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Merger Simulation with Nested Logit Demand – Implementation using Stata

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Abstract

In this article we show how to implement merger simulation in Stata after estimating an aggregate nested logit demand system with a linear regression model. We also show how to implement merger simulation when the demand parameters are not estimated, but instead calibrated to be consistent with outside information on average price elasticities and profit margins.

Keywords: mergersim, merger simulation, aggregate nested logit model, unit demand and constant expenditures demand.

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1 Introduction

Merger simulation is increasingly used in competition policy and antitrust analysis; see e.g. Werden and Froeb (1993), Nevo (2000), Epstein and Rubinfeld (2001), Ivaldi and Verboven (2005) and, for a recent survey, Budzinski and Ruhmer (2010). Merger simulation aims to predict the price effects of a merger following three distinct steps. The first step specifies and estimates a demand system, usually one with differentiated products. The second step makes an assumption about the firms' equilibrium behavior, typically multi-product Bertrand-Nash, to compute the products' current profit margins and their implied marginal costs. The third step usually assumes that marginal costs are constant, and predicts how prices will change after the merger, accounting for increased market power, cost efficiencies and perhaps remedies (such as divestiture). Stata is often used to estimate the demand system (the first step), but not to implement a complete merger simulation (including the second and third steps). In this paper, we show how to implement merger simulation in Stata after estimating the parameters of a demand system for differentiated products. We also illustrate how to perform merger simulation when the demand parameters are not estimated, but rather calibrated to be consistent with outside industry information on price elasticities and profit margins.

We consider an oligopoly model with multi-product price-setting firms, who may partially collude and have constant marginal cost. Following Berry (1994), we specify the demand system as an aggregate nested logit model, which can be estimated with market-level data using linear regression methods (as opposed to the individual-level nested logit model). We consider both a unit demand specification, as in Berry (1994) and Verboven (1996), and a constant expenditures specification, as in Björnerstedt and Verboven (2012). The model requires a data set on products sold in a single market, or in a panel of markets, with information on the products' prices, their quantities sold, firm and nest identifiers, and possibly other product characteristics.

In section 2 we discuss the merger simulation model, including the nested logit demand system. In section 3 we introduce the commands required to carry out the merger simulation. Section 4 provides examples and section 5 concludes.

2 Merger simulation with an aggregate nested logit demand system

2.1 Merger simulation

Suppose there are J products, indexed by $j = 1, \dots, J$. The demand for product j is $q_j(\mathbf{p})$, where \mathbf{p} is a $J \times 1$ price vector, and its marginal cost is constant and equal to c_j . Each firm f owns a subset of products F_f and chooses the prices of its own products $j \in F_f$ to maximize:

$$\Pi_f(\mathbf{p}) = \sum_{j \in F_f} (p_j - c_j) q_j(\mathbf{p}) + \phi \sum_{j \notin F_f} (p_j - c_j) q_j(\mathbf{p}), \quad (1)$$

where $\phi \in (0, 1)$ is a conduct parameter to allow for the possibility that firms partially coordinate. If $\phi = 0$, firms behave non-cooperatively as multi-product firms. If $\phi = 1$, they behave as a perfect, joint-profit maximizing cartel. A Bertrand-Nash equilibrium is defined by the following system of first-order conditions:

$$q_j(\mathbf{p}) + \sum_{k \in F_f} (p_k - c_k) \frac{\partial q_k(\mathbf{p})}{\partial p_j} + \phi \sum_{k \notin F_f} (p_k - c_k) \frac{\partial q_k(\mathbf{p})}{\partial p_j} = 0, \quad j = 1, \dots, J \quad (2)$$

Let $\boldsymbol{\theta}$ be a $J \times J$ product-ownership matrix, with $\theta(j, k) = 1$ if products j and k are produced by the same firm and $\theta(j, k) = \phi$ otherwise. If $\phi = 0$ (no collusion), $\boldsymbol{\theta}$ becomes the usual block diagonal matrix; if in addition all firms own only one product, $\boldsymbol{\theta}$ becomes the identity matrix. Furthermore, let $\mathbf{q}(\mathbf{p})$ be the $J \times 1$ demand vector, $\boldsymbol{\Delta}(\mathbf{p}) \equiv \partial \mathbf{q}(\mathbf{p}) / \partial \mathbf{p}'$ be the $J \times J$ Jacobian of first derivatives, and \mathbf{c} is the $J \times 1$ marginal cost vector. We can then write (2) in vector notation as

$$\mathbf{q}(\mathbf{p}) + (\boldsymbol{\theta} \odot \boldsymbol{\Delta}(\mathbf{p})) (\mathbf{p} - \mathbf{c}) = 0.$$

This can be inverted to write price as the sum of marginal cost and a markup, where the markup term (inversely) depends on the price elasticities and on the product-ownership matrix:

$$\mathbf{p} = \mathbf{c} - (\boldsymbol{\theta} \odot \boldsymbol{\Delta}(\mathbf{p}))^{-1} \mathbf{q}(\mathbf{p}). \quad (3)$$

In the case of single-product firms with no collusion ($\phi = 0$), the markup term is simply price divided by the own-price elasticity of demand. With multiproduct-firms and/or partial collusion, the cross-price elasticities also matter and this increases the markup term (if products are substitutes).

Equation (3) serves two purposes. First, it can be rewritten to uncover the pre-merger marginal cost vector \mathbf{c} based on the pre-merger prices and estimated price elasticities of

demand, i.e.

$$\mathbf{c}^{pre} = \mathbf{p}^{pre} + (\boldsymbol{\theta}^{pre} \odot \boldsymbol{\Delta}(\mathbf{p}^{pre}))^{-1} \mathbf{q}(\mathbf{p}^{pre}).$$

Second, (3) can be used to predict the post-merger equilibrium. The merger involves two possible changes: a change in the product ownership matrix from $\boldsymbol{\theta}^{pre}$ to $\boldsymbol{\theta}^{post}$ and, if there are efficiencies, a change in the marginal cost vector from \mathbf{c}^{pre} to \mathbf{c}^{post} . To simulate the new price equilibrium, one may use fixed point iteration on (3), possibly with a dampening parameter in the markup term, or another algorithm such as the Newton method (see e.g. Judd, 1998).

2.2 Nested logit demand system

The demand system $\mathbf{q} = \mathbf{q}(\mathbf{p})$ for the J products, $j = 1, \dots, J$, is specified as a nested logit model with two levels of nests, referred to as groups and subgroups. This model belongs to McFadden's (1978) generalized extreme value discrete choice model. Consumers choose the choice alternative that maximizes random utility, resulting in a specification for choice probabilities for each choice alternative. The nested logit model relaxes the IIA property of the simple logit model, and allows consumers to have correlated preferences for products that belong to the same subgroup or group. While discrete choice models were initially developed to analyze individual-level data (see Train (2003) for an overview), Berry (1994) and Berry, Levinsohn and Pakes (1995) show how to estimate the models with aggregate data. The data set consists of $J \times 1$ vectors of the products' quantities \mathbf{q} , prices \mathbf{p} and a $J \times K$ matrix of product characteristics \mathbf{x} , including indicator variables for the products' subgroup and group and their firm affiliation. The data set is either for a single market or for a panel of markets, for example different years or different regions and countries. The panel is not necessarily balanced since new products may be introduced over time, or old products may be eliminated, and not all products may be for sale in all regions.

In addition to each product j 's quantity sold q_j , its price p_j and the vector of product characteristics x_j , it is necessary to observe (or estimate) the potential market size for the differentiated products. In the common unit demand specification of the nested logit, consumers have inelastic conditional demands: they either buy a single unit of their most preferred product $j = 1, \dots, J$, or they buy the outside good $j = 0$. The potential market size is then the potential number of consumers I , for example an assumed fraction γ of the observed population in the market, $I = \gamma L$. An alternative is the constant expenditures specification, where consumers have unit elastic conditional demand: they buy a constant expenditure of their most preferred product or the outside good. In this case the potential market size is the potential total budget B , for example an assumed fraction γ of total GDP

in the market, $B = \gamma Y$.

As shown by Berry (1994) and the extensions by Verboven (1996) and Björnerstedt and Verboven (2012), the aggregate two-level nested logit model gives rise to the following linear estimating equation for a cross section of products $j = 1, \dots, J$:

$$\ln(s_j/s_0) = x_j\beta + \alpha\tilde{p}_j + \sigma_1 \ln(s_{j|h_g}) + \sigma_2 \ln(s_{h|g}) + \xi_j. \quad (4)$$

A subscript t can be added to consider multiple markets or time periods, as in most empirical applications. The price variable is $\tilde{p}_j = p_j$ in the unit demand specification, and $\tilde{p}_j = \ln(p_j)$ in the constant expenditures specification. The variable s_j is the market share of product j in the potential market, $s_{j|h_g}$ is the market share of product j in its subgroup h of group g , and $s_{h|g}$ is the market share of subgroup h in group g . More precisely, as discussed in more detail in Björnerstedt and Verboven's (2012), the market shares are quantity shares in the unit demand specification

$$s_j = \frac{q_j}{I}, \quad s_{j|h_g} = \frac{q_j}{\sum_{j \in H_{h_g}} q_j}, \quad s_{h|g} = \frac{\sum_{j \in H_{h_g}} q_j}{\sum_{h=1}^{H_{h_g}} \sum_{j \in H_{h_g}} q_j},$$

and they are expenditure shares in the constant expenditures specification

$$s_j = \frac{p_j q_j}{B}, \quad s_{j|h_g} = \frac{p_j q_j}{\sum_{j \in H_{h_g}} p_j q_j}, \quad s_{h|g} = \frac{\sum_{j \in H_{h_g}} p_j q_j}{\sum_{h=1}^{H_{h_g}} \sum_{j \in H_{h_g}} p_j q_j},$$

where H_{h_g} is the set (or number) of products of subgroup h of group g .

Furthermore, in (4) x_j is a vector of observed product characteristics and ξ_j is the error term, capturing the product's quality that is unobserved to the econometrician. Equation (4) has the following parameters to be estimated: a vector of mean valuations β for the observed product characteristics, a price parameter $\alpha < 0$, and two nesting parameters σ_1 and σ_2 , measuring the consumers' preference correlation for products in the same subgroup and group. The model reduces to a one-level nested logit model with only subgroups as nests if $\sigma_2 = 0$, to a one-level nested logit model with only groups as nests if $\sigma_1 = \sigma_2$, and to a simple logit model without nests if $\sigma_1 = \sigma_2 = 0$. The mean gross valuation for product j is defined as $\delta_j \equiv x_j\beta + \xi_j = \ln(s_j/s_0) - \alpha\tilde{p}_j - \sigma_1 \ln(s_{j|h_g}) - \sigma_2 \ln(s_{h|g})$, so it can be computed from the product's market share, price and the parameters α , σ_1 and σ_2 .

In sum, the aggregate nested logit model is essentially a linear regression of the products' market shares on price, product characteristics, and (sub)group shares. In the unit demand specification price enters linearly and market shares are in volumes; in the constant expenditures specification price enters logarithmically and market shares are in values. In both cases, the error term ξ_j may be correlated with price and market shares, so that instrumental

variables should be used. Cost shifters would qualify as instruments, but these are typically not available at the product level. Berry, Levinsohn and Pakes (1995) suggest to use sums of the other products' characteristics (over the firm and the entire market). For the nested logit model, Verboven (1996) adds sums of the other product characteristics by subgroup and group.

3 Commands

Various `mergersim` subcommands implement merger simulation, either as post-estimation commands after a linear nested logit regression to estimate α , σ_1 and σ_2 , or as stand-alone commands where α , σ_1 and σ_2 are specified by the user. With a panel data set, it is necessary to time set the dataset before invoking the `mergersim` subcommands, using `xtset id time` or `tsset id time`, where `id` is the unique product identifier within the market and `time` is the market identifier (time and/or region). With a dataset for a single market, time setting is not required before invoking the `mergersim` subcommands.

Syntax

```
mergersim init | market | simulate | mre [if] [in] [, options]
```

Demand and market options

The demand and market specification are set in `mergersim init` and `mergersim market` (and in `mergersim simulate` if `mergersim market` is not explicitly invoked by the user).

- Prices and quantities must be specified by using any two of `price(varname)`, `quantity(varname)` and `revenue(varname)`.
- One or two nesting variables can be specified with `nests(varlist)`, with the outer (higher) nest specified first. If only one variable is specified, a one-level nested logit model applies. Without nests, a simple logit model applies.
- `marketsize(varname)` is used to specify the potential size of market.
- `cesdemand` specifies constant expenditure specification rather than the default unit demand (`unitdemand`).
- `firm(varname)` is an integer variable, indexing the firm owning the product.
- `conduct(#)` can be used to specify the degree of joint profit maximization between firms before the merger, in percentage terms (number between 0 and 1).

- **alpha(#)** and **sigmas(# [#])** can be used to specify values for the demand parameters rather than using an estimate. The first sigma corresponds to the parameter of the log share of the product in the subgroup and the second corresponds to that of the log share of the subgroup in the group.

Merger options

The merger specification is set in **mergersim simulate**, or in **mergersim mre**. Either the identity of buyer and seller firms or the new ownership structure have to be specified. The identity corresponds to the value in the variable specified with the **firm** option.

- The post-merger ownership structure can be specified using **buyer(#)** and **seller(#)** to specify the id in the firm variable. A new more complicated change in ownership can be specified with a new ownership structure using the **newfirm(varname)** option. For example, it can be used to simulate divestitures or two cumulative mergers, by manually constructing a new firm ownership variable that differs from the firm variable specified with the **firm** option.
- Efficiency gains, in terms of percentage reduction in marginal costs, can be specified in two ways. A first way is to specify the same efficiency for all seller and buyer products using the **buyereff(#)** and **sellereff(#)** option. The default value of 0 indicates no efficiency gain. An alternative, more general way is to specify efficiencies or post-merger costs for each product using **efficiencies(varname)** or **costs(varname)**.
- **newconduct(#)** is used to specify the degree of joint profit maximization between firms after the merger, in percentage terms.

Computation options

The computation options can be set in **mergersim simulate**, where the post-merger Nash equilibrium is computed.

- **method(fixedpoint | newton)** is used to specify the method used to find post-merger Nash equilibrium.
- **maxit(#)** is the maximum number of iterations used in the solver methods.
- **dampen(#)** can be used to set a dampening factor lower than the default 1 in the fixed point method. If fixedpoint does not converge, the method automatically tries a dampening factor of half of the initial dampening.

Display and results options

The display and results options can be set in **mergersim market** and **mergersim simulate**, where the post-merger Nash equilibrium is computed.

- **marketshares** shows market shares in **mergersim results**. These market shares are relative to total actual sales (excluding the outside good).
- **keepvars** specifies that all generated variables should be kept. By default, only post-merger prices and quantities and calculated costs are kept (M_price2, M_quantity2 and M_costs).

Description

mergersim performs a merger simulation, using three main subcommands: **init**, **market**, **simulate**. **mergersim init** must be invoked first to initialize the settings. **mergersim market** calculates the price elasticities and marginal costs. **mergersim simulate** performs a merger simulation, automatically invoking **mergersim market** if the command has not been called by the user. In addition to displaying results, **mergersim** creates various variables at each step. By default the names of these variables begin with M_.

First, **mergersim init** initializes the settings for the merger simulation. It is required before estimation and before a first merger simulation. It defines the upper and/or lower nests, the specification (unit demand or constant expenditures demand), the price, quantity and revenue variables (two out of three) the potential market size variable and the firm identifier (numerical variable). It also generates the variables necessary to estimate the demand parameters (alpha and sigmas) using a linear (nested) logit regression, along the lines of Berry (1994) and the extensions of Björnerstedt and Verboven (2012). The names of the market share and price variables to use in the regression will depend on the demand specification, and are shown in the display output of **mergersim init**. Alternatively, the demand parameters can be calibrated with the **alpha()** and **sigmas()** options, rather than being estimated.

Second, **mergersim market** computes the pre-merger conditions: the gross valuations δ_j and marginal costs c_j of each product j , under assumptions regarding the degree of coordination. The computations are based on the last estimates of α , σ_1 and σ_2 , unless they are overruled by values specified by the user in the **alpha()** and **sigmas()** options. **mergersim market** is required after **mergersim init** and before the first **mergersim simulate**. It is not necessary to specify **mergersim market** before additional **mergersim simulate**s (unless one wants to specify new pre-merger values of δ_j and c_j).

Third, **mergersim simulate** computes the post-merger prices and quantities, under assumptions regarding the identity of the merged firms, their cost efficiencies and the degree

of collusion (the same as before the merger). It is possible to repeat the command multiple times after estimation.

In addition to these three main subcommands, there are several other subcommands may provide useful additional information. For example, `mergersim mre` computes the minimum required efficiencies per product for the price not to increase after the merger. It can be invoked after `mergersim init`.

4 Examples

4.1 Preparing the data

To show how to implement `mergersim`, we use the data set on the European car market, collected by Goldberg and Verboven (2001) and maintained on their webpages.¹ We take a reduced version of the data set with fewer variables and a slightly more aggregate firm definition, called `cars1.dta`. Each observation is a car model/year/country. The total number of observations is 11,483: there are 30 years (1970-1999) and 5 countries (Belgium, France, Germany, Italy and the U.K.), implying an average of 77 car models per year/country. The car market is divided into five upper nests (groups) according to the segments: subcompact, compact, intermediate, standard and luxury. Each segment is further subdivided into lower nests (subgroups) according to the origin: domestic or foreign origin (e.g. Fiat is domestic in Italy and foreign in the other countries). Sales are new car registrations (`qu`). Price is measured in local currency (`pr`) or relative to local GDP per capita (`princ`). The product characteristics are horsepower (in kW), fuel efficiency (in liter/100 km), width (in cm) and height (in cm).

```
. summarize year country co segment domestic firm qu pr princ horsepower fuel width height pop ngdp
```

Variable	Obs	Mean	Std. Dev.	Min	Max
year	11483	1985.43	8.540344	1970	1999
country	11483	2.918488	1.443221	1	5
co	11483	223.0364	206.6172	1	980
segment	11483	2.559087	1.289577	1	5
domestic	11483	.1886267	.3912288	0	1
firm	11483	14.49769	8.567491	1	34
qu	11483	19911.44	37803.6	51	433694
pr	11483	2857566	8237668	498	1.17e+08
princ	11483	.827373	.4092892	.2417908	6.472902
horsepower	11483	57.26393	23.89019	13	169.5
fuel	11483	6.728904	1.709702	3.8	18.6
width	11483	164.4574	9.567716	122	188
height	11483	140.4434	4.631175	117.5	173.5
pop	11483	4.81e+07	2.18e+07	9660000	8.21e+07
ngdp	11483	1.76e+14	4.73e+14	5.18e+10	2.13e+15

¹See <http://www.econ.kuleuven.be/public/ndbad83/frank/cars.htm>

A first key preparatory task is to define the two dimensions of the panel and to timeset the data (unless there is a single cross-section). The first dimension is the “product”, i.e. the car model (e.g. Volkswagen Golf). The second dimension is the “market”, which can be defined as the year/country (e.g. France in 1995).

```
. egen yearcountry=group(year country), label
. xtset co yearcountry
    panel variable:  co (unbalanced)
    time variable:  yearcountry, 1 to 150, but with gaps
                   delta: 1 unit
```

Note that the panel is unbalanced since most models are not available throughout the entire time period or in all countries.

A second key preparatory task is to define the potential market size. For the car market, it is sensible to adopt a unit demand specification. We specify the potential market size as total population divided by 4, a crude proxy for the number of households. In practice, the potential market size in a given year may be lower because cars are durable and consumers who just purchased a car may not consider buying a new one immediately.

```
. gen MSIZE=pop/4
```

4.2 Performing a merger simulation

Merger simulation can now proceed in three steps.

Initializing the merger simulation settings The first step initializes the settings for the merger simulation, using the command `mergersim init`. The next example specifies a two-level nested logit model, where the groups are the segments and the subgroups are domestic/foreign origin with the segment. This requires the option `nests(segment domestic)`. The specification is the default unit demand specification. The price, quantity, market size and firm variables are also specified.

```
. mergersim init, nests(segment domestic) price(princ) quantity(qu) marketsize(MSIZE) firm(firm)
-----
MERGERSIM: Merger Simulation Program
Version 1.0, Revision: 174
-----
Unit demand two-level nested logit
-----
                Depvar                Price                Group shares
-----
                M_ls                  princ                M_lsjh M_lshg
-----
Variables generated: M_share M_shareoutside M_ls M_lsjh M_lshg
-----
```

`Merger init` creates various market share and price variables, labeled with an “M_”-prefix (the default prefix). The variable `M_ls` is the dependent variable $\ln(s_j/s_0)$, `M_lsjh` is the log of the subgroup share $\ln(s_{j|hg})$, and `M_lshg` is the log of the group share $\ln(s_{h|g})$.

We can estimate the nested logit model with a linear regression estimator, using instrumental variables to account for the endogeneity of the price and market share variables. As a simplification to illustrate the approach, we consider a fixed effects regression without instruments.

```
. xtreg M_ls princ M_lsjh M_lshg horsepower fuel width height domestic year country2-country5, fe
```

```
Fixed-effects (within) regression      Number of obs      =    11483
Group variable: co                     Number of groups   =     351

R-sq:  within = 0.9001                 Obs per group: min =      1
      between = 0.7692                   avg =              32.7
      overall  = 0.8512                   max =             146

corr(u_i, xb) = -0.0100                F(13,11119)       =   7706.68
                                           Prob > F          =    0.0000
```

M_ls	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
princ	-1.171301	.0264398	-44.30	0.000	-1.223127	-1.119474
M_lsjh	.9081198	.0040417	224.69	0.000	.9001973	.9160423
M_lshg	.580436	.0083036	69.90	0.000	.5641596	.5967125
horsepower	.0049196	.0005739	8.57	0.000	.0037946	.0060447
fuel	-.0279489	.0044222	-6.32	0.000	-.0366173	-.0192806
width	.0105238	.0016329	6.44	0.000	.0073231	.0137245
height	.0005663	.0021589	0.26	0.793	-.0036656	.0047982
domestic	.5078974	.0121149	41.92	0.000	.4841501	.5316448
year	.0001413	.0011698	0.12	0.904	-.0021517	.0024344
country2	-.6406873	.013658	-46.91	0.000	-.6674594	-.6139152
country3	-.6127081	.0143898	-42.58	0.000	-.6409147	-.5845016
country4	-.4992317	.0150131	-33.25	0.000	-.52866	-.4698034
country5	-.3869142	.0156916	-24.66	0.000	-.4176725	-.3561559
_cons	-5.050566	2.185933	-2.31	0.021	-9.335383	-.7657489
sigma_u	.51238127					
sigma_e	.3543756					
rho	.67643215	(fraction of variance due to u_i)				

```
F test that all u_i=0:      F(350, 11119) =    23.79      Prob > F = 0.0000
```

The parameters that will influence the merger simulations are the price parameter $\alpha = -1.17$ (associated with the variable “princ” in the above table) and the nesting parameters $\sigma_1 = 0.91$ and $\sigma_2 = 0.58$ (the coefficients of, respectively, M_lsjh and M_lshg). These estimates satisfy the restrictions from economic theory, $\alpha < 0$ and $1 > \sigma_1 \geq \sigma_2 \geq 0$. It is however important to stress that the fixed effects estimator is inconsistent, because price and the subgroup and group market share variables are endogenous. As discussed in Berry (1994), an instrumental variable estimator is required (using for example ivreg or xtivreg with appropriate instruments). We therefore only use the fixed effects estimator for illustrative purposes.

Analyzing pre-merger market conditions The second step in the merger simulation calculates the pre-merger market conditions (the products’ gross valuations and their marginal costs, and the price elasticities of demand), using the command mergersim market. In the example below, these calculations are only done for the five countries in 1998. Since no values for α , σ_1 and σ_2 are specified, mergersim market uses the parameters in the last available Stata estimation, i.e. the ones from fixed effects regression.

```

. mergersim market if year == 1998
-----
Supply: Bertrand competition
Demand: Unit demand two-level nested logit
-----
Demand estimate
xtreg M_ls princ M_lsjh M_lshg horsepower fuel width height domestic year country2-country5, fe
Dependent variable: M_ls
-----

Parameters
alpha = -1.171
sigma1 = 0.908
sigma2 = 0.580
-----
Own- and Cross-Price Elasticities: unweighted market averages
-----

```

variable	mean	sd	min	max
M_ejj	-8,681	4,436	-41,319	-2,306
M_ejk	0,898	1,553	0,003	14,834
M_ejl	0,080	0,142	0,000	0,871
M_ejm	0,001	0,002	0,000	0,011

```

-----
Observations: 449
-----

Pre-merger Market Conditions
Unweighted averages by firm
-----

```

firm code	princ	Marginal costs	Pre-merger Lerner
BMW	0,910	0,806	0,126
Fiat	0,694	0,510	0,299
Ford	0,649	0,547	0,180
Honda	0,891	0,808	0,111
Hyundai	0,581	0,501	0,154
Kia	0,489	0,410	0,178
Mazda	0,647	0,566	0,136
Mercedes	1,150	0,994	0,141
Mitsubishi	0,701	0,619	0,127
Nissan	0,681	0,597	0,139
GeneralMotors	0,940	0,847	0,117
Peugeot	0,721	0,616	0,168
Renault	0,689	0,585	0,177
Suzuki	0,416	0,337	0,202
Toyota	0,636	0,554	0,154
VW	0,855	0,755	0,156
Volvo	1,054	0,967	0,085
Daewoo	0,625	0,545	0,145

```

-----
Variables generated: M_costs M_delta M_lerner
-----

```

These results imply fairly high own-price elasticities for the products in 1998, on average -8.681. The cross price elasticities are higher for products within the same subgroup (0.898) than for products of a different subgroup (0.080) and especially for products of a different group (0.001). The Lerner index or percentage markup over marginal cost varies from 8.5% to 29.9%, with a tendency of higher percentage markups for firms with lower priced models (a feature of most unit demand models).

Simulating the merger effects The third step performs the actual merger simulation, using the command `mergersim simulate`. The example below considers a merger where General Motors (GM) (firm=15) sells its operations to VW (firm=26). Note that the merger simulations would be the same if it was VW who sold its operations to GM. We first carry out the merger simulations for Germany in 1998, where it can be considered as a “domestic merger” (since GM sells the Opel brands, which are produced in Germany). It is assumed that there are no marginal cost savings to the seller or the buyer, and that there is no partial coordination (neither before, nor after the merger).

```
. mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26)
```

Merger Simulation

	Buyer	Seller	Simulation method: Newton
Firm	26	15	Periods/markets: 1
Marginal cost savings	0	0	Number of iterations: 6
			Max price change in last it: 1.8e-07

Uweighted averages by firm

firm code	Pre-merger price	Post-merger price	Price change
BMW	0,748	0,750	0,003
Fiat	0,639	0,639	0,000
Ford	0,546	0,556	0,022
Honda	0,657	0,658	0,000
Hyundai	0,538	0,538	0,000
Kia	0,470	0,470	0,000
Mazda	0,593	0,593	0,000
Mercedes	0,838	0,840	0,002
Mitsubishi	0,660	0,660	0,000
Nissan	0,629	0,629	0,000
GeneralMotors	0,830	0,874	0,071
Peugeot	0,683	0,683	0,000
Renault	0,637	0,637	0,000
Suzuki	0,384	0,384	0,000
Toyota	0,542	0,543	0,000
VW	0,716	0,738	0,033
Volvo	0,923	0,923	0,000
Daewoo	0,562	0,562	0,000

Variables generated: M_price2 M_share2 (Other M_ variables dropped)

The results show prices before and after the merger, and the percentage price change, averaged by firm. The merger simulations predict that General Motors will on average raise its prices by 7.1%, while VW will on average raise its prices by 3.3%. The rivals respond with only very small price increases (with the exception of Ford).²

More complicated merger simulations are possible with the option `newowner()`. This option enables one to specify a new firm variable after the merger. This makes it possible to evaluate the effects of remedies (divestitures) or cumulative mergers.

4.3 Accounting for efficiencies and partial collusion

It is possible to account for several specific features of the merger.

Efficiencies First, one may account for the possibility that the buying or the selling firm benefit from a marginal cost saving, that may be passed on into consumer prices. The cost saving is expressed as a percentage of current marginal cost. In the command below, the options `sellereff(0.2)` and `buyereff(0.2)` mean that the seller and the buyer each have a marginal cost saving of 20% on all of their products.

²Note that one can also specify the option `marketshares`, to display the market shares before and after the merger, and the percentage point difference. If one is interested to see more detailed results, one can use additional options under `mergersim results`. Or one can use standard Stata commands such as `table`, based on the variables `M_price` (pre-merger price) and `M_price2` (post-merger price).

```
. mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26) ///
> sellereff(0.20) buyereff(0.20) method(fixedpoint) maxit(40) dampen(0.5)
```

Merger Simulation

	Buyer	Seller	Simulation method: Dampened Fixed point
Firm	26	15	Periods/markets: 1
Marginal cost savings	.2	.2	Number of iterations: 14
			Max price change in last it: .

Uweighted averages by firm

firm code	Pre-merger price	Post-merger price	Price change
BMW	0,748	0,738	-0,011
Fiat	0,639	0,636	-0,004
Ford	0,546	0,546	0,001
Honda	0,657	0,656	-0,002
Hyundai	0,538	0,538	-0,000
Kia	0,470	0,470	-0,000
Mazda	0,593	0,592	-0,001
Mercedes	0,838	0,801	-0,033
Mitsubishi	0,660	0,659	-0,001
Nissan	0,629	0,624	-0,005
GeneralMotors	0,830	0,788	-0,027
Peugeot	0,683	0,682	-0,002
Renault	0,637	0,636	-0,003
Suzuki	0,384	0,384	-0,001
Toyota	0,542	0,542	-0,001
VW	0,716	0,653	-0,079
Volvo	0,923	0,918	-0,005
Daewoo	0,562	0,562	-0,000

Variables generated: M_price2 M_share2 (Other M_ variables dropped)

There is now a predicted price decrease in Germany, of -2.7% for GM and -7.9% for VW. This implies that the 20% cost savings are sufficiently passed through to consumers. To obtain convergence, fixed point iteration with a dampening factor of 0.5 was used, as the default newton method did not converge. `Sellereff()` and `buyereff()` assume the same percentage cost saving for all products of the seller and buyer. A more flexible option is `efficiencies()`, which enables one to have product-specific percentage cost saving, based on the variable that enters in `efficiencies()`.

Instead of simulating the prices in the post-merger equilibrium with `efficiencies`, it is also possible to compute the minimum required efficiency (percentage cost saving by product) for the prices to remain unchanged after the merger; see Froeb and Werden (1998) or Röller, Stennek and Verboven (2001). This can be done with the `mergersim mre` command:

```
. mergersim mre if year == 1998 & country == 3, seller(15) buyer(26)
```

Minimum Required Efficiencies for merging firms

variable	mean	sd	min	max
M_costs	0,644	0,396	0,267	1,825
M_costs2	0,586	0,412	0,240	1,824
M_mre	0,113	0,117	0,001	0,368

Weighted average MRE: 0.203 Observations: 19

Variable generated: M_mre

The generated variable `M_mre` refers to the minimum required efficiency per product

owned by the merging firms (and is set to a missing value for the products of the non-merging firms. According to the results, the minimum required efficiencies for the 19 products of the merging firms are on average 11.3% (unweighted) and 20.3% (weighted by sales).

Conduct Second, one may account for the possibility that firms partially coordinate, i.e. take into account a fraction of the competitors' profits when setting prices. Assume for example that firms maintain the same degree of coordination before and after the merger: one can set the conduct parameter such that the markups are in line with outside estimates. Performing mergersim market before mergersim simulate enables one to verify whether the conduct parameter results in pre-merger markups in line with outside estimates.

```
. mergersim market if year == 1998 & country == 3, conduct(0.5)
```

```
Supply: Partial collusion, factor = .5
Demand: Unit demand two-level nested logit
```

```
Demand estimate
xtreg M_ls princ M_lsjh M_lshg horsepower fuel width height domestic year country2-country5,
> fe
Dependent variable: M_ls
```

```
Parameters

alpha = -1.171
sigma1 = 0.908
sigma2 = 0.580
```

```
Own- and Cross-Price Elasticities: unweighted market averages
```

variable	mean	sd	min	max
M_ejj	-7,460	3,107	-23,810	-3,607
M_ejk	0,847	1,237	0,008	5,326
M_ejl	0,066	0,135	0,001	0,698
M_ejm	0,001	0,002	0,000	0,011

```
Observations: 97
```

```
Pre-merger Market Conditions
Uweighted averages by firm
```

firm code	princ	Marginal costs	Pre-merger Lerner
BMW	0,748	0,559	0,270
Fiat	0,639	0,465	0,310
Ford	0,546	0,353	0,389
Honda	0,657	0,489	0,265
Hyundai	0,538	0,380	0,324
Kia	0,470	0,312	0,363
Mazda	0,593	0,430	0,292
Mercedes	0,838	0,591	0,324
Mitsubishi	0,660	0,496	0,260
Nissan	0,629	0,457	0,294
GeneralMotors	0,830	0,634	0,276
Peugeot	0,683	0,517	0,278
Renault	0,637	0,467	0,316
Suzuki	0,384	0,224	0,428
Toyota	0,542	0,379	0,352
VW	0,716	0,519	0,327
Volvo	0,923	0,747	0,193
Daewoo	0,562	0,401	0,322

```
Variables generated: M_costs M_delta M_lerner
```

The results show that if firms coordinate by taking into account 50% of the competitors' profits, then the Lerner index becomes almost twice as high as when there is no coordination.

The predicted price effects after the merger can now be computed.

```
. mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26) conduct(0.5)
```

Merger Simulation

	Buyer	Seller	Simulation method: Newton
Firm	26	15	Periods/markets: 1
Marginal cost savings			Number of iterations: 5
			Max price change in last it: .00003

Conduct:	Pre	Post	
	.5	.5	

Prices
Unweighted averages by firm

firm code	Pre-merger	Post-merger	Percentage change
BMW	0,748	0,755	0,010
Fiat	0,639	0,643	0,007
Ford	0,546	0,576	0,059
Honda	0,657	0,662	0,007
Hyundai	0,538	0,542	0,008
Kia	0,470	0,474	0,009
Mazda	0,593	0,597	0,007
Mercedes	0,838	0,850	0,023
Mitsubishi	0,660	0,665	0,008
Nissan	0,629	0,633	0,007
GeneralMotors	0,830	0,879	0,079
Peugeot	0,683	0,687	0,007
Renault	0,637	0,641	0,007
Suzuki	0,384	0,388	0,009
Toyota	0,542	0,546	0,008
VW	0,716	0,746	0,046
Volvo	0,923	0,928	0,005
Daewoo	0,562	0,566	0,008

variables generated: M_price2 M_share2 (Other M_ variables dropped)

Under partial coordination, the merger simulation predicts larger price increases. On the one hand, there is a larger predicted price increase for the merging firms: this feature does not hold generally, since the merging firms already partially coordinate before the merger. On the other hand, there is also a larger predicted price increase for the outsider firms: this feature may hold more generally since it reflects the fact that outsiders have more cooperative responses to price changes by the merging firms.

4.4 Calibrating instead of estimating the price and nesting parameters

The merger simulation results depend crucially on the values of three parameters: α , σ_1 and σ_2 (and in addition on the price and quantity data per product). A practitioner may often not want to rely too heavily on the econometric estimates of these parameters, and want to verify whether the elasticities and markups are consistent with external industry information. In this case, a practitioner would not estimate but “calibrate” the parameters such that they result in price elasticities and markups that are equal to external estimates. Such calibration is possible, by specifying the option `alpha()` and `sigmas()` to `mergersim`

market. The selected values overrule the values in memory, for example the ones from a previous estimation. In the lines below, we specify $\alpha = -0.8$ (closer to 0 as compared with the econometric estimate of about $\alpha = -1.2$), and we set $\sigma_1 = \sigma_2 = 0.9$. Hence, we calibrate α such that demand would be less elastic. The results from this calibration imply indeed lower price elasticities (on average -5.2):

```
. mergersim market if year == 1998 & country == 3
```

```
Supply: Bertrand competition
Demand: Unit demand two-level nested logit
```

```
Demand calibration

Parameters

alpha = -0.800
sigma1 = 0.910
sigma2 = 0.580
```

```
Own- and Cross-Price Elasticities: unweighted market averages
```

variable	mean	sd	min	max
M_ejj	-5,200	2,165	-16,601	-2,515
M_ejk	0,593	0,865	0,006	3,736
M_ejl	0,045	0,092	0,000	0,476
M_ejm	0,001	0,001	0,000	0,008

```
Observations: 97
```

```
Pre-merger Market Conditions
Uweighted averages by firm
```

firm code	princ	Marginal costs	Pre-merger Lerner
BMW	0,748	0,607	0,202
Fiat	0,639	0,506	0,240
Ford	0,546	0,400	0,301
Honda	0,657	0,533	0,198
Hyundai	0,538	0,423	0,234
Kia	0,470	0,356	0,261
Mazda	0,593	0,472	0,216
Mercedes	0,838	0,616	0,268
Mitsubishi	0,660	0,537	0,196
Nissan	0,629	0,500	0,219
GeneralMotors	0,830	0,684	0,209
Peugeot	0,683	0,560	0,207
Renault	0,637	0,507	0,247
Suzuki	0,384	0,269	0,308
Toyota	0,542	0,423	0,258
VW	0,716	0,557	0,267
Volvo	0,923	0,784	0,151
Daewoo	0,562	0,447	0,230

```
Variables generated: M_costs M_delta M_lerner
```

The next lines show what this calibration implies for merger simulation.

```
. mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26)
```

Merger Simulation

	Buyer	Seller	Simulation method: Newton
Firm	26	15	Periods/markets: 1
Marginal cost savings	0	0	Number of iterations: 6
			Max price change in last it: 2.6e-07

Uweighted averages by firm

firm code	Pre-merger price	Post-merger price	Price change
BMW	0,748	0,751	0,004
Fiat	0,639	0,639	0,000
Ford	0,546	0,561	0,031
Honda	0,657	0,658	0,000
Hyundai	0,538	0,538	0,000
Kia	0,470	0,470	0,000
Mazda	0,593	0,593	0,000
Mercedes	0,838	0,840	0,004
Mitsubishi	0,660	0,660	0,000
Nissan	0,629	0,629	0,000
GeneralMotors	0,830	0,893	0,102
Peugeot	0,683	0,683	0,000
Renault	0,637	0,637	0,000
Suzuki	0,384	0,384	0,000
Toyota	0,542	0,543	0,000
VW	0,716	0,747	0,048
Volvo	0,923	0,923	0,000
Daewoo	0,562	0,562	0,000

Variables generated: M_price2 M_share2 (Other M_ variables dropped)

These results show that the predicted price increase is larger when demand is less elastic.

4.5 Constant expenditures demand

We can finally illustrate how to do merger simulation based on the constant expenditures demand instead of the unit demand specification. For cars, this may not be a realistic option, since consumers typically buy one unit or no unit, rather than a constant expenditures. Nevertheless, we can use the constant expenditures specification to see how functional form affects the predictions from merger simulation.

We first need to define the potential market size.

```
. gen MSIZE1=ngdp/5
```

This assumes the potential expenditures on cars in a country/year are 20% of total GDP.

Next, we calibrate (rather than estimate) the parameters to $\alpha = -0.5$, $\sigma_1 = 0.9$ and $\sigma_2 = 0.6$.

```
. quietly mergersim init, nests(segment domestic) ces price(pr) quantity(qu) ///
> marketsize(MSIZE1) firm(firm) alpha(-0.5) sigmas(0.9 .6)
```

Note that the price variable is now “pr” (price in Euro), rather than “princ” (price relative to income).

```
. mergersim market if year == 1998 & country == 3
```

```
Supply: Bertrand competition
Demand: Constant expenditure two-level nested logit
```

```
Demand calibration

Parameters

alpha = -0.500
sigma1 = 0.900
sigma2 = 0.600
```

```
Own- and Cross-Price Elasticities: unweighted market averages
```

variable	mean	sd	min	max
M_ejj	-5,574	0,493	-5,995	-4,054
M_ejk	0,426	0,493	0,005	1,946
M_ejl	0,039	0,065	0,000	0,283
M_ejm	0,001	0,001	0,000	0,006

```
Observations: 97
```

```
Pre-merger Market Conditions
Uweighted averages by firm
```

firm code	pr	Marginal costs	Pre-merger Lerner
BMW	34231,668	27419,880	0,194
Fiat	29257,455	23750,927	0,189
Ford	24975,000	20033,644	0,202
Honda	30097,500	24680,508	0,180
Hyundai	24630,000	20471,297	0,169
Kia	21509,000	17900,492	0,168
Mazda	27142,000	22288,345	0,177
Mercedes	38369,000	27140,523	0,260
Mitsubishi	30200,250	24756,190	0,180
Nissan	28805,000	23426,182	0,183
GeneralMotors	38000,000	30107,953	0,206
Peugeot	31277,500	25700,746	0,179
Renault	29170,000	23851,598	0,188
Suzuki	17596,666	14613,672	0,170
Toyota	24833,750	20485,894	0,175
VW	32774,922	25550,836	0,221
Volvo	42250,000	33584,989	0,201
Daewoo	25720,000	21366,422	0,169

```
Variables generated: M_costs M_delta M_lerner
```

At the calibrated parameter values, the pre-merger elasticities and markups are roughly comparable to the ones of the estimated unit demand model (with less variation between firms). The merger simulation, however, results in a larger predicted price increase, by +10.1% for GM and 4.4% for VW. This follows from the different functional form: the constant expenditures specification has the property of quasi-constant price elasticity, while the unit demand specification has the property that consumers become more price sensitive as firms raise prices. For this same reason, efficiencies in the form of marginal cost savings would also be passed through more to consumers under this specification.

```
. mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26)
```

Merger Simulation

	Buyer	Seller	Simulation method: Newton
Firm	26	15	Periods/markets: 1
Marginal cost savings	0	0	Number of iterations: 8
			Max price change in last it: 5.4e-09

Uweighted averages by firm

firm code	Pre-merger price	Post-merger price	Price change
BMW	34231,668	34375,158	0,004
Fiat	29257,455	29264,621	0,000
Ford	24975,000	25373,765	0,017
Honda	30097,500	30101,862	0,000
Hyundai	24630,000	24630,610	0,000
Kia	21509,000	21509,247	0,000
Mazda	27142,000	27145,800	0,000
Mercedes	38369,000	38446,383	0,003
Mitsubishi	30200,250	30205,192	0,000
Nissan	28805,000	28809,877	0,000
GeneralMotors	38000,000	41166,190	0,101
Peugeot	31277,500	31281,896	0,000
Renault	29170,000	29175,391	0,000
Suzuki	17596,666	17597,301	0,000
Toyota	24833,750	24836,155	0,000
VW	32774,922	34207,541	0,044
Volvo	42250,000	42269,812	0,000
Daewoo	25720,000	25720,763	0,000

Variables generated: M_price2 M_share2 (Other M_ variables dropped)

5 Conclusions

This overview has shown how to apply two specifications of the two-level nested logit demand system to merger simulation. We show that merger simulation can either be applied as a post-estimation command based on estimated parameter values, or it can be implemented without estimation but based on calibrated parameters. The merger simulation results yield intuitive predictions given the assumed demand parameters. We stress however that the parameters were obtained from an inconsistent fixed effects estimator. In practice, one should use instrumental variables to estimate the parameters consistently.

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