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 as a post-estimation command, i.e. 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. We allow for a variety of extensions, including the role of (marginal) cost savings, remedies (divestiture) and conduct different from Bertrand-Nash behavior.

1 Introduction

Competition and antitrust authorities have long been concerned with the possible anticompetitive effects of mergers. This is in particular the case for horizontal mergers, which are mergers between firms selling substitute products. The traditional concern has been that such mergers raise market power, which may hurt consumers and reduce total welfare (the sum of producer and consumer surplus). At the same time however, it has been recognized that mergers may also result in cost savings or other efficiencies. While such cost savings may often not be sufficient to reduce prices and benefit consumers, it has been shown that even small cost savings can be sufficient to raise total welfare, see Williamson (1968) and Farrell and Shapiro (1991).[1] Despite the possible total welfare gains, most competition authorities in practice take a consumer surplus standard when evaluating proposed mergers.

Merger simulation is increasingly used as a tool to evaluate the effects of horizontal mergers. Consistent with policy practice, the focus is often on the price and consumer surplus effects, but various applications also evaluate the effects on total welfare.[2] Merger simulation aims to predict the merger effects in the 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 computes the post-merger price equilibrium, accounting for increased market power, cost efficiencies and perhaps remedies (such as divestiture). This enables one to compute the effect of the merger on prices and consumer surplus, and also on producer surplus and total welfare. 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 as a post-estimation command, i.e. 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

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[1] According to Williamson's analysis, the deadweight loss from the output reduction after the merger is a second-order effect, which is easily compensated by the cost savings from the merger. Posner (1975), however, argues that there is another source of inefficiency from mergers, as firms must spend wasteful resources to make a merger and maintain market power. In this alternative view, it may be more natural to use consumer surplus as a standard to evaluate mergers, and ignore the transfer from consumers to firms.

[2] Early contributions to the merger simulation literature are e.g. Werden and Froeb (1993), Nevo (2000), Epstein and Rubinfeld (2001) and Ivaldi and Verboven (2005). For a recent survey, see Budzinski and Ruhmer (2010)

margins. We allow for a variety of extensions, including the role of (marginal) cost savings, remedies (divestiture) and conduct different from Bertrand-Nash behavior.

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 $j = 1, \ldots, J$. 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:

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

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:

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

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:

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

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, $j = 1, \ldots, J$, 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 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 (2009) 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 $j = 1, \ldots, J$, 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 $j = 1, \ldots, J$:

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

A subscript t can be added to consider multiple markets or time periods, as in most empirical applications. The price variable is $\widetilde{p}_j = p_j$ in the unit demand specification, and $\widetilde{p}_j = \ln(p_j)$ in the constant expenditures specification. The variable s_j is the market share of product j in the potential market, $s_{j|hg}$ 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

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

and they are expenditure shares in the constant expenditures specification

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

where H_{hg} 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 $\delta_j \equiv x_j\beta + \xi_j = \ln(s_j/s_0) - \alpha\widetilde{p}_j - \sigma_1\ln(s_{j|hg}) - \sigma_2\ln(s_{h|g})$, 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 unobserved product characteristics 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 commands implement merger simulation, either as commands before and 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 commands,, 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 however not required.

   Syntax

$$\text{mergersim [init | market | simulate | mre] [if] [in] [, options]}$$

   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**).

- **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.

- **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).

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 **newcosts(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.

- **detail** shows additional premerger and postmerger information in **mergersim results** (in addition to the default information on prices): market shares by firm (expressed as a fraction of total actual sales, excluding the outside good), Herfindahl index, C4 and C8 ratio's, consumer surplus and producer surplus changes.

- **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_price_ch, 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 simulates (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 to implement mergersim, we use the data set on the European car market, collected by Goldberg and Verboven (2001) and maintained on their webpages.[3] We take a reduced version of that 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,

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[3]See http://www.econ.kuleuven.be/public/ndbad83/frank/cars.htm

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 1000 Euro (in 1999 purchasing power). The product characteristics are horsepower (in kW), fuel efficiency (in liter/100 km), width (in cm) and height (in cm). The commands below are provided in a script, called example.do.

```
. summarize year country co segment domestic firm qu price 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
       price |     11483     18.49683    8.922665   5.260726    150.3351
  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
```

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(price) quantity(qu) marketsize(MSIZE) firm(firm)

MERGERSIM: Merger Simulation Program
Version 1.0, Revision: 218

Unit demand two-level nested logit

            Depvar              Price              Group shares

            M_ls                price              M_lsjh M_lshg

Variables generated: 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 price 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  = 0.8948                         Obs per group: min =          1
       between = 0.7576                                        avg =       32.7
       overall = 0.8427                                        max =        146

                                                F(13,11119)        =    7271.50
corr(u_i, Xb)  = -0.0147                         Prob > F           =     0.0000

------------------------------------------------------------------------------
        M_ls |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       price | -.0468375   .0013002   -36.02   0.000    -.0493861   -.0442888
      M_lsjh |  .9047371   .0041489   218.07   0.000     .8966045    .9128696
      M_lshg |  .5677968   .0085109    66.71   0.000      .551114    .5844796
  horsepower |  .0038279   .0005921     6.46   0.000     .0026672    .0049886
        fuel | -.0270919    .004539    -5.97   0.000    -.0359892   -.0181946
       width |  .0103757   .0016768     6.19   0.000     .0070889    .0136625
      height |  .0004322   .0022161     0.20   0.845    -.0039117    .0047761
    domestic |  .5230743   .0124205    42.11   0.000     .4987279    .5474206
        year |  .0017336   .0012022     1.44   0.149     -.000623    .0040902
    country2 | -.6621749     .01399   -47.33   0.000    -.6895977   -.6347521
    country3 | -.5883123   .0147382   -39.92   0.000    -.6172017   -.5594229
    country4 | -.7129762   .0137524   -51.84   0.000    -.7399333    -.686019
    country5 | -.4155907    .016715   -24.86   0.000     -.448355   -.3828265
       _cons | -8.193457   2.246407    -3.65   0.000    -12.59681   -3.790101
-------------+----------------------------------------------------------------
     sigma_u |  .52455749
     sigma_e |  .36374004
         rho |  .6752947   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(350, 11119) =     22.69              Prob > F = 0.0000
```

The parameters that will influence the merger simulations are the price parameter $\alpha =$

-0.0468 and the nesting parameters $\sigma_1 = 0.905$ and $\sigma_2 = 0.568$ (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 results from 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 a fixed effects regression.

```
. mergersim market if year == 1998

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

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


Parameters

alpha = -0.047
sigma1 = 0.905
sigma2 = 0.568

Own- and Cross-Price Elasticities:  unweighted market averages

    variable |     mean      sd      min      max

       M_ejj |   -7.488    3.761  -30.454   -1.710
       M_ejk |    0.766    1.276    0.003   10.908
       M_ejl |    0.068    0.120    0.000    0.768
       M_ejm |    0.001    0.002    0.000    0.011

Observations: 449


Pre-merger Market Conditions
Unweighted averages by firm


      firm code  |          price   Marginal costs   Pre-merger Lerner

            BMW  |         20.194           17.499              0.146
           Fiat  |         15.277           10.553              0.372
           Ford  |         14.557           11.923              0.207
          Honda  |         20.094           17.941              0.128
        Hyundai  |         12.915           10.849              0.179
            Kia  |         10.814            8.772              0.207
          Mazda  |         14.651           12.557              0.156
        Mercedes |         25.598           21.569              0.162
      Mitsubishi |         15.955           13.825              0.145
          Nissan |         15.438           13.259              0.159
             GM  |         21.054           18.633              0.135
            PSA  |         16.243           13.533              0.194
         Renault |         15.518           12.837              0.203
          Suzuki |          9.289            7.226              0.234
          Toyota |         14.560           12.430              0.172
             VW  |         18.990           16.388              0.181
           Volvo |         23.167           20.912              0.099
          Daewoo |         13.871           11.789              0.170

Variables generated: M_costs M_delta
```

These results imply fairly high own-price elasticities for the products in 1998, on average -7.488. The cross price elasticities are higher for products within the same subgroup (0.766) than for products of a different subgroup (0.068) and especially for products of a different group (0.001). The Lerner index or percentage markup over marginal cost varies from 9.9% to 37.2%, with a tendency of higher percentage markups for firms with lower priced models (a feature of most unit demand logit 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) detail

Merger Simulation

                                         Simulation method: Newton
                      Buyer     Seller   Periods/markets: 1
Firm                  26        15       Number of iterations: 6
Marginal cost savings                    Max price change in last it: 4.5e-06


Prices
Unweighted averages by firm

        firm code  |    Pre-merger       Post-merger      Relative change
       ------------+--------------------------------------------------------
              BMW  |       17.946           18.002             0.003
             Fiat  |       15.338           15.341             0.000
             Ford  |       13.093           13.362             0.023
            Honda  |       15.778           15.780             0.000
          Hyundai  |       12.912           12.912             0.000
              Kia  |       11.276           11.276             0.000
            Mazda  |       14.229           14.231             0.000
          Mercedes |       20.114           20.155             0.003
        Mitsubishi |       15.832           15.834             0.000
           Nissan  |       15.101           15.103             0.000
               GM  |       19.921           21.054             0.076
              PSA  |       16.397           16.399             0.000
           Renault |       15.292           15.295             0.000
           Suzuki  |        9.225            9.225             0.000
           Toyota  |       13.019           13.020             0.000
               VW  |       17.182           17.739             0.036
            Volvo  |       22.149           22.154             0.000
           Daewoo  |       13.483           13.484             0.000
       ------------+--------------------------------------------------------
Variables generated: M_price2 M_quantity2 M_price_ch (Other M_ variables dropped)
```

The results show prices before and after the merger (in 1,000 Euro), and the percentage price change, averaged by firm. This information is provided standard, even without the option "detail" at the end. The merger simulations predict that General Motors will on average raise its prices by 7.6%, while VW will on average raise its prices by 3.6%. The

rivals respond with only very small price increases (with the exception of Ford).[4]

Since the new price vector is saved, one can make use of Stata's graphics to plot these results. Consider the following commands:

```
. gen perc_price_ch=M_price_ch*100
(11386 missing values generated)

. graph bar (mean) perc_price_ch if country==3&year==1998, ///
>        over(firm, sort(perc_price_ch) descending label(angle(vertical))) ///
>        ytitle(Percentage) title(Average percentage price increase per firm)
```

This produces the following plot:
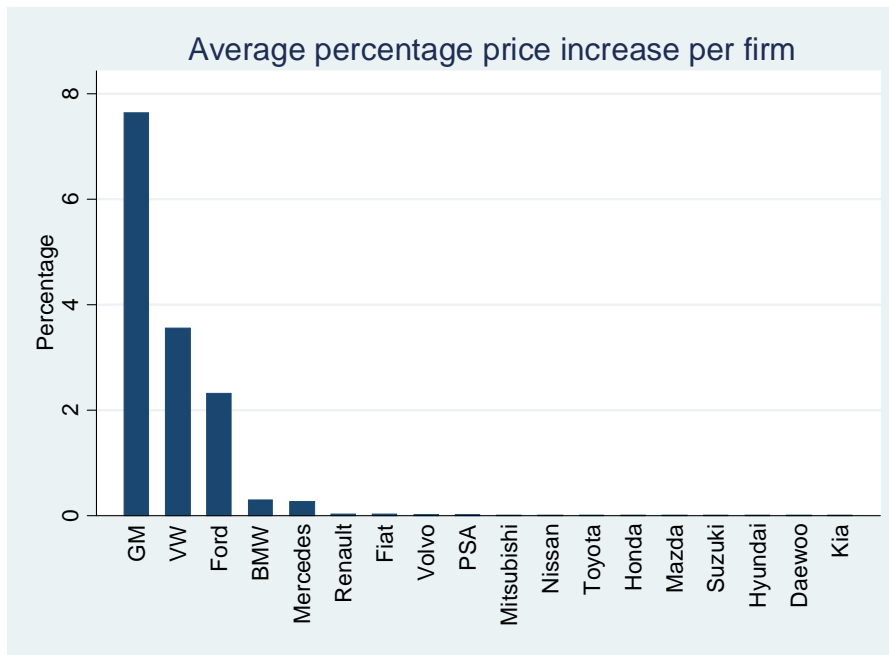
Without the option "detail" after the mergersim simulate command, the output only reports the price information. The option "detail" produces additional results on the following variables (before, after and/or changes): market shares by firm, Herfindahl index, C4 and C8 ratio (market share of 4 and 8 largest firms), consumer and producer surplus.[5]

---

[4]Note 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).

[5]In logit and nested logit models, consumer surplus (up to a constant) is given by the well-known log(sum) expression, divided by the marginal utility of income. Caution is warranted in the constant expenditure specification, since marginal utility is not constant. See Train (2009).

```
Market shares by quantity
Unweighted averages by firm
```

firm code	Pre-merger	Post-merger	Difference
BMW	0.074	0.079	0.005
Fiat	0.043	0.045	0.003
Ford	0.095	0.132	0.037
Honda	0.012	0.012	0.001
Hyundai	0.006	0.006	0.000
Kia	0.003	0.003	0.000
Mazda	0.025	0.027	0.002
Mercedes	0.100	0.116	0.017
Mitsubishi	0.015	0.017	0.001
Nissan	0.025	0.027	0.002
GM	0.166	0.108	-0.058
PSA	0.034	0.037	0.003
Renault	0.051	0.054	0.003
Suzuki	0.006	0.006	0.000
Toyota	0.027	0.029	0.002
VW	0.300	0.280	-0.020
Volvo	0.012	0.013	0.001
Daewoo	0.006	0.007	0.001

	Pre-merger	Post-merger
HHS:	1501	1972
C4:	66.07	71.50
C8:	86.21	88.01

	Change
Consumer surplus:	-1,839,750
Producer surplus:	1,303,353

For example, the Herfindahl index increases from 1501 to 1972. Consumer surplus (in Germany) drops by 1.8 billion Euro or 586 Euro per car (since 3.1 million cars were sold in Germany in 1998). This is partly compensated by an increase in producer surplus of 1.3 billion Euro.

4.3 Accounting for efficiencies, remedies 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, which 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.

```
. 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
			Periods/markets: 1
Firm	26	15	Number of iterations: 19
Marginal cost savings	.2	.2	Max price change in last it: .

Prices
Unweighted averages by firm

firm code	Pre-merger	Post-merger	Relative change
BMW	17.946	17.703	-0.011
Fiat	15.338	15.265	-0.004
Ford	13.093	13.125	0.003
Honda	15.778	15.737	-0.002
Hyundai	12.912	12.908	-0.000
Kia	11.276	11.274	-0.000
Mazda	14.229	14.212	-0.001
Mercedes	20.114	19.259	-0.031
Mitsubishi	15.832	15.810	-0.001
Nissan	15.101	14.981	-0.005
GM	19.921	18.980	-0.022
PSA	16.397	16.372	-0.002
Renault	15.292	15.261	-0.003
Suzuki	9.225	9.219	-0.001
Toyota	13.019	13.005	-0.001
VW	17.182	15.717	-0.075
Volvo	22.149	22.036	-0.005
Daewoo	13.483	13.477	-0.000

Variables generated: M_price2 M_quantity2 M_price_ch (Other M_ variables dropped)

There is now a predicted price decrease in Germany, by –2.2% for GM and –7.5% 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, since 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	15.247	9.504	6.233	43.649
M_costs2	13.769	9.938	5.439	43.620
M_mre	0.123	0.128	0.001	0.401

Weighted average MRE: 0.221   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 12.3% (unweighted) and 22.1% (weighted by sales).

Divestiture as a remedy   Second, one may take into account divestiture as a remedy to mitigate the price effects of a mergers. Under such a remedy, the competition authority accepts the merger, on the condition that the firms sell of some of their products or brands. To simulate the effects of a merger with divestiture, one can replace the options **buyer(#)** and **seller(#)** by the more general option **newfirm(varname)**, which specifies a variable for the new ownership structure after the merger. To illustrate, consider a merger between Renault (firm=18) and PSA (firm=16), where PSA sells the brands Peugeot and Citroën. This merger would substantially raise average prices in France, by 59.8% for the Renault products and 63.1% for the PSA products (ignoring entry and substitution to other countries). To mitigate the anticompetitive effects, the competition authority may request that PSA sells one of its brands, Citroën (brand=4), to Fiat (firm=4). The commands below show how to how to simulate the effects of such a merger with divestiture, after creating the appropriate variable "firm_rem" for the new ownership structure.[6]

---

[6]Note that this example starts with mergersim init and movest to mergersim simulate without performing a regression to obtain the price and nesting parameters. In this case, mergersim continues to make use of the most recent results.

```
. gen firm_rem=firm

. replace firm_rem=16 if firm==18          // original merger
(890 real changes made)

. replace firm_rem=4 if brand==4           // divestiture
(583 real changes made)

.
. quietly mergersim init, nests(segment domestic) unit price(price) quantity(qu) m
> arketsize(MSIZE) firm(firm)

. quietly mergersim simulate if year == 1998 & country == 2, seller(16) buyer(18)

. mergersim simulate if year == 1998 & country == 2, newfirm(firm_rem)
```

```
Merger Simulation

                                       Simulation method: Newton
                        Variable name  Periods/markets: 1
Ownership from:         firm_rem       Number of iterations: 7
Marginal cost savings                  Max price change in last it: 9.7e-08


Prices
Unweighted averages by firm
```

firm code	Pre-merger	Post-merger	Relative change
BMW	18.342	18.347	0.000
Fiat	12.688	12.749	0.006
Ford	11.995	12.001	0.001
Honda	15.742	15.744	0.000
Hyundai	9.862	9.863	0.000
Kia	7.040	7.040	0.000
Mazda	12.536	12.536	0.000
Mercedes	25.239	25.240	0.000
Mitsubishi	14.880	14.880	0.000
Nissan	12.371	12.372	0.000
GM	18.963	18.966	0.000
PSA	15.303	16.317	0.089
Renault	14.996	17.114	0.162
Suzuki	7.824	7.824	0.000
Toyota	12.638	12.638	0.000
VW	17.735	17.744	0.001
Volvo	22.641	22.642	0.000
Daewoo	13.939	13.940	0.000

```
Variables generated: M_price2 M_quantity2 M_price_ch (Other M_ variables dropped)
```

The results show that the merger with divestiture only raises the average price by 16.2% for Renault, and by 8.9% for the Peugeot brand, whereas the price of Fiat (now including the Citroën brand) increases by 0.6%. The option **newfirm(varname)** can also be used for other applications, for example to assess the impact of two consecutive mergers.

Conduct Third, 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. This is shown in the following example (which returns to the earlier merger between GM and VW

in Germany).

```
. mergersim market if year == 1998 & country == 3, conduct(0.5)
─────────────────────────────────────────────────────────────────────
Supply: Partial collusion, conduct = .5
Demand: Unit demand two-level nested logit
─────────────────────────────────────────────────────────────────────
Demand estimate
xtreg M_ls price M_lsjh M_lshg horsepower fuel width height domestic year country2-countr
> y5, fe
Dependent variable: M_ls
─────────────────────────────────────────────────────────────────────

Parameters

alpha = -0.047
sigma1 = 0.905
sigma2 = 0.568
─────────────────────────────────────────────────────────────────────
Own- and Cross-Price Elasticities:  unweighted market averages

      variable │    mean      sd      min      max
─────────────────────────────────────────────────
         M_ejj │  -6.907   2.876  -22.039   -3.339
         M_ejk │   0.781   1.141    0.007    4.920
         M_ejl │   0.060   0.123    0.001    0.637
         M_ejm │   0.001   0.002    0.000    0.011
─────────────────────────────────────────────────
Observations: 97
─────────────────────────────────────────────────

Pre-merger Market Conditions
Unweighted averages by firm

─────────────────────────────────────────────────────────────────────
    firm code │       price   Marginal costs   Pre-merger Lerner
─────────────────────────────────────────────────────────────────────
          BMW │      17.946           13.079               0.290
         Fiat │      15.338           10.845               0.334
         Ford │      13.093            8.114               0.419
        Honda │      15.778           11.433               0.286
      Hyundai │      12.912            8.818               0.349
          Kia │      11.276            7.196               0.391
        Mazda │      14.229           10.012               0.315
      Mercedes │     20.114           13.753               0.348
   Mitsubishi │      15.832           11.612               0.280
       Nissan │      15.101           10.651               0.316
           GM │      19.921           14.862               0.297
          PSA │      16.397           12.106               0.299
      Renault │      15.292           10.893               0.340
       Suzuki │       9.225            5.084               0.461
       Toyota │      13.019            8.794               0.379
           VW │      17.182           12.104               0.352
        Volvo │      22.149           17.596               0.208
       Daewoo │      13.483            9.339               0.346
─────────────────────────────────────────────────────────────────────
Variables generated: M_costs M_delta
─────────────────────────────────────────────────────────────────────
```

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

			Simulation method: Newton
	Buyer	Seller	Periods/markets: 1
Firm	26	15	Number of iterations: 6
Marginal cost savings			Max price change in last it: 2.1e-07

	Pre	Post	
Conduct:	.5	.5	

Prices
Unweighted averages by firm

firm code	Pre-merger	Post-merger	Relative change
BMW	17.946	18.125	0.011
Fiat	15.338	15.434	0.007
Ford	13.093	13.881	0.063
Honda	15.778	15.889	0.008
Hyundai	12.912	13.019	0.009
Kia	11.276	11.379	0.009
Mazda	14.229	14.334	0.008
Mercedes	20.114	20.427	0.025
Mitsubishi	15.832	15.956	0.008
Nissan	15.101	15.194	0.007
GM	19.921	21.171	0.084
PSA	16.397	16.503	0.007
Renault	15.292	15.395	0.008
Suzuki	9.225	9.314	0.010
Toyota	13.019	13.115	0.008
VW	17.182	17.947	0.049
Volvo	22.149	22.265	0.005
Daewoo	13.483	13.584	0.008

variables generated: M_price2 M_quantity2 M_price_ch (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

4.4.1 Calibration

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 $\alpha = -0.035$ (closer to 0 as compared with the econometric estimate of about $\alpha = -0.047$), and we keep σ_1 and σ_2 to the previous values. Hence, we calibrate α such that demand would be less elastic. The results from this calibration imply indeed lower price elasticities (on average -5.5):

```
. mergersim market if year == 1998 & country == 3
─────────────────────────────────────────────────────────
Supply: Bertrand competition
Demand: Unit demand two-level nested logit
─────────────────────────────────────────────────────────
Demand calibration

Parameters

alpha = -0.035
sigma1 = 0.910
sigma2 = 0.570
─────────────────────────────────────────────────────────
Own- and Cross-Price Elasticities:  unweighted market averages

      variable │    mean       sd      min      max

         M_ejj │  -5.457    2.273  -17.430   -2.640
         M_ejk │   0.624    0.911    0.006    3.946
         M_ejl │   0.045    0.093    0.000    0.480
         M_ejm │   0.001    0.001    0.000    0.008
─────────────────────────────────────────────────────────
Observations: 97
─────────────────────────────────────────────────────────


Pre-merger Market Conditions
Unweighted averages by firm

─────────────────────────────────────────────────────────────────────
        firm code │          price   Marginal costs   Pre-merger Lerner

              BMW │         17.946           14.738              0.193
             Fiat │         15.338           12.297              0.229
             Ford │         13.093            9.765              0.287
            Honda │         15.778           12.921              0.189
          Hyundai │         12.912           10.294              0.223
              Kia │         11.276            8.681              0.248
            Mazda │         14.229           11.455              0.206
         Mercedes │         20.114           15.030              0.255
       Mitsubishi │         15.832           13.019              0.186
           Nissan │         15.101           12.155              0.209
               GM │         19.921           16.573              0.199
              PSA │         16.397           13.576              0.197
          Renault │         15.292           12.302              0.236
           Suzuki │          9.225            6.586              0.294
           Toyota │         13.019           10.280              0.246
               VW │         17.182           13.540              0.254
            Volvo │         22.149           18.974              0.144
           Daewoo │         13.483           10.860              0.220
─────────────────────────────────────────────────────────────────────
Variables generated: M_costs M_delta
─────────────────────────────────────────────────────────────────────
```

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

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

```
Merger Simulation
                                          Simulation method: Newton
                          Buyer   Seller  Periods/markets: 1
Firm                      26      15      Number of iterations: 6
Marginal cost savings                     Max price change in last it: 5.9e-06
```

Prices
Unweighted averages by firm

firm code	Pre-merger	Post-merger	Relative change
BMW	17.946	18.018	0.004
Fiat	15.338	15.342	0.000
Ford	13.093	13.443	0.030
Honda	15.778	15.781	0.000
Hyundai	12.912	12.912	0.000
Kia	11.276	11.276	0.000
Mazda	14.229	14.231	0.000
Mercedes	20.114	20.167	0.003
Mitsubishi	15.832	15.835	0.000
Nissan	15.101	15.103	0.000
GM	19.921	21.372	0.098
PSA	16.397	16.399	0.000
Renault	15.292	15.296	0.000
Suzuki	9.225	9.226	0.000
Toyota	13.019	13.020	0.000
VW	17.182	17.892	0.045
Volvo	22.149	22.155	0.000
Daewoo	13.483	13.484	0.000

Variables generated: M_price2 M_quantity2 M_price_ch (Other M_ variables dropped)

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

4.4.2 Application: bootstrapping confidence intervals

One can also use the calibration options alpha() and sigmas() to implement a parametric bootstrap for constructing confidence intervals of the computed merger effects. The following lines perform three steps. First, we take 100 draws for α, σ_1 and σ_2 assuming the parameters are normally distributed. Second, we perform 100 merger simulations, for each draw. Third, we save the results for the average price increase of the buying firm and the selling firm, and we compute summary statistics.

```
. quietly mergersim init, nests(segment domestic) price(price) quantity(qu) marketsize(MS
> IZE) firm(firm)

. matrix b=e(b)

. matrix V=e(V)

. matrix bsub = ( b[1,1] , b[1,2] , b[1,3] )

. matrix Vsub = ( V[1,1], V[1,2], V[1,3] \ V[2,1] , V[2,2], V[2,3] \ V[3,1], V[3,2], V[3,
> 3] )

. local ndraws 100

. set seed 1

. preserve

. drawnorm alpha sigma1 sigma2, n(`ndraws') cov(Vsub) means(bsub) clear
(obs 100)

. mkmat alpha sigma1 sigma2, matrix(params)

. restore

. matrix pr_ch = J(`ndraws',2,0)

. forvalues i = 1 2 to `ndraws' {
  2. local alpha = params[`i',1]
  3. local sigma1 = params[`i',2]
  4. local sigma2 = params[`i',3]
  5. quietly mergersim init, nests(segment domestic) price(price) quantity(qu) ///
>       marketsize(MSIZE) firm(firm) alpha(`alpha') sigmas(`sigma1' `sigma2')
  6. quietly mergersim simulate if year == 1998 & country == 3, seller(15) buyer(26)
  7. sum M_price_ch if year == 1998 & country == 3&firm==15, meanonly
  8. matrix pr_ch[`i',1] = r(mean)
  9. sum M_price_ch if year == 1998 & country == 3&firm==26, meanonly
 10. matrix pr_ch[`i',2] = r(mean)
 11. }

. clear

. quietly svmat pr_ch , names(pr_ch)

. sum pr_ch1 pr_ch2

    Variable |        Obs        Mean    Std. Dev.        Min        Max
-------------+--------------------------------------------------------
     pr_ch1 |        100    .0768658    .0038062    .0673019    .0856966
     pr_ch2 |        100    .0358342    .0019004    .0310405    .0403905
```

We earlier obtained point estimates for the percentage price increase of 7.6% for GM and 3.6% for VW (for the base scenario). The 95% confidence intervals for these price increases are [6.7–8.6]% for GM and [3.1–4.0]% for VW.

4.5 Constant expenditures demand

We can finally illustrate how to do merger simulation based on a constant expenditures demand instead of a 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=((ngdpe)/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 $\sigma_2 = 0.6$.

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

We can verify what are the pre-merger elasticities and markups at these calibrated parameters:

```
. 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
Unweighted averages by firm

firm code	price	Marginal costs	Pre-merger Lerner
BMW	17.946	14.375	0.194
Fiat	15.338	12.451	0.189
Ford	13.093	10.502	0.202
Honda	15.778	12.938	0.180
Hyundai	12.912	10.732	0.169
Kia	11.276	9.384	0.168
Mazda	14.229	11.684	0.177
Mercedes	20.114	14.228	0.260
Mitsubishi	15.832	12.978	0.180
Nissan	15.101	12.281	0.183
GM	19.921	15.784	0.206
PSA	16.397	13.473	0.179
Renault	15.292	12.504	0.188
Suzuki	9.225	7.661	0.170
Toyota	13.019	10.739	0.175
VW	17.182	13.395	0.221
Volvo	22.149	17.606	0.201
Daewoo	13.483	11.201	0.169

Variables generated: M_costs M_delta

The pre-merger elasticities and markups are roughly comparable to the ones of the estimated unit demand model (with less variation between firms). However, as shown below, the merger simulation 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) detail

─────────────────────────────────────────────────────────────────────────────
Merger Simulation

                                        Simulation method: Newton
                        Buyer    Seller  Periods/markets: 1
Firm                    26       15      Number of iterations: 7
Marginal cost savings   ───────────────  Max price change in last it: 4.7e-09


Prices
Unweighted averages by firm

─────────────────────────────────────────────────────────────────────────────
        firm code  │   Pre-merger      Post-merger    Relative change
─────────────────────────────────────────────────────────────────────────────
              BMW  │       17.946          18.021              0.004
             Fiat  │       15.338          15.342              0.000
             Ford  │       13.093          13.302              0.017
            Honda  │       15.778          15.781              0.000
          Hyundai  │       12.912          12.912              0.000
              Kia  │       11.276          11.276              0.000
            Mazda  │       14.229          14.231              0.000
         Mercedes  │       20.114          20.155              0.003
       Mitsubishi  │       15.832          15.835              0.000
           Nissan  │       15.101          15.103              0.000
               GM  │       19.921          21.581              0.101
              PSA  │       16.397          16.399              0.000
          Renault  │       15.292          15.295              0.000
           Suzuki  │        9.225           9.225              0.000
           Toyota  │       13.019          13.020              0.000
               VW  │       17.182          17.933              0.044
            Volvo  │       22.149          22.159              0.000
           Daewoo  │       13.483          13.484              0.000
─────────────────────────────────────────────────────────────────────────────
Variables generated: M_price2 M_quantity2 M_price_ch (Other M_ variables dropped)
```

Because the option "detail" was added, the mergersim simulate command reports additional results. Consumer surplus now drops by -2.2 billion Euro (versus -1.8 billion Euro in the unit demand specification), and producer surplus increases by 1.1 billion Euro (versus 1.3 billion Euro before).

```
─────────────────────────────────────────────────
                     Pre-merger      Post-merger
─────────────────────────────────────────────────
HHS:                       1501             1906
C4:                       66.07            70.52
C8:                       86.21            87.61
─────────────────────────────────────────────────

─────────────────────────────────────────
                              Change
─────────────────────────────────────────
Consumer surplus:         -2,190,399
Producer surplus:          1,140,647
─────────────────────────────────────────
```

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.[7] The set of merger simulation

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[7]We stress however that the estimated parameters were based on an inconsistent fixed effects estimator. In practice, one should use instrumental variables to estimate the parameters consistently.

commands can be used to simulate the effects of horizontal mergers in a standard setting (differentiated products, multi-product Bertrand price-setting). But one can also incorporate various extensions, including efficiencies in the form of cost savings, remedies through partial divestiture, and alternative behavioral assumptions (partial collusive behavior).

Various other applications and extensions could be considered. For example, in the case of the car market it could be interesting to generalize the demand model to allow consumers to substitute between countries by introducing an upper nest for the choice of country (instead of assuming such substitution is not possible. These additional substitution possibilities would limit the market power effects of mergers. Other demand models may also be considered such as a random coefficients logit model, or the almost ideal demand system.

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