Who should handle retail? Vertical contracts, customer service, and social welfare in a Chinese mobile phone market - APPENDIX

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Abstract

Using data on mobile phone handset sales from a single retail store, we examine the impact of different retail responsibility designations and vertical contracts on seller service provision, firm profitability, and social welfare. During our sample, this store switched from retailer-managed retailing with linear pricing contracts to manufacturer-managed retailing with revenue sharing. We estimate consumer demand and manufacturer cost parameters. Demand estimates indicate a large positive shift that coincided with the vertical change, consistent with improved retail customer service. Welfare estimates suggest that consumers derived substantial surplus from the improved customer service in addition to that from lowered prices.

Keywords: Marketing channel, vertical relationship, channel switch, revenue-sharing contract, customer service, structural models, choice modeling, mobile phones

JEL codes: D43, L14, L63, L81, M31

This appendix includes the full discussion of our nested logit model of demand and supplementary material on the supply side that explains our approach in inferring equilibrium impacts of wholesale prices on retail prices. It also includes additional tables summarizing the data and additional empirical results.

1 Model of Consumers, Retailers, and Manufacturers

In line with our above description, we consider a situation in which data are available from one retailer ($r = 1$) for $b = 1, \ldots, B$ brands (in which a brand corresponds to a manufacturer)

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over $t = 1, \ldots, T$ periods in a single market with M potential consumers. While we observe only our retailer, we assume that the market contains N essentially symmetric retailers, each of which sells the same set of brands as our observed retailer. For each brand, the data contain the average retail transaction price p_{rbt}, the quantity sold q_{rbt}, brand characteristics that may affect demand and costs (x_{bt} and w_{bt} respectively), and retailer characteristics x_{rt}.[1] We also observe the proportion of revenue retained by the retailer (γ) after the regime-switch.

1.1 A model of demand for mobile phones

As discussed in the literature review and unlike the U.S. market, the Chinese mobile phone market did not bundle phones and service plans during our sample period. We therefore follow Berry (1994) and assume that each consumer makes a relatively straightforward discrete choice among possible phone brands and retailers, reflecting preferences over characteristics including price and features such as ringtone, game, and camera capabilities. Formally (and suppressing time subscripts for notational convenience), consumer i has conditional indirect utility for brand b from retailer r given by

$$V_{irb} = x_{rb}\beta - \alpha p_{rb} + \xi_{rb} + \varepsilon_{irb} \tag{1}$$

From (1), $x_{rb}\beta$ is the mean utility from observable characteristics of brand b at retailer r, $-\alpha p_{rb}$ is the mean disutility associated with the price of brand b at retailer r, and ξ_{rb} represents the mean valuation of characteristics that all agents in the market observe but the econometrician does not.

Consumers also have the option of not purchasing any brand from any retailer, instead keeping an older phone or doing without. Denoting this outside option as brand $b = 0$, we assume that its mean utility is normalized to zero so that $V_{i0} = \varepsilon_{i0}$. This normalization has two implications. First, as it applies to all retailers and not just our observed retailer, it puts additional strain on our assumption of essentially symmetric retailers. To the extent that unobserved retailers change their strategies over time, these changes must be either identical to those of our observed retailer or completely captured by the model. Second, it essentially asserts that there is no inherent seasonality in the opportunity cost of not purchasing a

[1] Our model is similar to Villas-Boas and Zhao (2005) in the sense that both of us model a market taking into account all parties involved: the manufacturer, the retailer, and the consumer. Both models are then estimated using data from only one retailer in the market. Villas-Boas and Zhao, though, have micro-level household purchase data and do not consider competition among retailers in the market. Another difference is that product differentiation is arguably more important in the mobile phone category than in their category (ketchup).

mobile phone in China. While we have no reason to suspect a strong seasonal component to Chinese phone demand, Einav (2007) offers an alternative specification to accommodate seasonality: $V_{it0} = D_t\mu + \varepsilon_{it0}$. As the relevant measure to consumers is the utility difference between a brand-retailer and no purchase, seasonality variables such as the month fixed effects that we employ are also potential regressors.[2] To the extent that the opportunity cost of not purchasing a phone is increasing over our sample, the same approach suggests the inclusion of secular time trends.

The term ε_{irb} represents unobserved idiosyncratic variation in the preference of consumer i. We assume that this component is distributed according to the generalized extreme value (GEV) model of McFadden (1978) that generates a nested logit allowing for consumers to be more likely to substitute among brands than to the option of no purchase.[3] This form of segmentation mitigates mismeasurement of market size and has been useful in prior research (Berry and Waldfogel, 1999; Einav, 2007). It is operationalized by including information on a choice's market share as traditionally defined ($\widetilde{s}_i = \frac{q_i}{Q}$). The importance of segmentation between the inside options and the outside option is captured by the unit interval parameter σ, the coefficient on $\ln(\widetilde{s})$. If $\sigma = 0$, then such segmentation is unimportant and the model reduces to the simple logit. As $\sigma \rightarrow 1$, this segmentation becomes complete, and total demand for the product becomes perfectly inelastic. The assumption's primary implication is that the retailer will charge a common markup for all brands during a period.[4] The absence of data from other retailers precludes us from allowing segmentation among retailers.

Consumers choose whichever product yields the highest indirect utility so that consumer i purchases brand b from retailer r if and only if

$$V_{irb} = \max_{j=1,\ldots,N;k=0,1,\ldots,B} V_{ijk} \tag{2}$$

The utility maximization condition defines the consumer-level unobservables under which a consumer would purchase brand b from retailer r as

$$\Omega_{rb} = \{\varepsilon_i : \delta_{rb} + \varepsilon_{irb} \geq \delta_{mk} + \varepsilon_{imk}\}, \forall m, k \tag{3}$$

in which $\delta_{rb} = x_{rb}\beta - \alpha p_{rb} + \xi_{rb}$ is the mean utility of alternative b at retailer r across consumers and $\varepsilon_i = (\varepsilon_{i0}, \varepsilon_{i11}, \varepsilon_{i12} \ldots, \varepsilon_{iNB})$. To test the demand-shifting effect of the regime

[2] Because we only have four years of data, employing week fixed effects as in Einav (2007) is not viable.

[3] Cardell (1997) offers an alternative specification that also yields this nested logit framework.

[4] While our retailer's managers claimed to use different rules for markups, they did not find this assumption especially troublesome.

switch, we include a binary indicator regarding whether the week falls before or after the switch to manufacturer-managed retailing under revenue sharing. Our eventual estimate therefore reflects the average impact across brands.[5]

The probability that a consumer makes a particular choice thus depends on all brands' prices at all retailers and all brands' characteristics (both observed and unobserved to the econometrician) as well as parameters to be estimated $\theta_1 = (\beta, \alpha, \sigma)$. We henceforth denote the probability that an individual chooses to purchase brand b at retailer r as $s_{rb}(p, x, \xi; \theta_1)$ and empirically construct this probability as $s_{rb} = \frac{q_{rb}}{M}$, in which q_{rb} denotes the analogous quantity and M the number of consumers in the market-period. The probability of no purchase is then denoted as $s_0(p, x, \xi; \theta_1) = 1 - \sum_{r=1}^{N} \sum_{b=1}^{B} s_{rb}(p, x, \xi; \theta_1)$.

Let a brand's market share be defined as that brand's units sold as a share of all units sold, denoted $\widetilde{s}_{rb} = \frac{q_{rb}}{\sum_{m=1}^{N} \sum_{k=1}^{B} q_{mk}}$. The nested logit model then has the convenient transformation $\ln(s_{rb}) - \ln(s_{r0}) = \delta_{rb} + \sigma \ln(\widetilde{s}_{rb})$. This simple (but adequate) demand specification allows us to sidestep many of the concerns associated with applying the more technically complex random coefficients models to insufficiently rich data.[6] We are then able to focus our attention on the more interesting supply-side.

The essential symmetry assumption

As discussed above, we have data only on our retailer, and so we do not observe the total market quantity sold. We accommodate this limitation in our data by assuming an essentially symmetric N-firm oligopoly in which our retailer is a participant. By *symmetric*, we mean that there are $N - 1$ other retailers (identical to each other and denoted as $r = 2$; correspondingly, our focus retailer is denoted as $r = 1$) that sell the same brands as our observed retailer and share a common valuation of unobserved characteristics (i.e., $\xi_{rb} = \xi_{mb}$ $\forall r, m$). Our assumption of symmetry, though, is *essential* rather than *total* in that our model can accommodate observed idiosyncratic shocks incurred only by our retailer. Specifically and as discussed above, our retailer twice relocated the selling areas for mobile phones during the sample period. A total symmetry assumption would imply that other retailers would experience the same shock from this counter relocation. Our essential symmetry

[5] In theory the differing contractual revenue shares would generate differential impacts, but in practice the range of manufacturers' retained shares (74% to 77.5%) was too small to exploit in this manner.

[6] Our choice of the nested logit instead of random coefficients model is broadly consistent with the current literature on vertical contracting. It is further driven by our lack of consumer-level data. Knittel and Metaxoglou (2012) demonstrate that employing random coefficients with our level of data can generate very non-robust results. While Dube, Fox, and Su (2012) show that many of these concerns can be eliminated by using tighter contraction mappings and convergence criteria, we do not judge the gains worth the additional computational costs.

assumption, on the other hand, allows this observed shock to be idiosyncratic, and thus our observed retailer and these other retailers may charge different prices in equilibrium. Under this N-firm oligopoly assumption, we denote the purchase probability as $s_{rb}(p, x, \xi, N; \theta_1)$.

Allowing for more than one retailer has two immediate demand-side implications on which we expand to link this more closely to the extant literature. First, it will affect the observed likelihood of consumers choosing the outside option of no purchase. As the observed total purchase probabilities at retailer r are $\sum_{k=1}^{B} s_{rk}$, the market-wide probability of no purchase will be $s_0 = 1 - \sum_{k=1}^{B} s_{1k} - (N-1) \sum_{k=1}^{B} s_{2k}$. When assuming a fixed population of consumers, larger values of N will then cause the implied number of consumers making no purchase to decrease. Second, it will lower any retailer's true market share for a given brand, as the retailer-specific market share to be included in the demand regression must now be constructed as

$$\widetilde{s}_{1b} = \frac{q_{1b}}{\sum_{k=1}^{B} q_{1k} + (N-1) \sum_{k=1}^{B} q_{2k}} \tag{4}$$

to reflect the retailer's share of the entire market.

The demand equation that will then be taken to the data is

$$\ln(s_{1b}) - \ln(s_0) = x_{1b}\beta - \alpha p_{1b} + \sigma \ln(\widetilde{s}_{1b}) + \xi_{1b} \tag{5}$$

in which s_0 and $\widetilde{s}_{1b}$ are both dependent upon the assumed number of retailers N. In the case of total symmetry in which our retailer incurs no idiosyncratic shocks and all retailers are identical in equilibrium, the above becomes

$$\ln(s_{1b}) - \ln\left(1 - N \sum_{k=1}^{B} s_{1k}\right) = x_{1b}\beta - \alpha p_{1b} + \sigma \ln\left(\frac{q_{1b}}{N \sum_{k=1}^{B} q_{1k}}\right) + \xi_{1b} \tag{6}$$

As we will assume that the N-firm oligopoly is constant across the sample, the appearance of N on the right-hand side will be absorbed into the intercept. There is some superficial identification of N on the left-hand side, but we expect to find that N is not empirically identified by demand estimation. As N will also appear in firms' profit-maximization conditions, though, identification may come from the supply side. It is this supply-side identification suggested by Moul (2012) that we hope to exploit in comparing demand-only estimates and demand estimates joint with cost in order to pin down plausible market structures. We will further discuss this inference of market structure in the estimation results section.

Analytical forms of nested logit under essential symmetry

From McFadden (1978), the unconditional purchase probability of brand k from retailer r will take the form

$$s_{rk} = \frac{e^{\delta_{rk}} \frac{\partial G}{\partial e^{\delta_{rk}}}}{G}$$

in which $G\left(e^{\delta_{rk}}, e^{\delta_{-rk}}\right)$ must satisfy certain regularity restrictions. We will follow the literature and interpret δ_{rk} as consumer mean utility derived from the consumption of brand k from retailer r. As such, it will depend upon exogenous product characteristics (both observed and unobserved) and price. Assuming N retailers and B brands, we consider a GEV specification that permits segmentation between consumer choice of the outside good and any of the inside goods.

Let σ denote a unit-interval parameter that captures the degree of segmentation between the inside options and the outside option. Define G as

$$G = 1 + \left(\sum_{i=1}^{N}\sum_{b=1}^{B} e^{\delta_{ib}/(1-\sigma)}\right)^{1-\sigma}$$

The unconditional purchase probability is then

$$s_{rk} = \frac{e^{\delta_{rk}} \left(\sum_{i=1}^{N}\sum_{b=1}^{B} e^{\delta_{ib}/(1-\sigma)}\right)^{-\sigma} \left(e^{\delta_{rk}}\right)^{\left(\frac{\sigma}{1-\sigma}\right)}}{1 + \left(\sum_{i=1}^{N}\sum_{b=1}^{B} e^{\delta_{ib}/(1-\sigma)}\right)^{1-\sigma}}$$

Imposing the essentially symmetric assumption, the above becomes

$$s_{1k} = \frac{\left(\left(\sum_{b=1}^{B} e^{\delta_{1b}/(1-\sigma)}\right) + (N-1)\left(\sum_{b=1}^{B} e^{\delta_{2b}/(1-\sigma)}\right)\right)^{-\sigma} \left(e^{\delta_{1k}}\right)^{\left(\frac{1}{1-\sigma}\right)}}{1 + \left(\left(\sum_{b=1}^{B} e^{\delta_{1b}/(1-\sigma)}\right) + (N-1)\left(\sum_{b=1}^{B} e^{\delta_{2b}/(1-\sigma)}\right)\right)^{1-\sigma}}$$

Define a brand's inside market share as

$$\widetilde{s}_{rk} = \frac{e^{\delta_{rk}/(1-\sigma)}}{\sum_{i=1}^{N}\sum_{b=1}^{B} e^{\delta_{ib}/(1-\sigma)}}$$

Under essential symmetry, this becomes

$$\widetilde{s}_{1k} = \frac{e^{\delta_{1k}/(1-\sigma)}}{\left(\sum_{b=1}^{B} e^{\delta_{1b}/(1-\sigma)}\right) + (N-1)\left(\sum_{b=1}^{B} e^{\delta_{2b}/(1-\sigma)}\right)}$$

This can be substituted into the above expression for s_{rk} to yield

$$s_{1k} = \frac{e^{\delta_{1k}} \widetilde{s}_{1k}^{\sigma}}{1 + \left(\left(\sum_{b=1}^{B} e^{\delta_{1b}/(1-\sigma)}\right) + (N-1)\left(\sum_{b=1}^{B} e^{\delta_{2b}/(1-\sigma)}\right)\right)^{1-\sigma}}$$

In situations in which $\widetilde{s}_{rk}$ and s_0 can be observed (e.g., monopoly case, oligopoly under total symmetry assumption), this format facilitates the traditional nested logit application of

$$\ln s_{1k} - \ln s_0 = \sigma \ln \widetilde{s}_{1k} + X_{1k}\beta - \alpha p_{1k} + \xi_{1k}$$

Of primary concern on the demand side is how one would construct price effects and the resulting price elasticities given the above framework. The price derivatives allowing for general inside-outside segmentation are

$$\frac{\partial s_{rk}}{\partial p_{rb}} = -\alpha s_{rk}\left(\left(\frac{1}{1-\sigma}\right)1\left(b=k\right) - \left(\frac{\sigma}{1-\sigma}\right)\widetilde{s}_{rb} - s_{rb}\right)$$

$$\frac{\partial s_{rk}}{\partial p_{-rb}} = \alpha s_{rk}\left(\left(\frac{\sigma}{1-\sigma}\right)\widetilde{s}_{-rb} + s_{-rb}\right)$$

$$\frac{\partial \widetilde{s}_{rk}}{\partial p_{rb}} = -\alpha\left(\frac{1}{1-\sigma}\right)\widetilde{s}_{rk}\left(1\left(b=k\right) - \widetilde{s}_{rb}\right)$$

$$\frac{\partial \widetilde{s}_{rk}}{\partial p_{-rb}} = \alpha\left(\frac{1}{1-\sigma}\right)\widetilde{s}_{rk}\widetilde{s}_{rb}$$

The second-order price effects that will be used in the Cramer's Rule application are then

$$\frac{\partial^2 s_{rm}}{\partial p_{ri}\partial p_{rk}} = -\alpha\frac{\partial s_{rm}}{\partial p_{rk}}\left(\left(\frac{1}{1-\sigma}\right)1\left(m=i\right) - \left(\frac{\sigma}{1-\sigma}\right)\widetilde{s}_{ri} - s_{ri}\right) - \alpha s_{rm}\left(\frac{\sigma}{1-\sigma}\right)\frac{\partial \widetilde{s}_{ri}}{\partial p_{rk}} - \alpha s_{rm}\frac{\partial s_{ri}}{\partial p_{rk}}$$

$$\frac{\partial^2 s_{rm}}{\partial p_{ri}\partial p_{dk}} = -\alpha\frac{\partial s_{rm}}{\partial p_{dk}}\left(-\left(\frac{\sigma}{1-\sigma}\right)\widetilde{s}_{ri} - s_{ri}\right) - \alpha s_{rm}\left(\frac{\sigma}{1-\sigma}\right)\frac{\partial \widetilde{s}_{ri}}{\partial p_{dk}} - \alpha s_{rm}\frac{\partial s_{ri}}{\partial p_{dk}}$$

All these can be converted to quantity-effects $\frac{\partial q}{\partial p}$ by multiplying by market size M.

1.2 A model of linear pricing

First consider a generic retailer's profit maximizing conditions under the maintained assumption that the wholesale price (W) is the only variable cost to retailers (i.e., $c_{rb}^{R} = 0$). Retailer r chooses prices for all its brands to maximize its profit:

$$\max_{p_{rk}} \pi_r = \sum_{b=1}^{B}\left(p_{rb} - W_b\right)q_{rb}$$

$$FOC_k : q_{rk} + \sum_{b=1}^{B}\left(p_{rb} - W_b\right)\frac{\partial q_{rb}}{\partial p_{rk}} = 0 \;\forall\; k$$

Recognizing that there are B first order conditions for each of the N retailers, define the $B \times B$ matrix Δ_{1r} to consist of price effects for retailer r so that the $(i,k)^{th}$ element of Δ_{1r} is $\Delta_{1r}(i,k) = \frac{\partial q_{rk}}{\partial p_{ri}}$. Then the above can be rewritten as

$$q_r + \Delta_{1r} \cdot (p_r - W) = 0$$

As such, it is straightforward to see that wholesale prices W can be recovered as

$$W = p_1 - \widetilde{\Delta}_{11}^{-1}(q_1)$$

We must infer wholesale prices from our observed retailer; we have no other price or quantity data.

With wholesale prices inferred, we now use Cramer's Rule to calculate the direct equilibrium impacts of wholesale prices upon retailer prices. We totally differentiate our $N \cdot B$ generic retailers' profit maximizing conditions with respect to all retailers' prices (dp) and with respect to any one of the brand's wholesale prices (dW_i). This yields (in matrix form)

$$H\frac{dp}{dW_i} = \frac{dq_i}{dp}$$

As H is a $NB \times NB$ symmetric matrix, denote its $B \times B$ submatrices so that (for the $N = 3$ case)

$$H = \begin{bmatrix} A & B & B \\ C & D & E \\ C & E & D \end{bmatrix}$$

The $(i,k)^{th}$ element of submatrices A (in which $r = 1$) and D (in which $r = 2$) are then

$$A_{ik} = D_{ik} = \frac{\partial q_{ri}}{\partial p_{rk}} + \frac{\partial q_{rk}}{\partial p_{ri}} + \sum_{b=1}^{B} (p_{rb} - W_b) \frac{\partial^2 q_{rb}}{\partial p_{ri} \partial p_{rk}}$$

The $(i,k)^{th}$ element of submatrices B (in which $r = 1$) and C (in which $r = 2$) are

$$B_{ik} = C_{ik} = \frac{\partial q_{ri}}{\partial p_{(3-r)k}} + \sum_{b=1}^{B} (p_{rb} - W_b) \frac{\partial^2 q_{rb}}{\partial p_{ri} \partial p_{(3-r)k}}$$

Using subscript 3 to denote competition among hypothetical retailers, the $(i,k)^{th}$ element of submatrix E is

$$E_{ik} = \frac{\partial q_{2i}}{\partial p_{3k}} + \sum_{b=1}^{B} (p_{2b} - W_b) \frac{\partial^2 q_{2b}}{\partial p_{2i} \partial p_{3k}}$$

The impacts of a wholesale prices change on equilibrium retail prices are then

$$\frac{dp}{dW_i} = H^{-1}\frac{dq_i}{dp}$$

With these equilibrium impacts in hand, we can (at last) turn to recovering manufacturer's marginal cost from the manufacturer's first order condition:

$$\max_{W_b} \pi_b = (W_b - c_b) \sum_{r=1}^{N} q_{rb}$$

$$FOC : \left(\sum_{k=1}^{N} q_{kb} \right) + (W_b - c_b) \sum_{k=1}^{N} \sum_{r=1}^{N} \sum_{i=1}^{B} \frac{\partial q_{kb}}{\partial p_{ri}} \frac{dp_{ri}}{dW_b} = 0$$

Denoting the cumulative equilibrium impacts of brand b's wholesale price change on retailer r's derived quantity demanded as $\frac{dq_{rb}}{dW_b}$ and applying our essential symmetry assumption, manufacturer marginal costs for brand b are then recovered as

$$c_b = W_b - \frac{q_{1b} + (N-1)\, q_{2b}}{\frac{dq_{1b}}{dW_b} + (N-1)\frac{dq_{2b}}{dW_b}}$$

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Table A1. Mobile phone characteristics and their definitions

Characteristic		Definition
Form Factor		Candybar, Flip, Slider/Swivel, Touch, Special (promotional shapes)
# of Available Colors		
Network	Standard	GSM, CDMA, Mixed
	# of Frequencies	800MHz, 900MHz, 1800MHz
Size	Length (mm)	
	Width (mm)	
	Height (mm)	
	Imputed Volume (cm^3)	
	Mass (g)	
Screen and Display	# of Screen (Presence of Second Screen)	1 or 2
	Main Screen Color?	Indicator variable that main screen is a color screen
	Secondary Screen Color?	Indicator variable that secondary screen (if any) is a color screen
Battery	Talk Time	Listed upper bound
	Standby Time	Listed upper bound
Playback	# of Ringtone Voices	
	Downloadable Voices?	Indicator variable for if users can download new ringtones
Support Multimedia Message?		Indicator variable for if phone supports delivering and receiving multimedia messages
Game	Game Capable?	Indicator variable for if phone can play any games
	# of Pre-Installed Games	
	Game Download Capability	Indicator variable for if users can download new games
Camera and Video Recording	Attachable Camera?	Indicator variable for if phone can be used with attachable camera
	Built-In Camera?	Indicator variable for if phone has a built-in camera
	Camera Resolution (MP)	
GPS?		Indicator variable for if phone has a built-in GPS

Note: All phone models in our sample support regular text messages

Table A2: Simple logit estimates for monopoly demand: OLS and 2SLS (n=2496)

	logit - OLS		logit - 2SLS		nested logit - 2SLS	
	b	s.e.	b	s.e.	b	s.e.
Price (000s RMB): $-\alpha$	-0.31***	0.06	-0.78***	0.22	-0.35***	0.08
ln(sh): σ	---		---		0.85***	0.06
Switch	0.29***	0.08	0.28***	0.08	0.23***	0.02
1st Relocation	0.12*	0.07	0.15**	0.07	0.24***	0.02
2nd Relocation	-0.35***	0.07	-0.34***	0.07	-0.25***	0.02
Form Factor-Bar	0.53***	0.13	0.52***	0.14	0.08	0.05
Form Factor-Slide	0.02	0.15	0.11	0.16	0.09**	0.04
Form Factor-Touch	1.32	0.74	2.36***	0.84	0.99***	0.30
Form Factor-Special	0.41***	0.16	0.31*	0.17	0.02	0.06
CDMA only?	-0.23	0.32	-0.01	0.36	0.14	0.12
#Frequencies	-0.33***	0.09	-0.24**	0.10	0.00	0.03
#Colors (00s)	0.09***	0.03	0.09***	0.03	1.42	0.94
Length (00s mm)	0.01	0.01	0.01	0.01	0.07	0.31
Width (00s mm)	0.02	0.01	0.02	0.01	-0.09	0.53
Depth (00s mm)	0.10***	0.04	0.10***	0.04	0.88	1.38
Implied Volume (000s cm^3)	-0.15*	0.08	-0.16*	0.09	-1.72	3.00
Mass (000s g)	-0.003	0.003	0.01	0.01	4.35***	1.54
2nd Screen?	-0.01	0.10	0.17	0.13	0.15***	0.04
Main Screen Color?	-0.02	0.12	0.26	0.18	0.18***	0.05
2nd Screen Color?	0.20***	0.08	0.20**	0.08	0.02	0.03
Battery -Talk (000s min)	0.54	0.37	0.45	0.39	0.05	0.12
Battery-Standby (000s hr)	0.79**	0.34	0.79**	0.35	0.08	0.10
#RingTone Voices (00s)	0.001	0.002	0.003	0.002	0.16**	0.07
Downloadable RingTone?	0.16*	0.08	0.16*	0.09	0.03	0.03
Message?	0.02	0.07	0.04	0.07	0.01	0.02
Game Capable?	-0.27***	0.09	-0.19*	0.10	0.07*	0.04
Downloadable Game?	0.05	0.07	0.13*	0.08	0.08***	0.02
Attachable Camera?	0.45***	0.15	0.35**	0.17	0.00	0.05
Built-In Camera?	0.16*	0.10	0.23**	0.10	0.04	0.03
Camera Resolution (MP)	-0.09	0.07	0.05	0.10	0.09***	0.03
GPS?	0.20*	0.11	0.22*	0.12	0.04	0.04
#Models (00s)	0.006***	0.002	0.006***	0.002	0.23***	0.08
HHI-Models	-0.79***	0.16	-0.82***	0.16	-0.13**	0.06
Time (00s wk)	-0.47**	0.21	-0.99***	0.32	-0.59***	0.10
$Time^2$ (00s wk)	0.12	0.10	0.18	0.11	0.03	0.03
R^2	0.828		0.818		0.983	
$E(\eta^D)$	-0.50		-1.26		-3.49	
$\#(\eta^D>-1)$	2463		712		0	

*/**/*** denote 90%/95%/99% confidence levels

Notes: Regressions also include brand fixed effects and month fixed effects; omitted form factor is Flip. Standard errors reflect inefficient estimation and Newey-West correction with two lags.

Table A3: Demand-alone 2SLS estimation (N=3), robustness to Oaxaca-style decomposition

	Full Sample (n=2496)		Pre-Switch (n=2088)		Post-Switch (n=408)	
	b	s.e.	b	s.e.	b	s.e.
Price/1000: α	0.35***	0.08	0.36***	0.10	0.55	0.35
ln(sh/N): σ	0.85***	0.06	0.68***	0.12	0.50***	0.13
1st Relocation	0.24***	0.02	0.11***	0.02	---	
2nd Relocation	-0.25***	0.02	---		-0.20***	0.07
Switch	0.23***	0.02	---		---	
Form Factor-Bar	0.08	0.05	0.10	0.08	0.14	0.13
Form Factor-Slide	0.09**	0.04	-0.03	0.10	-0.05	0.17
Form Factor-Touch	0.99***	0.30	2.07***	0.56	-0.75	0.67
Form Factor-Special	0.02	0.06	0.02	0.10	-0.19	0.23
CDMA only?	0.14	0.12	-0.06	0.17	-0.29	1.46
#Frequencies	0.00	0.03	-0.08	0.06	0.10	0.11
#Colors (00s)	1.42	0.94	3.20**	1.50	-4.73	4.07
Length (00s mm)	0.07	0.31	0.31	0.61	-1.30	1.07
Width (00s mm)	-0.09	0.53	-0.19	0.99	-0.80	1.17
Depth (00s mm)	0.88	1.38	3.64	2.95	-3.38	4.03
Implied Volume (000s cm^3)	-1.72	3.00	-7.49	6.61	2.88	6.03
Mass (000s g)	4.35***	1.54	5.15**	2.18	10.53	6.48
2nd Screen?	0.15***	0.04	0.08	0.05	0.14	0.16
Main Screen Color?	0.18***	0.05	0.21***	0.08	0.24	0.29
2nd Screen Color?	0.02	0.03	0.12**	0.06	-0.22	0.14
Battery-Talk (000s min)	0.05	0.12	0.12	0.18	0.79	0.57
Battery-Standby (000s hr)	0.08	0.10	0.31	0.20	-0.30	0.44
#RingTone Voices (00s)	0.16**	0.07	0.14	0.11	0.04	0.31
Downloadable RingTone?	0.03	0.03	0.04	0.04	0.31*	0.17
Message?	0.01	0.02	0.01	0.03	-0.04	0.12
Game Capable?	0.07*	0.04	0.01	0.07	0.18	0.15
Downloadable Game?	0.08***	0.02	0.10***	0.04	-0.06	0.06
Attachable Camera?	0.00	0.05	0.10	0.08	-0.03	0.32
Built-In Camera?	0.04	0.03	0.06	0.05	0.09	0.18
Camera Resolution (MP)	0.09***	0.03	0.02	0.06	0.01	0.13
GPS?	0.04	0.04	0.14	0.07	-0.01	0.11
#Models (00s)	0.23***	0.08	0.44***	0.14	0.79	0.49
HHI-Models	-0.13**	0.06	-0.34**	0.14	-0.37**	0.15
Time (00s wk)	-0.59***	0.10	-0.74***	0.16	1.57	1.98
$Time^2$ (00s wk)	0.03	0.03	0.13**	0.06	-2.21	5.55

*/**/*** denote 90%/95%/99% confidence levels

mean(η^D)	-3.49	-1.81	-1.54

Notes: Standard errors reflect Newey-West covariance matrix with two-week lags. Omitted form factor is Flip. Month and brand fixed effects not shown.