change will be passed through to prices and so the profit share will change: $\widehat{s_{AL}^{\pi}}^{A} = -\frac{\widehat{\varepsilon}}{\widehat{\varepsilon}+1}$. Further, unlike the CES case, changes in quantities also reflect changes in the sectoral price index:

$$\Delta\pi_{AL} = \pi_{AL}^{A} - \pi_{AL}^{N} = R_0\frac{1}{\varepsilon}\left((1+\alpha\widehat{m})^{1-\rho}\,(1+\widehat{x})^{\rho-\eta} - \frac{\widehat{\varepsilon}}{\widehat{\varepsilon}+1} - (1-\varepsilon)\,\widehat{m} - 1\right). \quad \text{(OA2)}$$

Note that equation (OA2) is identical to (OA1) when $\rho = \eta$. From this point, consider increasing the wedge between the rates of intersectoral and intrasectoral substitution and leaving the market share and elasticity of demand unchanged, which implies $d\eta = \frac{s-1}{s}d\rho$. While the expression for non-adjustment is unchanged from the constant markup case, the combined benefit of adjustment, $\widehat{R}^{A} + \widehat{s^{\pi}}^{A}$, typically decreases, implying a lower overall incentive to change prices (numerical examples across the parameter space suggests this generally holds). The intuition for this comes from the definition for the elasticity of demand in the model: A larger gap between the intersectoral and intrasectoral elasticities of substitution reduces the importance of sectoral relative prices for large market share firms and increases it for smaller market share firms. Holding fixed the elasticity of demand, but widening this gap, means that a cost increase – which worsens a firm's relative price and decreases it's market share – will be punished relatively harder due to the greater elasticity, and a cost decrease – which improves a firm's relative price and increases it's market share – will be rewarded less due to the smaller elasticity.

So far, we have shown there are two implications of this model for arm's length price duration compared with the constant markup case. First, even given identical elasticities of demand, substitution elasticities for the sector itself matters for duration. Second, given firm size and the elasticity of demand, the variable markup case does not require adjustment

[2] $\frac{d\left(\widehat{R}-\widehat{s_{\Pi}}\right)}{d\varepsilon} = \widehat{m} - (\widehat{m}+1)^{1-\varepsilon}\ln(\widehat{m}+1) > \widehat{m} - \ln(\widehat{m}+1) > 0$ for any $\widehat{m} \neq 0$.

costs as large as the constant markup case in order to generate a particular duration pattern. A third difference which can be shown numerically is that, given a sector's revenues, the variable markup model generally makes the incentive to change prices less sensitive to the size of the firm. In the CES setting, a firm with twice the revenues of another will have twice the incentive to change prices in response to any given shock, but the incentive generally does not scale this way for the variable markup case. Given my dataset lacks market share information, this is beneficial.

Next, we consider the case of related parties. Since the optimal markup at the manufacturer level is zero and the distributor's markup is constant, the overall firm's profit share is constant after adjustment. Writing the equivalent disaggregation as above, one can write:

$$\Delta\pi_{RP} = \pi_{RP}^{A} - \pi_{RP}^{N} = R_{RP}^{Man,0}\frac{1}{\eta-1}\frac{1}{s_{RP}^{0}}\left((1+\widehat{x})^{1-\eta} - s_{RP}^{0}\left(1-\eta\right)\widehat{m} - 1\right) \qquad \text{(OA3)}$$

where $R_{RP}^{Man,0}$ denotes the initial size (revenues) of the related party manufacturer and $s_{RP}^{0} = \left(\frac{p_{RP}^{0}}{x}\right)^{1-\rho}$ is the related party manufacturer's initial share of the input market. Note that when $s_{RP}^{0} = 1$ and setting $\eta = \varepsilon$, expression (OA3) reduces to (OA1) multiplied by the distributor's (fixed) markup. This implies that a wholly-owned upstream manufacturer with full share of its input market will change prices to its distributor more frequently than a monopolistically competitive independent manufacturer with equal revenues that sells its output directly to the consumer. The reason, of course, is largely superficial – conditioning on manufacturer revenues defines firm size by costs for the integrated manufacturer compared with revenues for the independent one. Nonetheless, these simple one-period exercises suggest that even with homogeneous adjustment costs, related party exporters may have weakly shorter price durations than arm's length exporters with the same export volume.

This analysis helps clarify how duration in this system differs from more standard models, but is less useful for explaining the differences across goods shown in Table 1. The above expressions show that, fixing market shares, all components of $\Delta\pi_{AL}$ are functions of the substitution parameter, while ρ's only impact on $\Delta\pi_{RP}$ is via $\widehat{x}$ ($\frac{d\Delta\pi_{RP}}{d\rho} = \frac{d\Delta\pi_{RP}}{d\widehat{x}}\frac{d\widehat{x}}{d\rho} > 0$, implying lower homogeneous good duration). Though suggestive that arm's length duration will be more sensitive to ρ, analytically comparing the two comparative statics is not tractable. Further, the exercise of increasing ρ while holding the market share fixed is presumably less important than doing so while holding productivities fixed, which will lead to differing market shares across sectors. Section 9 gives numerical analyses of such situations.