WELCOM

User manual[1]

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Abstract

This user manual presents the **WELCOM** Stata tool, a novel microsimulation tool that estimates the welfare effects of changes in the market structure (e.g. monopoly to oligopoly) of one or more products of interest. Such changes are often driven by market regulatory reforms, like the lifting of trade barriers or elimination to legal barriers for the entry of new firms. The **WELCOM** tool works with minimum data requirements, such as household consumption expenditure, market parameters, and a poverty line. The tool first estimates the price change driven by the change in the competitive structure of the market. Then, it estimates the effect on welfare caused by such a price drop. The tool relies on a poverty line and a relevant welfare aggregate to assess first-order effects on poverty and inequality measure such as the poverty headcount rate and the Gini Index. The **WELCOM** tool was developed by the Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity at the Poverty and Equity Global Practice .

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List of Acronyms and Abbreviations

CEA—Counsel of Economic Advisers

CD—Cobb-Douglass function

CES—Constant elasticity of substitution utility function

CMA—Competition and Markets Authority

FGT—Foster-Greer-Thorbecke class of poverty measures

GP—Global Practice

GSG—Global Solutions Group

PCO—Partial Collusive Oligopoly

PERC—Perfect Competition

WB—The World Bank

Contents

1. Introduction

This user manual discusses the theoretical background and provides a guideline to use the WELCOM Stata tool. This tool aims to help at analyzing the welfare effects of policy reforms aimed at correcting market imperfections. Market imperfections reduce social welfare and have bigger negative impacts on households at the bottom of the income distribution (Urzua, 2013; Busso and Galiani, 2015; and Atkin et al., 2016).[6]

Interventions to correct market imperfections and foster competition can have mixed effects on welfare, given the overlapping roles that households play in the economy as consumers, employees, and assets' holders. First, competition policy reforms can affect consumer's wellbeing through their impacts on market prices, quality, and supply (Atkin et al., 2016; Begazo and Nyman, 2016). Second, competition reforms can affect household through their effects on labor market conditions and outcomes such as wages, labor demand (due a potential entry/exit of firms), and bargaining power (CEAb, 2016). Moreover, competition policy reforms also affect household welfare through their effects on capital. Such reforms can affect firms' profits which, ultimately, affects investors (Outreville, 2015).[7]

The impacts of competition reforms often depend on the initial characteristics of the market under analysis, as well as on the regulatory framework. Therefore, to design accurate policy interventions, it is necessary to first have a good understanding of the market of interest. For instance, an increase in revenue does not necessarily indicates a higher market power; similar price movements among producers can be evidence of either efficiency or of a cartel; higher prices can either be a signal of quality or of a lack of competition; and neither concentration nor large market share equal market (Gonzalez, et al. 2015; Furman, 2016).

Three common examples about how the behavior of private firms affect the competition level in a market are: (i) through the individual creation and exploitation of the market power, (ii) through the joint exploitation of market power by a group of firms, and (iii) with the partial or total exclusion of competitors from markets (Buccirossi, 2008). Since competition policy reforms can

[6] In spite that we use the term "income distribution," we could also organize and rank households based on their level of consumption or wealth, producing analysis based on consumption distribution or wealth distributions, respectively.

[7] The body of early literature in industrial organization known as the Structure-Conduct-Performance (SCP) hypothesis argues that there is a relationship between market concentration and firm profitability (Bain, 1951). For instance, according to the SCP theory dominant firms in concentrated markets are more capable of setting prices through collusion and, therefore, earn extraordinary profits. Later approaches such as the Relative-Market-Power (RMP) and the Efficient Structure (ES) also argued that market structure affects the market competition among firms (Outreville, 2015).

have mixed impacts on households, given the institutional characteristics of the markets, the identification of the overall effects of these policies must hinge on the individual analysis of each reform.

The user manual of the WELCOM[8] package is part of a larger effort by the World Bank to generate knowledge to improve the understanding of the links among competition, growth, and shared prosperity, as well as to promote policies that foster competition, especially in developing countries. This version of the tool focuses on the study of the potential distributional impacts of market concentration in consumer welfare through the prices channel. This manual is divided into five main sections. The first one provides a general introduction that helps to motivate the importance of the WELCOM tool. The second section discusses the importance of competition policy reforms and presents relevant empirical studies on the relationship between competition and welfare. Section three shows the theoretical framework underlying the methods of analysis available in the tool. The fourth section presents the WELCOM Stata package. It shows examples on how to use the tool and how to interpret the outputs. The last section discusses an extension of the WELCOM tool that allows for the estimation of elasticities relying on systems of demand.

Additional modules to analyze the impact on welfare of trade liberation and entry of foreign distribution chains are expected.

[8] Welfare and Competition (WELCOM).

2. WELCOM Models

This section discusses the theoretical framework, assumptions, and data requirements of the WELCOM tool. First, subsection 2.1 presents the theoretical framework underlying the WELCOM tool. The following subsections show the three alternative market structures available in the tool: (i) monopolistic structure, (ii) oligopolistic market with firms involved in Cournot competition,[9] and (iii) oligopolistic market with collusion among the dominant firms. In addition, each subsection discusses key assumptions made. Finally, the last subsection discusses three alternative monetary measures of welfare that can be estimated using the tool.

2.1 The theoretical framework of WELCOM

In competitive markets firms are price takers unable to affect equilibrium prices through their individual actions.[10] However, the price-taking assumption does not adequately describe firm's behavior when there are few firms in the market whose actions affect market prices or when only few firms with large market shares collude.[11]

There are several negative effects associated with the excessive concentration of markets and with the unregulated exercise of market power. Microeconomic theory suggests that monopolistic profits are lower than the loss on consumer surplus from higher prices, leading to a deadweight loss. In the WELCOM tool, the transmission mechanisms between market concentration and household welfare is the price channel. More precisely, the tool measures the estimated price variation due to a change in the competitive structure of the market. Then, the tool uses such price change to estimate the effect on households' welfare.

[9] For details on the model of oligopoly competing via quantities see Mas-Colell et al. (1995) and Varian (2006).

[10] More precisely, in competitive markets "*all consumers and producers are assumed to act as price takers, in effect behaving as if the demand or supply functions that they face are infinitely elastic at going market prices.*" (Mas Colell et al. 1995:383).

[11] The term "market-power-rents" refers to profits that a firm earns in virtue of its market power and that would not be possible in the absence of it (Khan and Vaheesan, 2017). These rents extracted by firms exploiting their market power are also called "extranormal rents" (Rodriguez-Castelan, 2015).

2.2 Market concentration structure and prices

This subsection describes the three market structures available in WELCOM to simulate the effects of competition policy reforms on welfare: monopoly, oligopoly, and partial collusive oligopoly. Each model relies on a different set of assumptions about the underlying structure of the relevant market and the behaviors of the firms interacting in it.

a. Monopolistic structure

The extreme case of market concentration involves a single producer (indexed with $MONO$). Generally, a monopolist is able to increase profits by setting the price above the competitive level (Mas-Colell et al. 1995).

The monopolistic problem consists on choosing the level of output, $q_{MONO} \geq 0$, that maximizes profits, given a demand function, $p(q)$ and a cost function, $c(q)$:

$$\operatorname*{Max}_{q \geq 0} p(q) \cdot q - c(q). \tag{2.1}$$

Assuming that the demand and cost functions are continuous and twice differentiable for any non-negative level of output, the monopolistic optimal output, q_{MONO}, satisfies

$$p'(q_{MONO}) \cdot q_{MONO} + p(q_{MONO}) = c'(q_{MONO}). \tag{2.2}$$

The left-hand side of Equation 2.2 is equivalent to the marginal and the right-hand side corresponds is the marginal cost . The previous results can be reorganized as

$$p'(q_{MONO}) \cdot q_{MONO} + p(q_{MONO}) = c'(q)$$

$$p(q_{MONO}) = \frac{\eta}{1+\eta} \cdot c'(q) \tag{2.3}$$

where η denotes the own-price elasticity of demand faced by the monopolist. Note that in a competitive market, the absolute value of the price elasticity of demand is above unity and tends to infinity in the limit. This implies that, in a competitive market, the price tends to be equal to the marginal cost.[12]

Now, assume a simple model of constant returns to scale such that the marginal cost is a constant term (MC). Then, under a monopolistic structure, the equilibrium price is

$$p_{MONO} = \frac{\eta}{1+\eta} \cdot MC \tag{2.5}$$

Therefore, it follows that the price change of moving from a competitive equilibrium to a monopolistic structure is

$$\begin{aligned} dp_{MONO} &= \frac{p_{MONO} - p_{COMP}}{p_{COMP}} \\ &= -\frac{1}{1+\eta}. \end{aligned}$$

Where η denotes the own-price elasticity of demand at the monopoly equilibrium. A key assumption is that the demand function is linear. Notice that the price change (in percentage) of moving from a monopolistic structure to a competitive equilibrium will also be a function just of the elasticity of demand:

$$dp_{MONO} = \frac{\eta}{1+\eta} - 1 = -\frac{1}{1+\eta}. \tag{2.8}$$

If we assume that a market goes from a competitive market structure to a monopoly, it is useful to express the final price of the monopoly market as a function of the initial elasticity (i.e. with competitive outcomes). Denote the price elasticity of demand under the competitive structure as η^*. Then,

$$\eta = \frac{\partial Q}{\partial p} \frac{p_{MONO}}{Q_{MONO}} = \frac{\partial Q}{\partial p} \cdot \frac{p_{COMP} \cdot (1 + dp)}{Q_{COMP} \cdot (1 + \eta^* \cdot dp)}.$$

Note that the previous expression suggests that the price elasticity of demand evaluated at the monopoly equilibrium is equivalent to the response of the demand function to changes in prices

[12] In addition, note that equation (2.3) could be used to show that the **monopoly mark-up** (how much can a monopolist charge above the marginal cost) is given by the following relationship, also known as the *inverse elasticity pricing rule*: $\frac{p(q_{MONO}) - c'(q)}{p(q_{MONO})} = -\frac{1}{\eta}$.

multiplied by the ratio of the competitive price and output, adjusted by factors corresponding to the effects of moving from perfect competition to a monopoly structure. Then, setting $MC = 1$

$$\eta = \frac{\partial Q}{\partial p} \cdot \frac{p_{COMP}}{Q_{COMP}} \cdot \frac{(1 + dp)}{(1 + \eta^* dp)}$$

$$\eta = \eta^* \cdot \frac{(1 + dp)}{(1 + \eta^* dp)} = \eta^* \cdot \frac{(p_{MONO} - 1)}{1 + \eta^* \cdot (p_{MONO} - 1)}$$

$$\mathrm{p_{MONO}} = \frac{(1 + \mathrm{MC}) \cdot \eta^* - 1}{2 \cdot \eta^*}$$

Therefore, **under the assumption that $MC = 1$**,

$$\mathrm{p_{MONO}} = \frac{2 \cdot \eta^* - 1}{2 \cdot \eta^*}$$

and

$$dp_{MONO} = -\frac{1}{2\eta^*}.$$

Note that, by assuming a linear demand function, we have that

$$\eta = \frac{\partial Q}{\partial P} \frac{p_1}{Q_1} = \frac{\partial Q}{\partial P} \frac{p_0(1 + dp)}{Q_0(1 + \eta^* dp)} = \eta^* \frac{(1 + dp)}{(1 + \eta^* dp)}.$$

and

$$\eta^* = \frac{\eta}{1 + dp(1 - \eta)}.$$

To maximize the profit of the monopolist, the observed elasticity must be higher than one in absolute value (the empirical estimated elasticity is larger than -1).

b. Oligopolistic Cournot-Nash equilibrium structure

In an oligopolistic market with Cournot competition each firm chooses simultaneously the level of quantity to produce taking as given the opponents' decisions (Fudenberg and Tirole, 1991) and the demand function. This section focuses on the equilibrium produced in an oligopoly when the firms face a Cournot competition. This model implies a one-stage game in which firms choose quantities or capacities simultaneously.[13] Given the chosen quantities, the price adjusts to the level that clears the market. Each firm maximizes profit given the quantity supplied by all the other firms in the market,

$$\max_{q_i \geq 0} \Pi^i(q_1, \dots, q_i, \dots, q_n) = q_i \cdot p(q_1, \dots, q_i, \dots, q_n) - C_i(q_i) \tag{2.10}$$

It follows that

$$\frac{\partial \Pi^i(Q)}{\partial q_i} = p(q_1, \dots, q_i, \dots, q_n) + q_i \cdot p'(q_1, \dots, q_i, \dots, q_n) - C_i'(q_i) = 0 \tag{2.11}$$

We can also reorganize the results in equation (2.11) to facilitate their interpretation. In equation (2.12), the first two terms refer to the additional profit associated with an extra unit of output. The third term represents the effect on profits of producing an extra unit of output and taking into account the effect of increasing production in the market price,

$$p(q_1, \dots, q_i, \dots, q_n) - C_i'(q_i) + q_i \cdot p'(q_1, \dots, q_i, \dots, q_n) = 0. \tag{2.12}$$

Following Rodriguez-Castelan (2015), assume that there are $N \geq 2$ firms in the market, the firm's cost function is a constant c, and the inverse demand function is given by

$$p(Q) = \frac{\beta\omega}{Q}.$$

Therefore,

$$\max_{q_i \geq 0} \Pi^i(Q) = q_i \frac{\beta\omega}{Q} - cq_i = q_i \cdot \frac{\beta\omega}{\sum_{i=1}^{N} q_i} - c\, q_i \tag{2.13}$$

and the first order condition is

$$\partial \Pi^i(Q) \Big/ \partial q_i = \frac{\beta\omega}{\sum_{i=1}^{N} q_i} - q_i \frac{\beta\omega}{\left(\sum_{i=1}^{N} q_i\right)^2} - c = 0 \tag{2.13}$$

[13] An example of competition following a Cournot model are the "farmers *deciding how much of a perishable crop to pick each morning and send to a market. Once they have done so, the price at the market ends up being the level at which the crops that have been send are sold.*" (Mas-Colell et al. 1995:389).

With identical firm, $q_i = \bar{q}\ \forall i$ and $Q = N\bar{q}$, where N denotes the number of firms in the market. Then

$$\frac{\beta\omega}{N\bar{q}} - \bar{q}\frac{\beta\omega}{(N\bar{q})^2} - c = 0$$

$$\bar{q} = \frac{\beta\omega}{c}\left(\frac{N-1}{N^2}\right) \tag{2.14}$$

This level of individual firm production implies

$$Q = \frac{\beta\omega}{c}\cdot\left(\frac{N-1}{N}\right). \tag{2.15}$$

The equilibrium price is

$$p_{OLI-NASH} = \frac{N}{N-1}\cdot MC. \tag{2.16}$$

It follows that the change in price resulting from the oligopolistic structure, assuming a competition price equal to the marginal cost, is

$$dp = \frac{p_{OLI-NASH} - p_{COMP}}{p_{COMP}}$$

$$dp_{OLI-NASH} = \frac{1}{N-1}. \tag{2.17}$$

However, in practice we may not have the full information on the demand and the inverse demand function. Assume that we just have the price elasticity of demand, $\eta = \frac{\partial q/\partial p}{q/p}$. Given the quantity of the rest of firms, producer i maximizes

$$\pi_i = p(Q)\cdot q_i - Cq_i \tag{2.18}$$

given the other firm's choices.

The first order condition is

$$\begin{aligned}\frac{\partial \pi_n}{\partial q_n} &= \frac{\partial p(Q)}{\partial q_n} \cdot q_n + p - c = 0 \\ &= \frac{q_n}{Q} \cdot \frac{p}{\eta} + p - c = 0.\end{aligned} \tag{2.19}$$

Under the assumption that all firms are identical,

$$-\frac{q_n}{Q} \cdot \frac{p}{\eta} = p - c \tag{2.20}$$

Using equation (2.20) ,

$$p_{OLI-NASH} = \frac{\eta N}{1 + \eta N} \cdot MC \tag{2.21}$$

Relying in (2.21) and if in competitive markets prices are equal to the marginal cost (which we suppose is constant) is possible to find that:

$$\begin{aligned} dp &= \frac{p_{OLI-NASH} - p_{COMP}}{p_{COMP}} \\ dp_{OLI-NASH} &= -\frac{1}{1 + \eta \cdot N} \end{aligned} \tag{2.22}$$

c. Partial collusive oligopolistic structure

A common structure of concentrated markets, that this user manual refers to as Partial Collusive Oligopoly Structure (PCO), involves few firms with a significant share of the market and multiple smaller firms with no market power and small market share. The PCO model proposed assumes that

- **Assumption 1:** A small number of large firms have a significant share of the market. The rest of the market is supplied by many smaller firms that lack market power.
- **Assumption 2:** In the shorter or medium term the small firms cannot easily update their produced/supplied quantities. Their quantities are assumed to be fix or highly rigid for the adjustments. There are a lot of reasons that can explain this rigidity:
  - The limited supply of some specific production inputs: specialized labor, specific intermediate inputs, etc.
  - A prohibitive cost of entry for new firms.
  - The supplied quantity by the small firms is constant.

- **Assumption 3:** Firms with market power (the oligopoly part of the market) coordinate to maximize their profits. Their predefined market share—if they act as in a competitive market—is (ϕ_O). An additional assumption is that firms know the market reaction or price elasticity of demand (η).
- **Assumption 4:** The group composed by the smaller firms with no market power behave as followers. Firms in this group benefit from the increase in price implied by the reduction in the supplied quantity of the oligopoly group.

To find the equilibrium in this market, assume that the cartel (the oligopoly group) will act as a leader, and decides to reduce its supplied quantity share by $d\phi_O$. As indicated, the cartel cannot influence the quantity produced by the small firms (Q_S) that behave as price takers when $p \geq MC$. Assume we know the price elasticity of demand, η, the question is now what is the level of $d\phi_O$ that maximizes the profit of the oligopolistic group. For simplicity, suppose that the marginal cost is constant and equal to the price of the full competitive market. The profit of the oligopoly group is

$$\pi_O = p(Q_O + Q_S) \cdot Q_O - cQ_O \tag{2.24}$$

Under the previous conditions, and assuming that π_O is a concave and twice differentiable continuous function, the first order condition are given by:

$$\frac{\partial \pi_O}{\partial Q_O} = \frac{\partial P}{\partial Q} \cdot \frac{\partial Q}{\partial Q_O} \cdot Q_O + p - MC = 0 \tag{2.25}$$

$$\frac{1}{\eta} \cdot \phi_O + 1 = \frac{MC}{p}$$

$$p_{PCO} = \left(\frac{1}{1 + {}^{\phi_O}/_{\eta}} \right) \cdot MC \tag{2.26}$$

This formula reproduces some familiar results. For instance, it follows from formula (2.26) that if $\phi_O \to 0$, then $p = MC$, the classical result in competitive markets. Also, this formula could be used to infer some information on the proportion of increase in the price implied by the market concentration.

Going from the competitive market outcome, $(p_{CM} = MC)$, to the partial collusive oligopoly, $\left(p_{PCO} = \frac{MC}{1-\phi_O\eta}\right)$, implies a proportional price increase of

$$dp = \frac{p_{PCO} - p_{CM}}{p_{CM}}$$

$$dp = \frac{p_{PCO} - p_{CM}}{p_{CM}} = -\frac{\phi_O/\eta}{1 + \phi_O/\eta} = -\frac{\phi_O}{\eta + \phi_O} \qquad (2.28)$$

Empirically, it is assumed that the observed market share of the oligopoly group with PCO (ϕ_o^{PCO}) is lower than in the competitive market (ϕ_o^{COMP}). Precisely, the observed market share was

$$\phi_o^{PCO} = \frac{\phi_o^{COMP} + \eta^* \cdot dp}{1 + \eta^* \cdot dp}$$

Thus, we have

$$\phi_o^{COMP} = \phi_o^{PCO} \cdot (1 + \eta^* \cdot dp) - \eta^* \cdot dp$$

In general, while in the monopoly case a positive change in price implies that: $\eta < -1$, in the PCO model the constraint becomes $\eta < -\phi_O$. The PCO model can justify existence of the market power even if the elasticity is lower than one, and this what makes such a model attractive.

Based on 2.5 and 2.28, we find the following result:

$$\eta = \frac{\partial Q}{\partial P}\frac{p_1}{Q_1} = \frac{\partial Q}{\partial p} \cdot \frac{p_{COMP}}{Q_{COMP}} \cdot \frac{(1 + dp)}{(1 + \eta^* dp)}$$

$$\eta = \eta^* \cdot \frac{\frac{\eta + \phi_O - \phi_O}{\eta + \phi_O}}{\frac{\eta + \phi_O - \eta^* \cdot \phi_O}{\eta + \phi_O}} = \frac{\eta^* \cdot \eta}{\eta + \phi_O - \eta^* \cdot \phi_O} \qquad (2.29)$$

$$\eta^* = \frac{\eta + \phi_O}{1 + \phi_O} \qquad (2.30)$$

We now present two illustrative examples for the two suggested methods of the PCO model. Let $\eta = -0.8$, the share of the firms with market power ($\widetilde{\phi}_O$) be 0.20, and the observed exchanged total quantity is 1000. For the monopoly example, we assume that the elasticity is -1.2. The following table gives the results of the two examples.

Table 1. Examples of WELCOM tool

Competitive market	**PCO market**
$\eta^* = -1.5/(1+0.25*2.5)$ =-0.9231 $\eta^* = \eta/(1+dp(1-\eta))$	$\eta = -1.5$
$p_{comp} = 1.00$	$p_{OLI} = \left(\frac{1}{1+(\phi_O/\eta)}\right) = 1.25$
$MC = 1.00$	$MC = 1.00$
ϕ_R =0.7 $Q_R \quad = \ 700$ Q_{o_OLI}= $(1-0.9231*0.25)*Q_{o\_COMP}$ Q_{o_COMP} =390	$\tilde{\phi}_0 \quad = \ 0.3$ Q_{o_OLI} =300
Profit = (1-1)*390=0	Profit = (1.25-1)* 300≈75

Competitive market	**MONOPOLY market**
$\eta^* = -1.2/(1+5*2.2)$ =-.1 $\eta^* = \eta/(1+dp(1-\eta))$	$\eta = -1.2$
$p_{comp} = 1.00$	$p_{MONO} = \left(\frac{1}{1+1/\eta)}\right) = 6$
$MC = 1.00$	$MC = 1.00$
$Q_{o\_MONO} = 1000$ Q_{o_MON}= $(1-.1*5)*Q_{o\_COMP}$ Q_{o_COMP} =2000	
Profit = (1-1)*2000=0	Profit = (6-1)* 1000≈5000

d. Partial market adjustment

Suppose a situation when starting from a given number of firms, the user is interested in assessing the impact of a discrete increase in the number of firms . Starting from the equation (2.30), is possible to show that:

$$\eta^m = \eta^* \cdot (\phi_o^m + 1) - \phi_o^m.$$

Then,

$$dp_{PCO}^{m} = \frac{-\phi_o^m}{\eta^m + \phi_o^m}$$

Finally, for the case of oligopoly

$$\eta^m = \frac{1 + \eta^*(1 + N^m)}{N^m}$$

such that,

$$dp_{NASH}^{m} = \frac{1}{1 - \eta^m . N^m}.$$

2.3 Price changes and the household welfare

This section discusses how to measure welfare changes when the price of at least one of the goods considered changes and if utility, demand or both are unknown (Abdelkrim and Verme, 2016). There are three alternative money-metric welfare measurements in the **mcwel** Stata module:[14] the Laspeyres measure, the equivalent variation measurement and the compensated variation measurement. This section briefly discusses the characteristics of each of the measurements.

According to King (1983), the *equivalent income* is a level of income for which one can keep the level of utility unchanged after the change in prices. Formally, if the indirect-utility function is denoted by *V*, we can write:

$V(\mathbf{p}^{r}; m_e^t) \equiv V(\mathbf{p}^{t}; \mathrm{m}^0)$

where $\mathbf{p}^{\mathbf{r}}$ and $\mathbf{p}^{\mathbf{t}}$ denote the vectors of prices in r and t periods respectively and m_e^t denotes the equivalent income

$$m_e^t = f(\mathbf{p}^{r};\ \mathbf{p}^{t};\ \mathrm{m}^0)$$

The reference period can be the initial ($r = 0$) or the final ($r = 1$). The equivalent variation is equal to

$$EV = f(\mathbf{p}^{0};\ \mathbf{p}^{1};\ \mathrm{m}^0) - f(\mathbf{p}^{0};\ \mathbf{p}^{0};\ \mathrm{m}^0),$$

and the compensated variation

[14] Hicks (1942) discusses five common measures of welfare changes: (i) Consumer's surplus variation, (ii) compensating variation, (iii) equivalent variation, (iv) Laspeyres variation, and (v) Paasche variation. For a recent discussion of alternative welfare measures see Abdelkrim and Verme (2016).

$$CV = f(\mathbf{p^1};\ \mathbf{p^1};\ \mathrm{m}^0) - f(\mathbf{p^1};\ \mathbf{p^0};\ \mathrm{m}^0).$$

a. *The Laspeyres measurement*

The Laspeyres measurement of the change in welfare resulting from the change in prices is the change in the total expenditures when initial quantities are maintained. This measurement is equal to the first order Taylor approximation of the price impact on welfare (see Abdelkrim and Verme (2016) for more details). Formally, if we denote the expenditures of the household (h) on the product of interest (k) by $e_{h,k}$, we have that

$$dw_h^{Laspeyers} = -e_{h,k} \cdot dp_k \tag{2.32}$$

b. *The equivalent variation measurement*[15]

In addition to the Laspeyres approach to measure changes in welfare (which does not require any assumption on the functional form of the consumer's preferences), the user can select among two alternative consumer preferences functional forms. The first is the Cobb-Douglas function (CD). The second is the *constant elasticity of substitution* (CES) preferences. Let $\alpha_{k,h}$ denote the expenditure share of household h on the product of interest k. Using the King (1983) approach, and assuming initial prices are normalized to one in the initial period, the change in welfare of household h, measured by the equivalent variation, is equal to

$$dw_h^{EV:CD} = w_h \cdot \left[\frac{1}{(1+dp_k)^{\alpha_{k,h}}} - 1\right] \tag{2.33}$$

$$dw_h^{EV:CES} = w_h \cdot \left(\frac{\pi_{0,h}}{\pi_{1,h}} - 1\right) \tag{2.34}$$

where $\pi_{0,h} = \left(\alpha_{k,h}{}^{\sigma} + (1-\alpha_{k,h})^{\sigma}\right)^{\frac{1}{1-\sigma}}$ and $\pi_{1,h} = \left(\alpha_{k,h}{}^{\sigma}\,(1+dp_k)^{1-\sigma} + (1-\alpha_{k,h})^{\sigma}\right)^{\frac{1}{1-\sigma}}$.

c. *The compensated variation measurement*

The change in welfare of household h, measured by the compensated variation, is equal to:

$$dw_h^{CV:CD} = w_h \cdot (1 - (1+dp_k)^{\alpha_{k,h}}) \tag{2.35}$$

$$dw_h^{CV:CES} = w_h \cdot \left(1 - \frac{\pi_{1,h}}{\pi_{0,h}}\right) \tag{2.36}$$

[15] http://www2.econ.iastate.edu/classes/econ501/Hallam/documents/FunctionalForms.pdf
See http://www2.econ.iastate.edu/faculty/hallam/

3. The WELCOM Stata Package

This section discusses the installation, preparation of data, and alternative methods of analysis available in the **WELCOM** tool to estimate the impacts of competition policy reforms in welfare.

3.1 Installation

Commands 01 show the Stata commands needed for installing WELCOM.

Commands 01

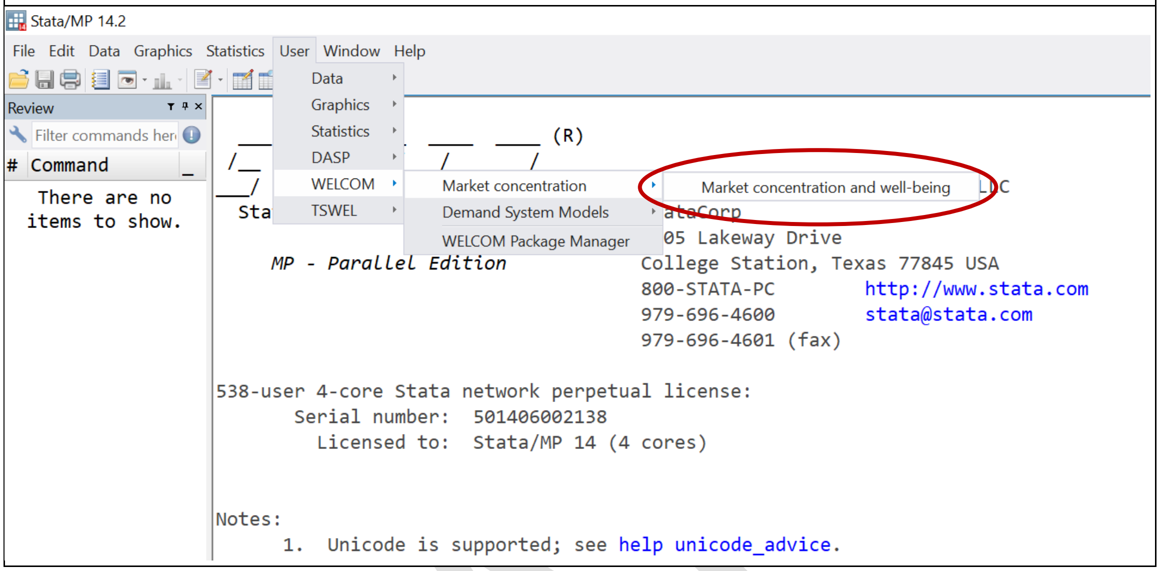
```
set more off
net from http://dasp.ecn.ulaval.ca/welcom/Installer
net install welcom_p1, force
net install welcom_p2, force
cap addITMenu profile.do _welcom_menu
```

Note: The Stata command lines in the chart **Commands 01** tries to add the file profile.do automatically or add the command **_welcom_menu** in this profile file, if the latter already exists. However, if the previous commands do not function, the user needs to manually copy and paste the profile.do file in the following locations (based on the operating system of the computer):

a. *Windows OS system:* copy the file in **c:/ado/personal/**
b. *Macintosh system:* copy the file in one of the Stata system directories. To find these directories, type the command **sysdir**.

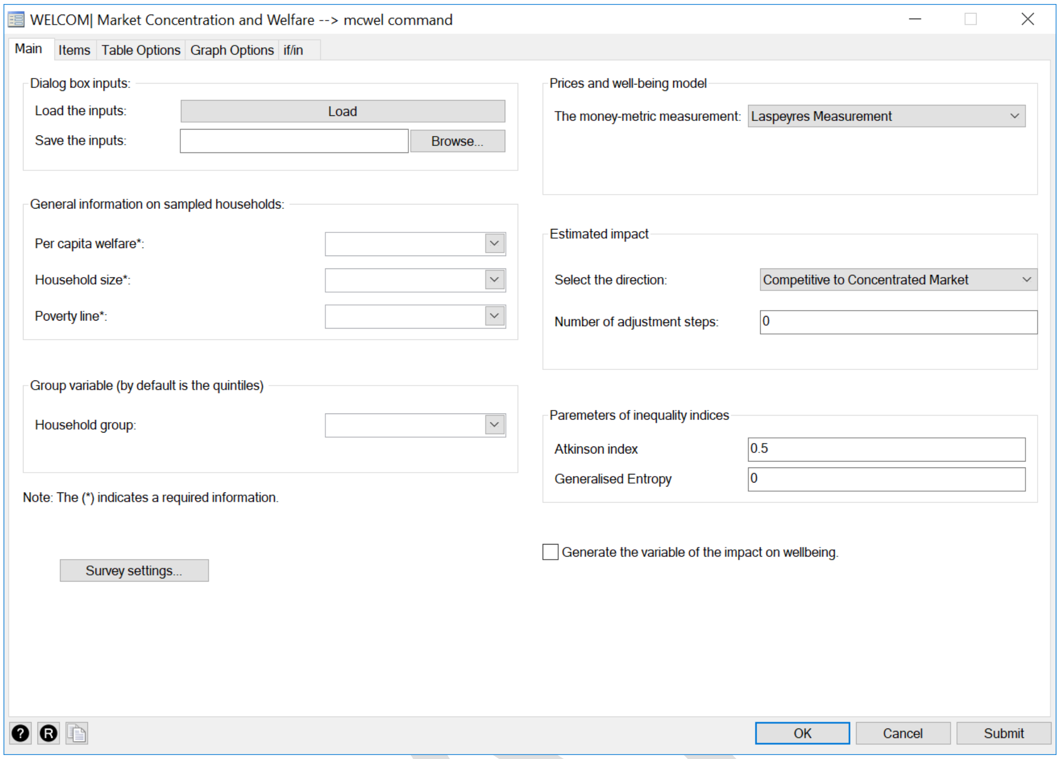
After executing these steps, the user should close all Stata sessions and restart the program. After opening a new window, the user can go to the menu bar in Stata, click on the user option, choose the WELCOM package, select the Market concentration option and launch the **WELCOM** tool by clicking on Market concentration and welfare:

Point and click 01
User > WELCOM > Market concentration > Market concentration and welfare



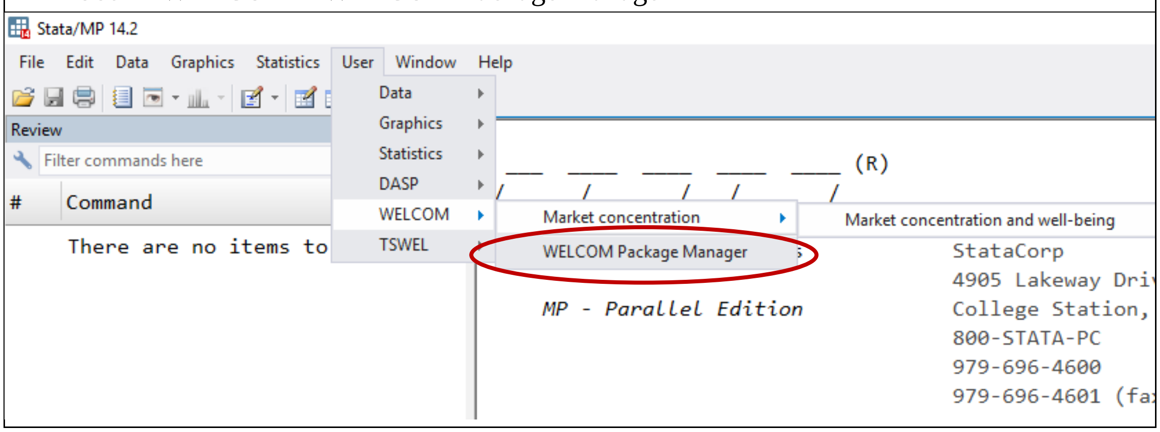
After selecting the “Market and welfare” option, a window with the main user interface of the **WELCOM** module will launch (Figure 4.1) and the user can start interacting with the program.

Figure 4.1: Main tab in **WELCOM** module interface



Note that the WELCOM package also provides the option of "WELCOM package manager" to manage updates in the tool, read the reference material or visit the WELCOM website[16] as shown in Figure 3.2 below.

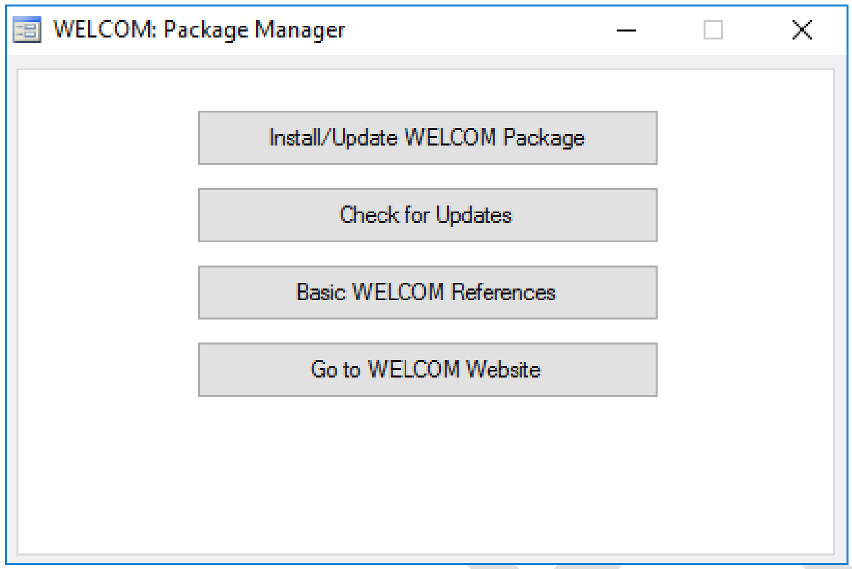
Point and click 02
User > WELCOM > WELCOM Package Manager



The window in Figure 3.2 corresponds to the user interface of the WELCOM: Package Manager, showing alternatives to manage the version of the WELCOM Stata tool:

16 http://dasp.ecn.ulaval.ca/webwel/welcom.html

Figure 3.2: WELCOM: Package Manage Window



After the user executes the commands in the table **Commands 01** and launches **WELCOM** following the instructions in **Point and click 01**, the tool is ready for use. The next section will discuss in more detail the user interphase of the **WELCOM** tool.

3.2 The **WELCOM package** for Stata

The empirical analysis produced by the tool is based on micro-economic models where the household is the unit of reference. One of the advantages the tool is its mild data requirements allowing the user to run *ex-ante* analysis of policies. The data requirements of the tool include:

- A representative sample of the population (i.e., a household or consumption survey).
- Information on total household expenditures (i.e., a variable representing the consumption aggregate).
- Data on household expenditures on the product traded in the market of interest (where the policy reform is expected to have an impact).
- Information on one of the following parameters of the model (market structure), based on the characteristics of the industry under study:
    - ➢ Monopoly: demand price elasticity.
    - ➢ Oligopoly: number of firms in the market and demand price elasticity.

- Partial collusive oligopoly: market share of the firms colluding and the demand price elasticity they face.

The data requirements of WELCOM can typically be met with data from two alternative sources. On one hand, a household survey with a detailed consumption module should provide enough information on total consumption and expenditure in the type of good of interest. On the other hand, basic information on the characteristics of the market and market structure can be obtained from industry reports (such as the number of firms and market shares), studies from government agencies (market shares, elastic of demand, collusive agreements) and firms or industry surveys (number of firms, market shares), among others.

The rest of this section presents the different elements and features of the tool in eight parts:

a. Preparing the dataset
b. Launch the dialog box
c. Load the key variables
d. The "Main" tab
e. The "Items" tab
f. Select options to produce tables
g. Select options to produce graphs
h. The "if/in" tab

a. Preparing the dataset

Prior to launching the dialog box it is necessary to load in the memory of Stata a database including the variables with the relevant information on consumption following the format required by the tool as well as additional characteristics on the market structure for the alternative options that the user would like to estimate.[17] The tool requires information on the following dimensions of household characteristics and poverty measurement in the market:

- **Expenditure per capita in the product of interest**
- **Total per capita expenditures**
- **Household size**

[17] Please notice that if the database of interest already includes all the necessary variables to use the **mcwel** command it can be directly load to memory from the mc dialog box.

- **Poverty line:** a variable representing the <u>relevant poverty line</u> (alternatively, other line such as extreme poverty, vulnerability or middle class could be used) in per capita terms is necessary to assess the effects of the intervention on poverty.[18]

In addition, **WELCOM** allows to include the sample weights of the survey and, ideally, additional variables indicating the Primary Sampling Unit (PSU) and Strata. Moreover, the tool also allows the user to include a variable with information on the finite sample population correction. However, if no information on the sample design of the survey is entered (the sampling design is not initialized), a simple random sampling is used by default.

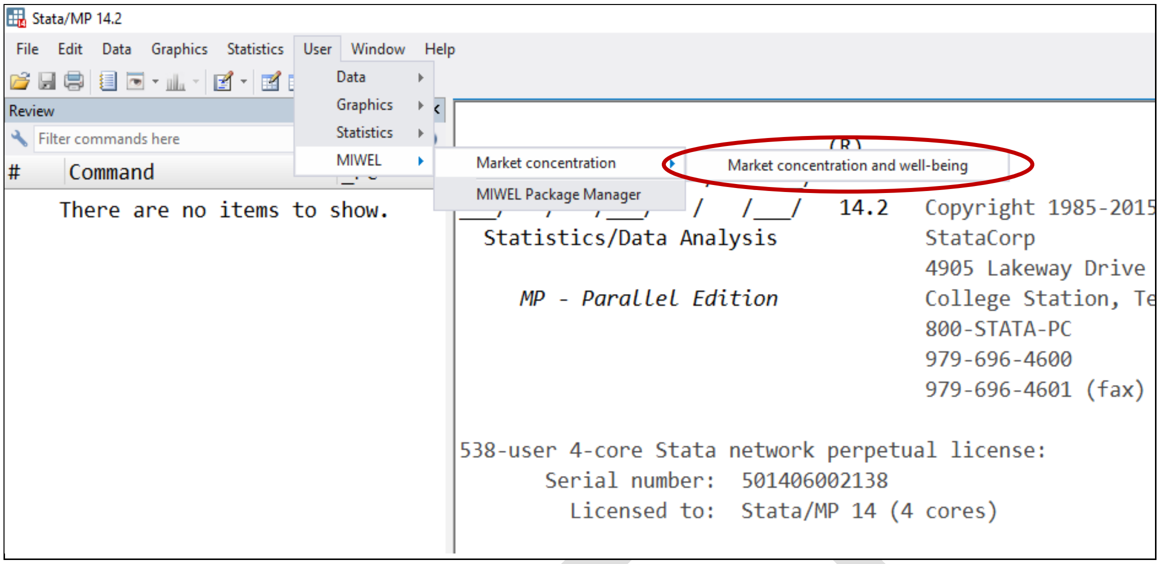
Moreover, by default the tool analyzes the impacts of the policies by expenditure quintiles, however we may want to include a variable capturing a different disaggregation such as income deciles (to perform a relative incidence analysis by income decile), the urban/rural divide, bottom 40 and top 60, or an indicator of ethnicity, among others.

b. Launch the dialog box

Once the relevant database is loaded in the memory of the Stata program, the dialog box of the tool enables the user to interact with the tool and identify the variables with the required information on household consumption, as well as to select the appropriate models—and their parameters—for the alternative market structures and estimations. The user can launch the tool by following **Point and click 03**.

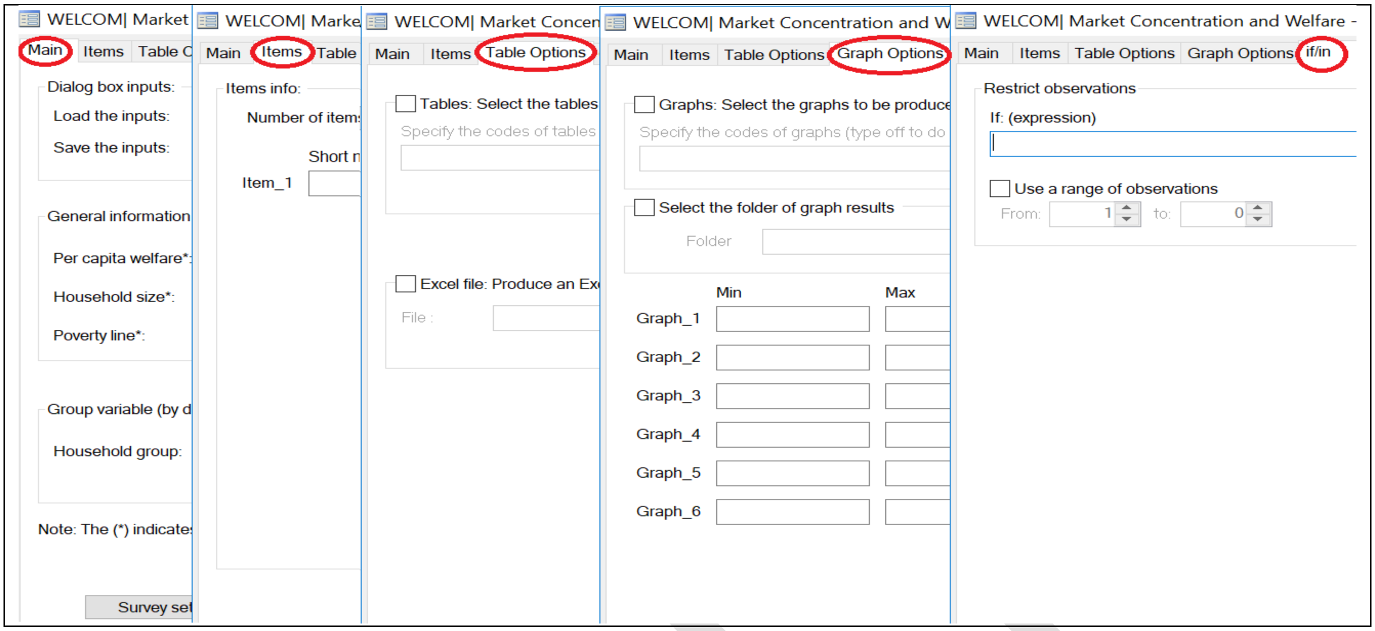
Point and click 03
User > WELCOM > Market concentration > Market concentration and welfare

[18] The current version of the tool expects that the three monetary variables (expenditure in the relevant good, total expenditure and poverty line) are expressed in comparative terms, for instance in current local currency units or in real terms using the same base year.



Once the tool in Stata is launched the user interface shows the “Main” tab, where the variables and parameters of the models to be analyzed are selected. In addition, a second tab labeled “Items” allows the user to indicate the markets or products under analysis. A third “optional” tab called “Table Options” allows to select the tables to be produced as well as the location to save an Excel file with such tables. Similarly, the “Graph Options” tab lets the user choose alternative options to produce graphs. Finally, the “if/in” allows to select a subsample of the observations for the analysis. The “Figure 3.4: Tabs in the **mcwel** window” shows the location and main view of each of the tabs available in WELCOM.

Figure 3.4: Tabs in the main window



In the rest of this section, the user manual will discuss the different elements that compound each of the tabs available in the dialog box of the tool.

c. The "Main" tab

The "Main" tab of the tool is organized in seven sections, as indicated by each of the red circles in Figure 3.5. Each section of the tab is associated with a different element of the data available, the characteristics of the sample design, the market structure, the survey design, and options to save the characteristics of the simulation, among others.

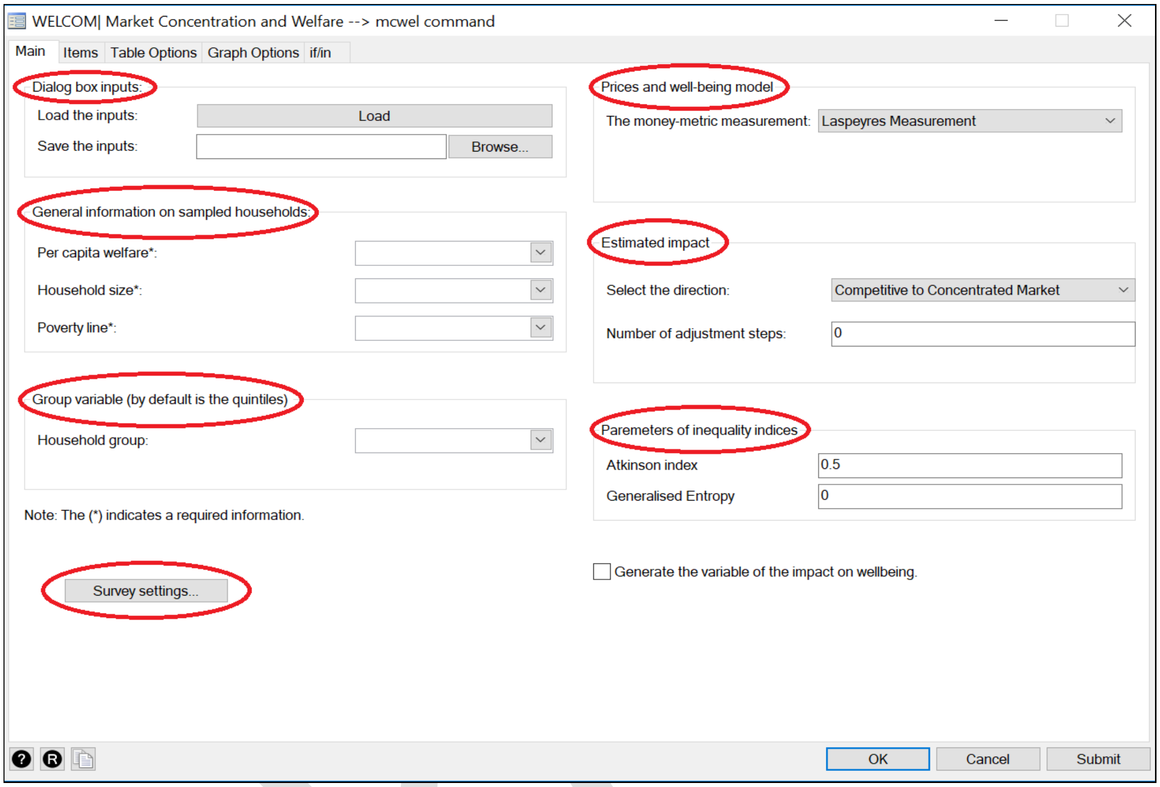
In addition, the "Main" tab also includes a box at the bottom right that the user can check if she wants to "Generate the variable for the impact on welfare", to generate a new variable in Stata storing these impacts.

The rest of this section discusses each of the options in the seven sections of the Main tab in Figure 3.5:

- Dialog box inputs
- General information on the sampled households
- Group variable
- Prices and welfare model
- Estimated impact

- Parameters of inequality indices
- Survey settings

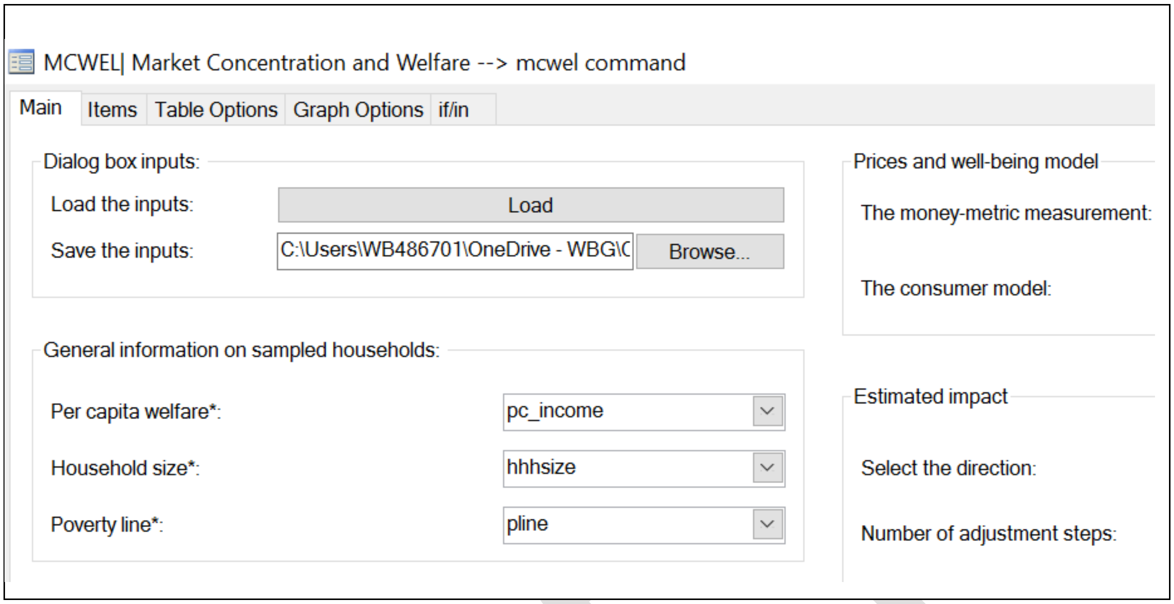
Figure 3.5: Elements of the Main Tab Window



- *The Dialog box inputs*

This section of the Main tab allows the user to load and save the dialog box with the details of the simulation run. The box enables the user to load into the WELCOM window information from a previous simulation exercise previously saved, or to save information from a new simulation based on the details currently shown in the dialog box. This information is stored in text files with the extension *.mcw. You can test this feature by uploading the file "mcwel_example.mcw" provided with the toolkit. Note that you can load the file from one directory ("Load the Inputs") and save it in a different directory with a different name ("Save the Inputs").

Point and click 04
User > WELCOM > Market concentration > Market concentration and welfare > Main > Dialog box inputs



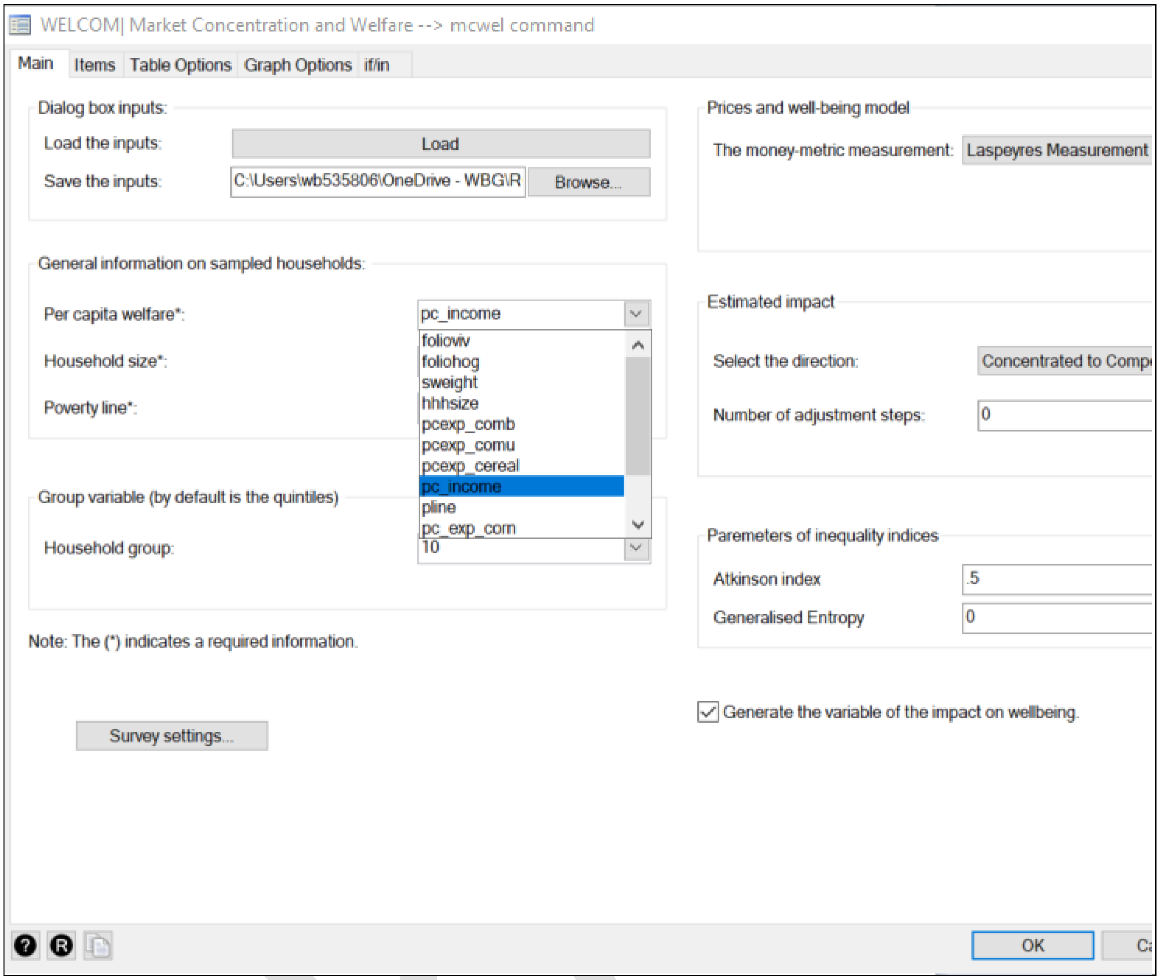
- *General information on the sampled households*

The box "General information on sampled households" is located mid-left section of the Main tab window. This box includes 3 dropdown menus to select key variables necessary for the simulation that should be available in the database in memory, as shown in the chart **Point and click 05**. At a minimum, the tool requires the user to introduce information about the following three variables of interest:

i. Per capita expenditures: continuous numerical variable with monetary values.
ii. The household size: integer variable.
iii. The poverty line: continuous numerical variable with monetary values.

Notice that these variables should be included in the database in memory and need to be prepared in advance in the required format following the discussion in the section "Preparing the dataset." In addition, the three monetary variables (Per capita expenditures on the product of interest, Per capita expenditures and Poverty line) should be expressed in comparable terms such as current currency units or in real terms using the same base year. Moreover, it is mandatory to have information on these variables to be able to run the simulations.

Point and click 05
User > WELCOM > Market concentration > Market concentration and welfare > Main > Per capita welfare / Household size / Poverty line



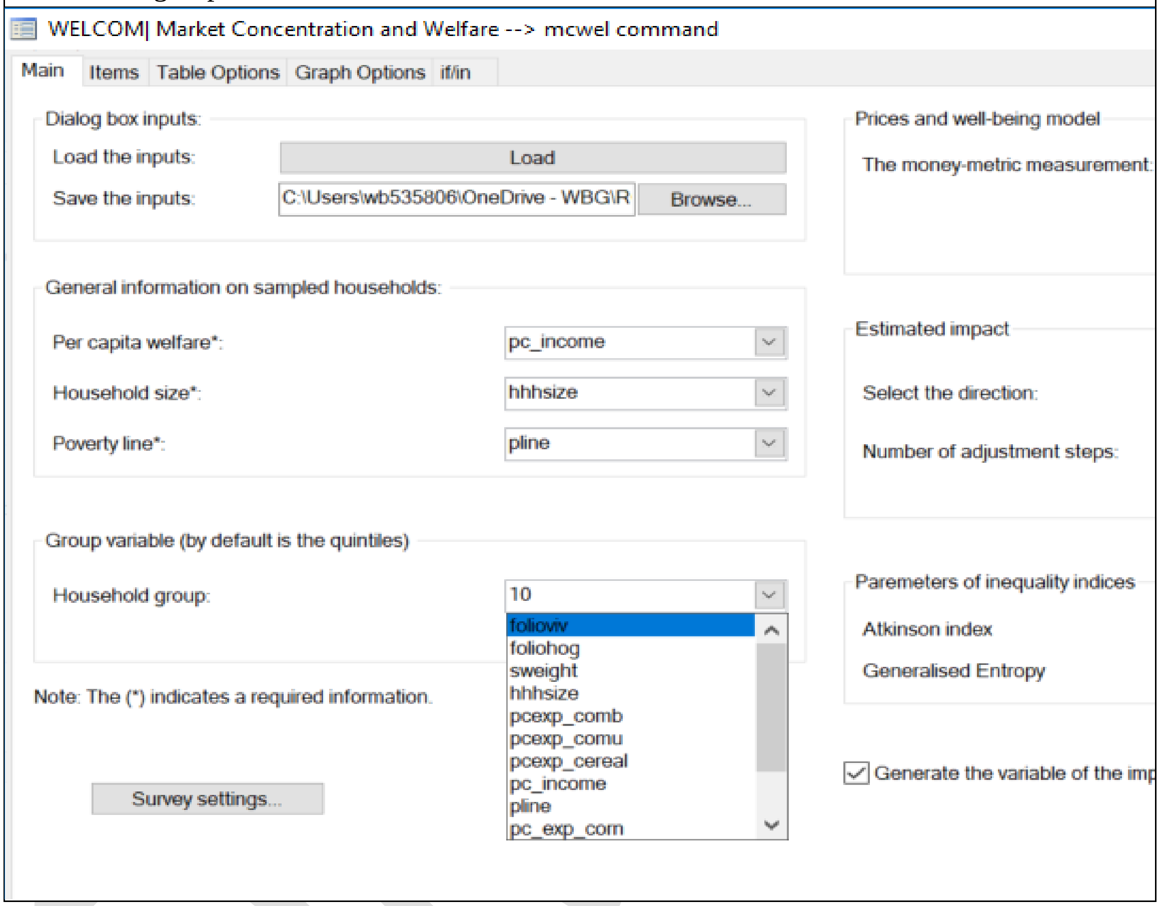
- *Group variable (by default is quintiles)*

Up to this point, the user introduced information on the main characteristics of the sampled households such as income or consumption per capita, household size and the poverty line. Now, the user must provide information on the way she wants the data to be analyzed and the results to be presented.

For instance, if the results should be estimated in deciles based on the relevant welfare aggregate, the user should introduce the integer 10. If the results are going to be organized by geographical location (such as provinces or other subnational level), then the name of the variable identifying the different locations must be included here. Thus, the box "Group variable" enables the user to select a population group in the dropdown menu, either from the database in memory or by directly introducing an integer to classify the households given their expenditure levels, as shown in the **Point and click 06**.

Point and click 06

User > WELCOM > Market concentration > Market concentration and welfare > Main > Household group



As previously discussed, in contrast with other sections of the Main tab where the user had to select a variable from the database, now she can either select a variable from the database or directly introduce an integer value representing the number of groups required. If the user decides to group the estimates using a variable, the results could show the differences by socio-demographic group such as gender or urban-rural area of residence. In contrast, if the user indicates an integer such as 10 in the "Household group" option, the population is organized by decile groups based on their level of expenditure. If the "Household group" option is left empty, then the results are shown organized by expenditure quintiles by default.

- *Survey settings*

An additional alternative available in **WELCOM** is to include the dataset sampling design to obtain estimates on the target population of the survey. Notice that to use the options for survey settings, the user needs to prepare the variables associated with the different dimensions of the survey design before launching tool. These settings include information on the sampling weights, sampling design, adjustment for finite population, among others. This can be done with the command "svyset" in Stata or using the button "Survey Settings…" located in the bottom right-hand corner of the "Main" tab, as shown in the **Point and click 07** chart. We declare the sampling weight with the **svyset** command to estimate accurately the standard errors.

Point and click 07

User > WELCOM > Market concentration > Market concentration and welfare > Main > Survey settings

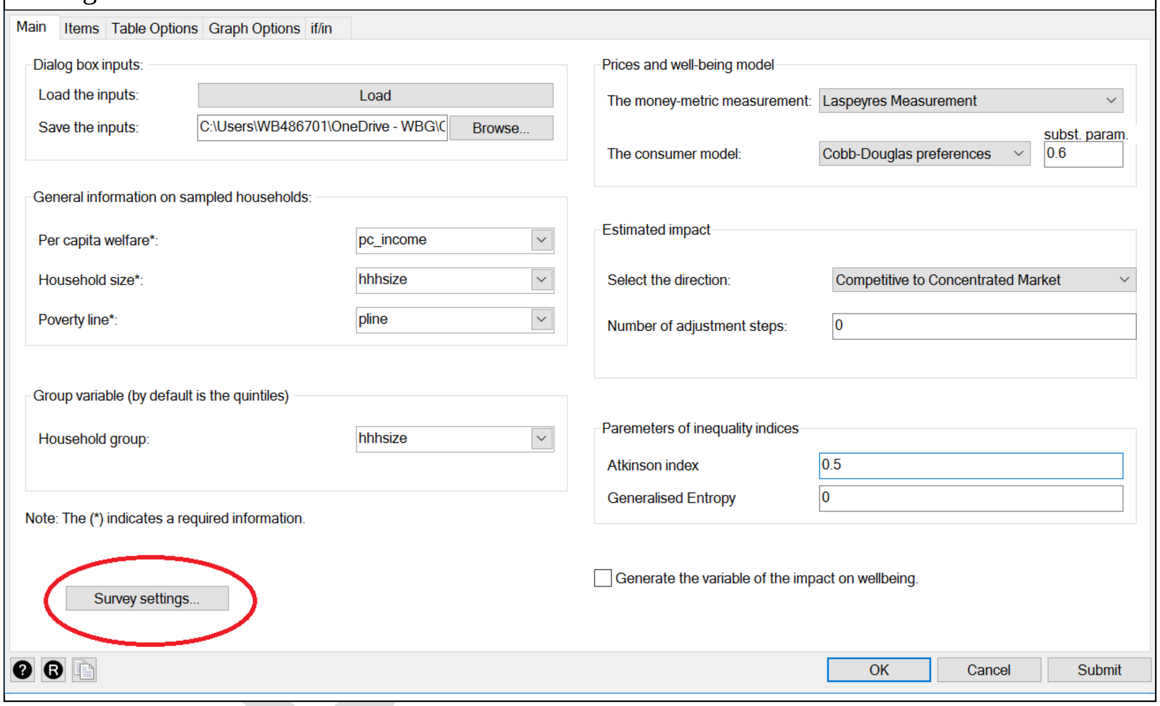


Figure 3.6: Survey Settings Options in the tool – Step 1

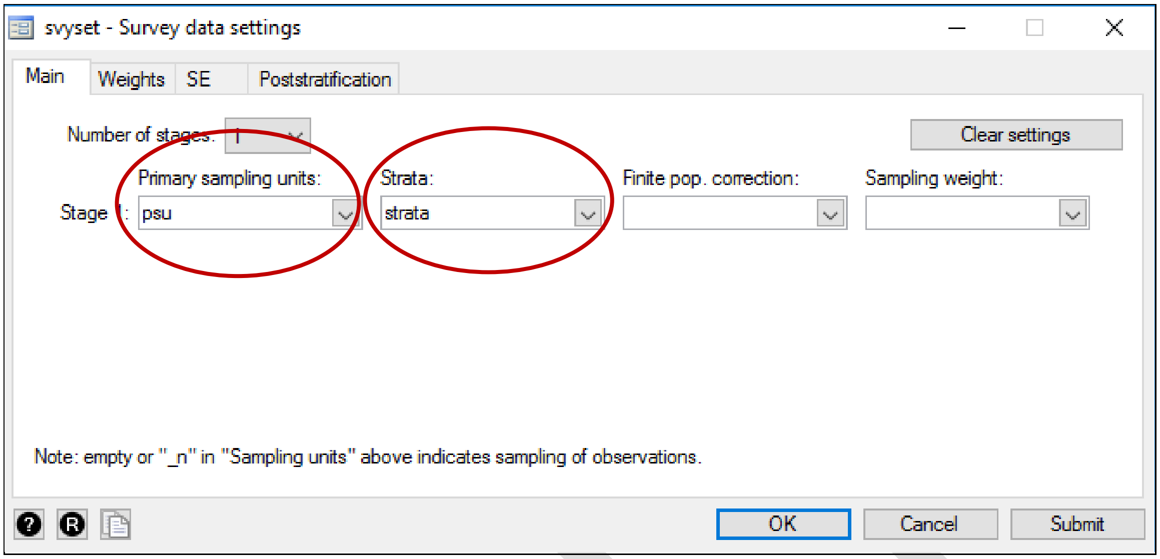
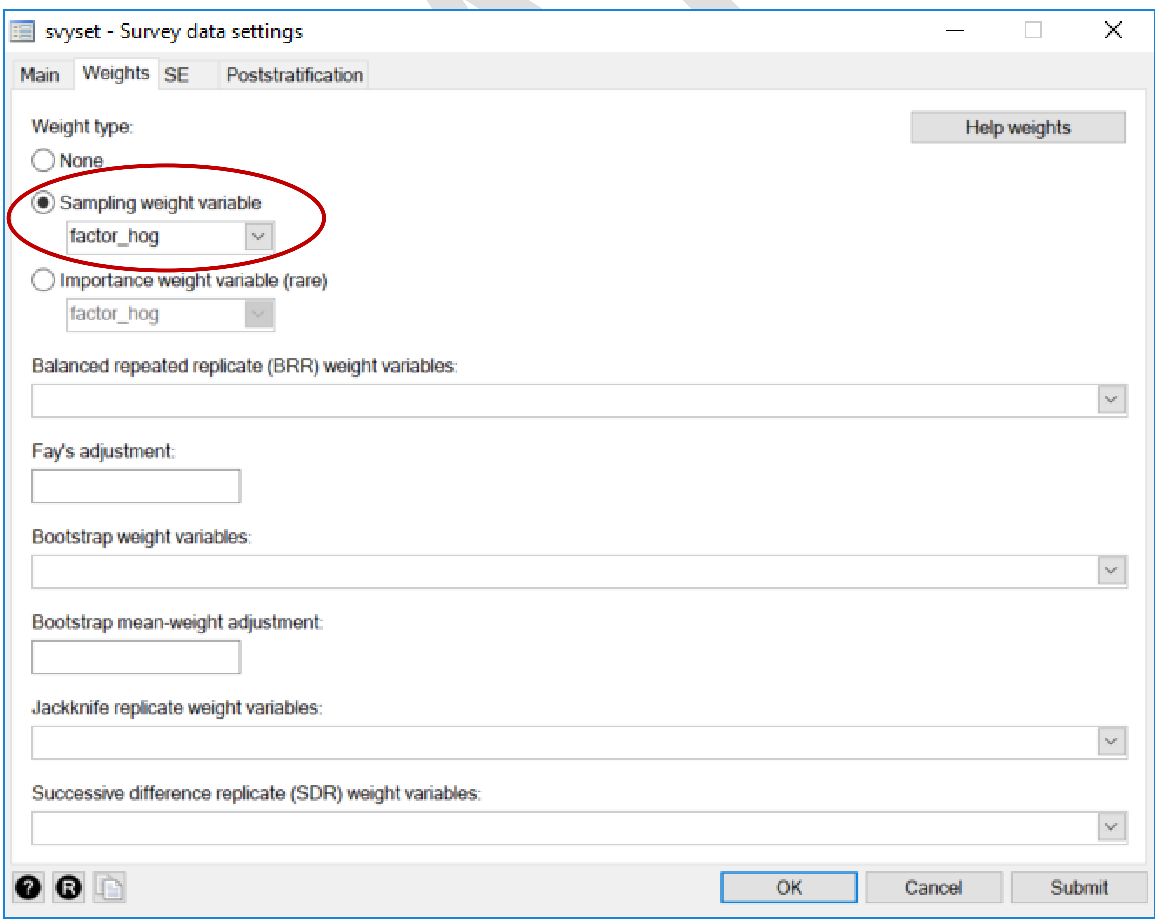


Figure 3.7: Survey Settings Options in the tool – Step 2



Typically, setting the sampling design of the survey is a two-step process:

1. Define "PSU" and "Strata" on the "Main" tab of the "Svyset" window (notice that the user should not define anything on the "Sampling weight" dropdown menu in this window), as in Figure 3.6.
2. To define the "Sampling weight variable", the user should click on the "Weights" tab (within the "svyset – Survey data settings" window) and select the "Sampling weight variable" from the dropdown menu, as shows in Figure 3.7.

Alternatively, the sampling weight can be declared manually with the command **svyset** using the command line in Stata. In any case (manual or interactive), once the sampling weight is declared, and the data is saved, this information continue to be saved with the data file.

For more information on the alternative survey settings available in the tool, see the Stata Reference manual on Survey Data.

- *Price and welfare model*

After specifying the characteristics of the dataset, the preferred organization of the results and setting the survey sampling design, the user must decide the type of measurement to estimate the impacts of the policy fostering competition. More precisely, this implies choosing the main approach to be adopted to assess the impact of price change on welfare. The user can select among the three following alternative measurements (see Section 2.3 for details on the characteristics of these measures):

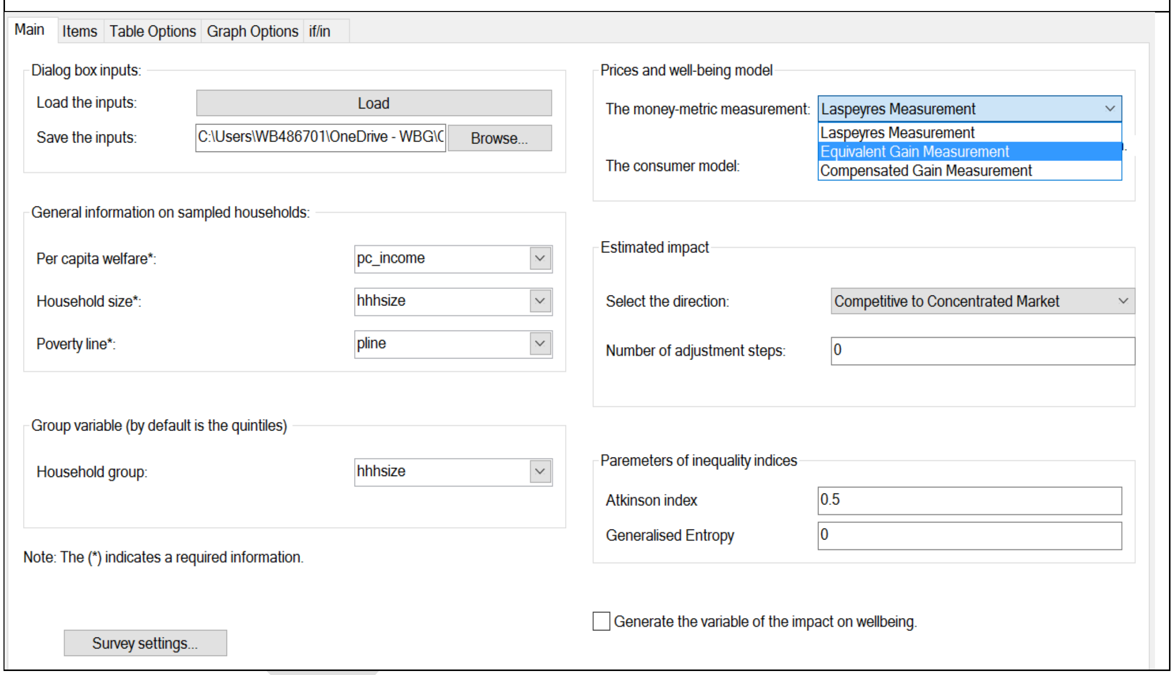
- The Laspeyres measurement (linear approximation).
- The equivalent variation (EV) measurement.
- The compensated variation (CV) measurement.

In addition, if the user decides to rely on an equivalent or compensated variation measurement as the money metric to assess the impacts, a set of additional parameters needs to be selected. When any of these two measures is selected, the **WELCOM** tool requires the user to specify the "Consumer model" she wants to use. Currently, the tool can run two alternative models, each with different data requirements and assumptions:

- Cobb-Douglas preferences: note that in this case the expenditure shares are estimated based on the share of each good in the dataset.
- Constant Elasticity of Substitution (CES) preferences: in this case, the user will need to define the value of the substitution parameter (also, note that the value of the substitution under a Cobb-Douglas is always equal to 1). As a reference, the CES function has the following properties:
    - Subst. param. = 0 (no substitution: Leontief function)
    - Subst. param. = 1 (Cobb-Douglas)
    - Subst. param. = Infinity (Perfect substitutes)

Point and click 08

User > WELCOM > Market concentration > Market concentration and welfare > Main > Select the structure > Prices and welfare model



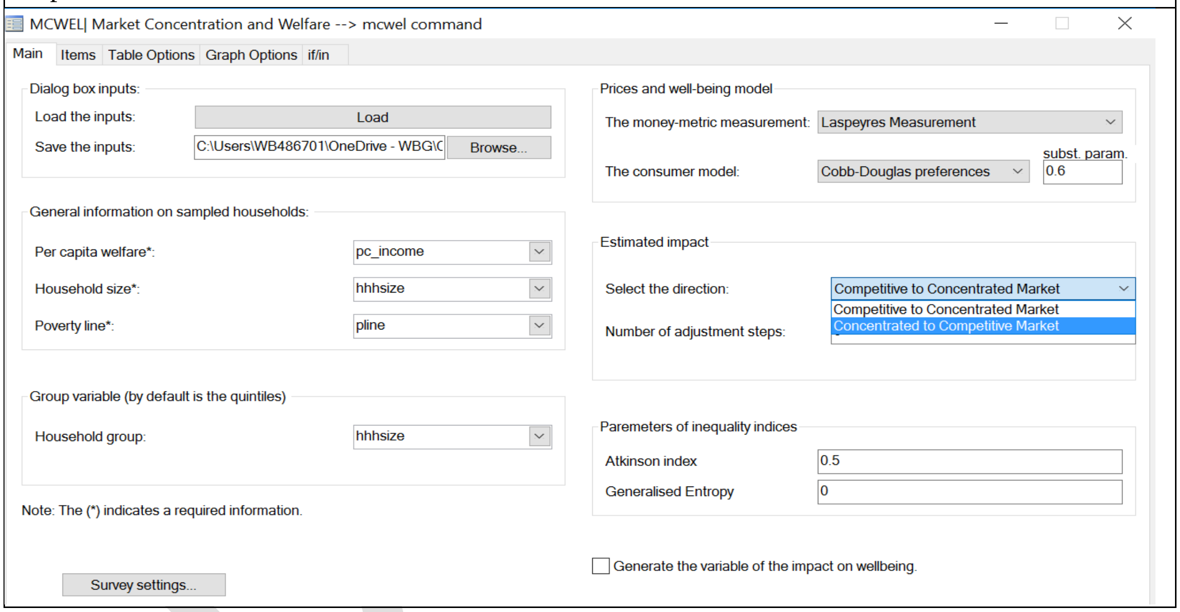
- *Estimated impact*

So far, this user manual implicitly assumed that the base scenario under analysis is one where a concentrated market exists, and policy makers are designing a policy to promote competition in a market where they have identified the presence of market power. Thus, the analysis of the effects of the policy implies moving from a concentrated market to a competitive market where firms are not able to extract market power rents and charge prices according to their marginal costs.

However, the WELCOM tool is able to accommodate the analysis of policies aimed at fostering competition in the market (e.g., by selecting the “Concentrate to Competitive Market” option in the “Select the direction” box) as well as the opposite scenario, where a policy is expected to somehow reduce competition in the market (e.g., setting tariffs on imports, setting price ceilings, creating artificial monopolies, etc.) and the user needs to assess the impact on welfare of moving from a competitive market to a more concentrated one.

Point and click 09

User > WELCOM > Market concentration > Market concentration and welfare > Main > Estimated impact



To switch between the base scenarios that the user wants to run for the analysis, she can go to the “Estimated Impact” box and follow the indications in the **Point and click 09**. As the user changes the base scenario, the interpretation of the results should also be adjusted to reflect the relevant conditions.

In addition to estimating the impact of moving from the initial to the final state (for instance from the concentrated market to the competitive market), the module can estimate the intermediate states of the partial movements toward the final state. This is can be achieved by indicating the number of steps of adjustments, but the adjustment will be based on the organization of the market under analysis.

For instance, assume that we have a case of a **PCO model** for which the market size of the oligopoly firms is equal to 60%. If the selected number of adjustment is zero, then the tool estimates directly the impact of a full adjustment. If the number of steps is one, then the impact is estimated from a change of the market change from 60% to 30% and then from 60% to 0%. As a rule, if we denote the initial market share by ϕ^I and the number of steps by s, then, the intermediate steps are: $\phi^I \rightarrow \frac{\phi^I}{(1+i)}$ $and\ i \in \{1;\ s\}$.

In addition, the **monopoly** is a special case of the previous step-adjustment rule, assuming that $\phi^I = 100\%$.

Moreover, in the case of the **oligopoly market** structure which a Nash equilibrium that depends on the number of firms. For instance, if the initial number of firms is $N^I = 4$, and the number of steps is three, the intermediate steps are: for $N = 6, 8\ and\ 12$. As a general rule, when the number of steps is s, then, the intermediate steps are:

$\boldsymbol{Step}$ **1**: $N^I \rightarrow N^I * 1.5$ // **Step 2 to s:** $N^I \rightarrow N^I * i \ \ and\ i \in \{2;\ s\}$.

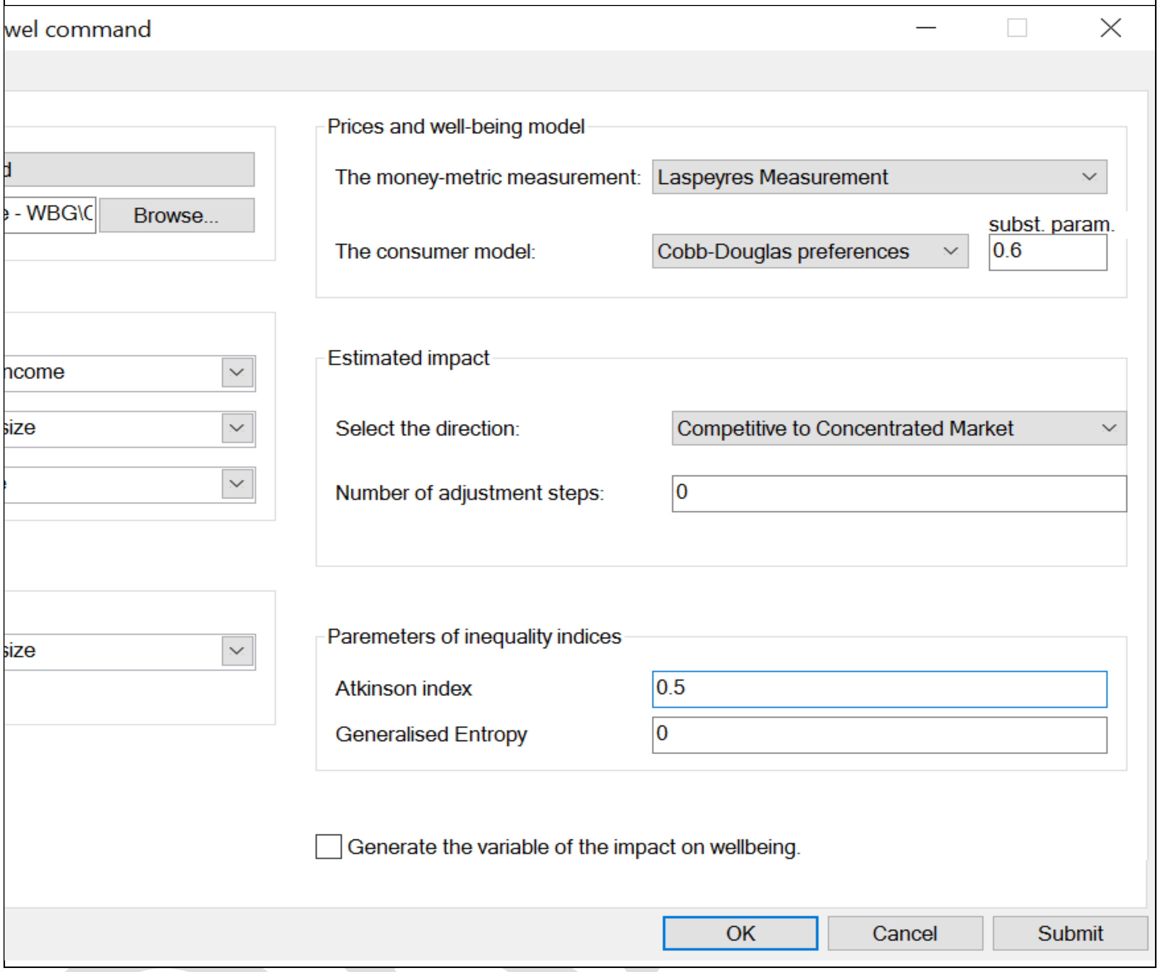
- *Parameters of inequality indices*

In the "Parameters of inequality indices" the tool offers the option to select some of the parameters necessary to estimate the two alternative inequality indices:

a. Atkinson index
b. Generalized Entropy

Note that the default option for Atkinson index is 0.5. This parameter allows you to change the weight placed on changes in a given portion of the income distribution. For instance, a value close to 1 makes the index more sensitive to changes in the upper end of the distribution. If the value approaches to 0, the Atkinson responds to changes at the lower end of the distribution. Typically, this parameter is set to 0.5 by default to have a "balanced" measure.

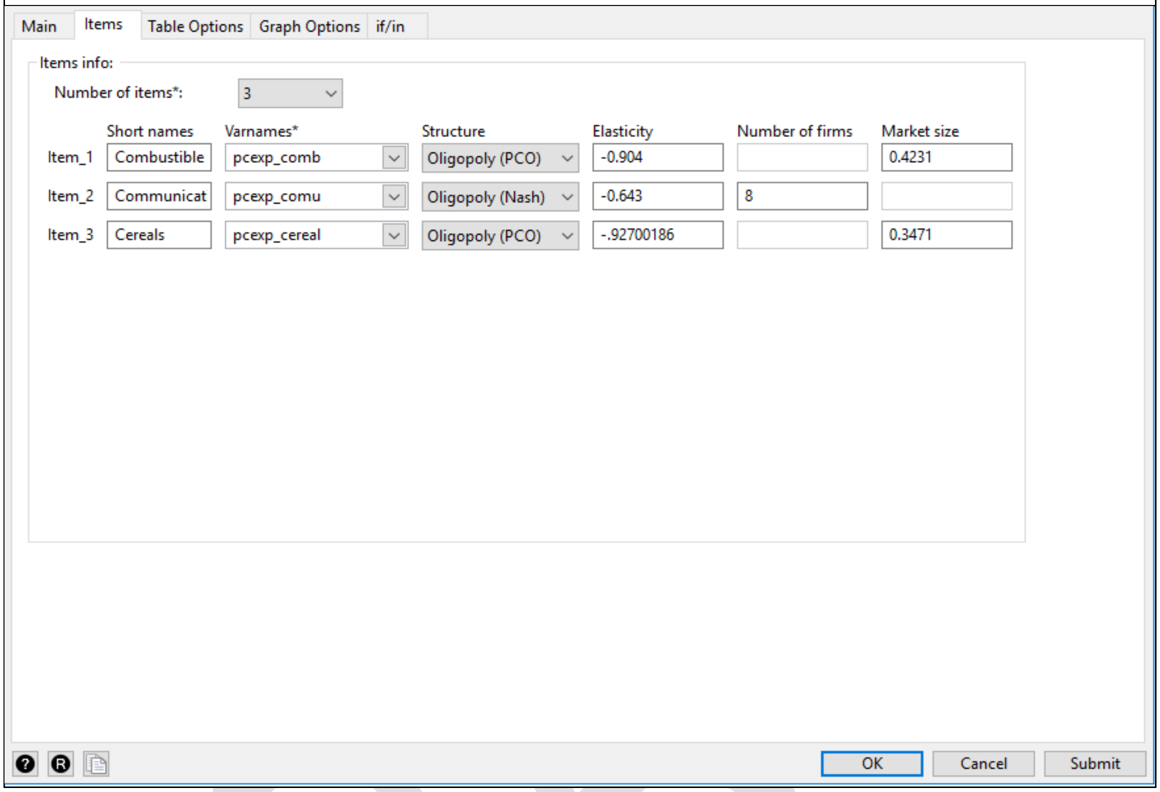
Point and click 10
User > WELCOM > Market concentration > Market concentration and welfare>Survey settings



d. The "Items" tab

The **WELCOM** tool allows to estimate the impacts of different market concentrations. The tab "Items" enables to indicate the number or products of interest with concentration markets, as well as the market structure of each product/item. While the options in the "Main" tab generally rely on information from a household or consumer survey, the information for the "Items" tab comes from studies on the organization of the industry or market under study and from firm surveys or analysis on competition conditions from the competition market authorities (CMA).

Point and click 11
User > WELCOM > Market concentration > Market concentration and welfare > Items > Number of firms



The user can choose from 1 to 10 items. For each item, the user can indicate:

- The short name of the item or the product (this is the name that will be used in the output tables and graphs).
- The variable name of the expenditures per capita (this is the name of the variable in the dataset).
- The market structure: The tool needs information on the structure of the supply side of the industry, i.e. how many firms or suppliers are and how they interact in the market. In addition, each model of market structure requires a different set of parameters that the user requires to feed into the mcwel tool. For instance, while the Monopoly structure only requires information on the elasticity of the demand, the Oligopoly: Nash Equilibrium needs in addition to the demand elasticity, information on the initial number of firms in the market. Following the instructions in the chart Point and click 05, the user can select among three alternative structures and the required industry parameters:

a. *Monopoly:* The user only needs to provide the value of the price elasticity of the demand. Notice that this elasticity is typically a negative parameter in the range (-1,0) since by theory the monopolist optimizes by producing in the elastic segment of the demand curve.

b. *Oligopoly-Nash equilibrium*: Under this type of market structure, the user must provide information on the elasticity of demand faced by the firms, as well as on the number of firms in the oligopolistic market.

c. *Partial collusive oligopoly*: In this scenario, the user must provide the value of the price elasticity of demand as well as the observed market share of the oligopolistic group.

- The non-compensated elasticity.
- The number of firms (model: Oligopoly: Nash equilibrium).
- The market size of the oligopoly group (model: PCO).

It must be noted that one of the caveats of the analysis currently available in the tool is that the welfare outcomes of the alternative market structures are compared against a perfect competition counterfactual. This implies that the tool assumes, for instance, that after implementing a policy reform aimed at eliminating a monopoly in a market, this market will become perfectly competitive, assumption that might be problematic in some circumstances.

e. The "Table Options" tab

This tab allows the user to select the tables' options. The default option when you do not select the tables and override options is the production of all tables.

- *Tables: Select the tables to be produced*

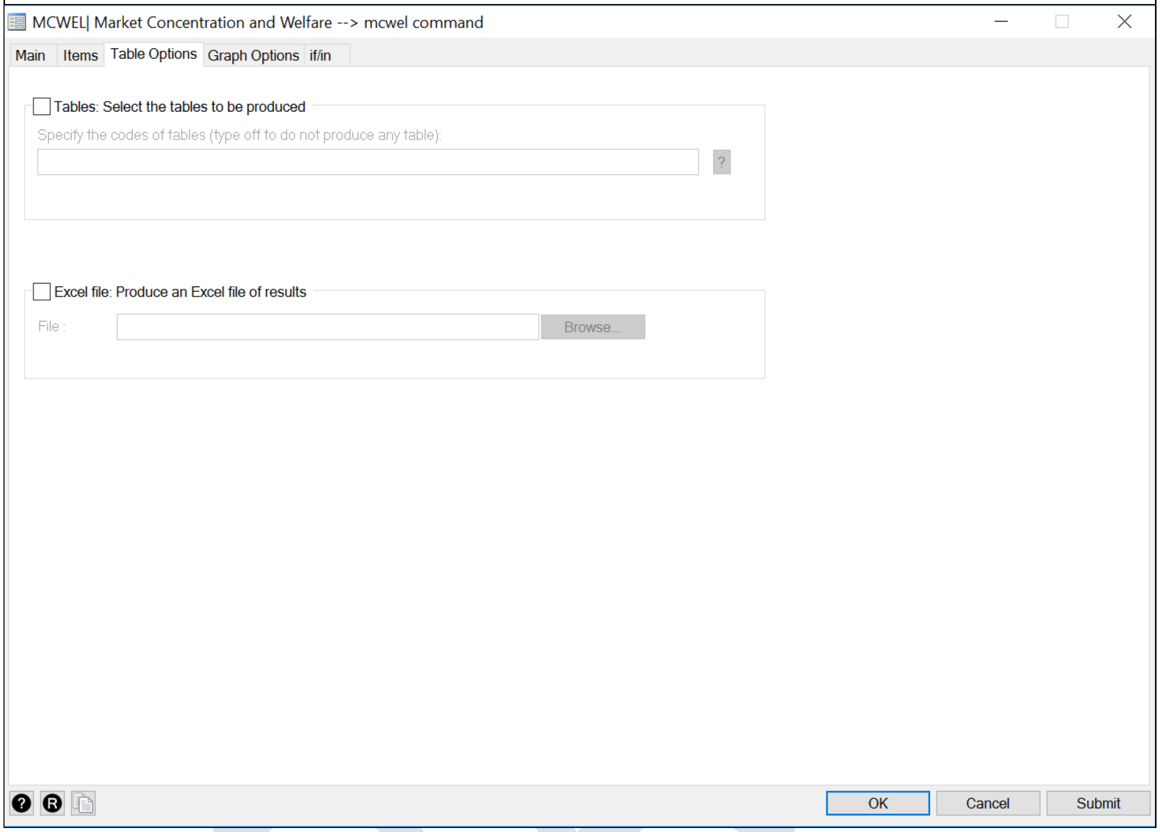
In case the user wishes to have only a selected number of tables the code of these tables can be indicated in the box. The list of codes with the titles of the tables can be seen by clicking on the question mark button "?". For example, you can type "*11 23*" to produce tables 1.2 and 2.3 only (no commas, one space between numbers).

- *Excel file: Produce an Excel file of results*

This box allows the user to define the Excel file where all tables should be stored. The user can select an existing file to override or create a new file. The user can either specify the name of the file or not. In the case of an existing file, the user should make sure that this file is closed when the program is launched, otherwise an error message will appear.

Point and click 12

User > WELCOM > Market concentration > Market concentration and welfare > Table Options

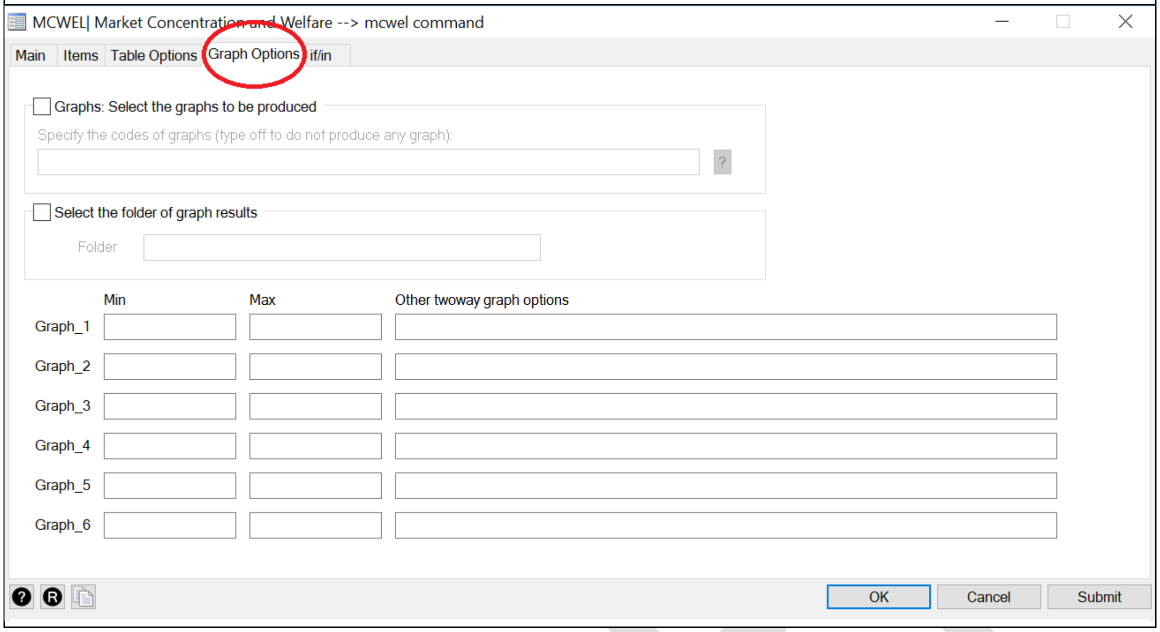


f. The "Graph Options" tab

The tab on the Graph Options allows the user to decide if she wants the tool to produce graphs with the estimated impacts of the analysis of the policy interventions aimed at foster competition, and what are the parameters and characteristics of the graphs. To access the "Graph Options" tab, the user should follow the indications in the **Point and click 10** box. The three main options available to allow to select the graphs to be produced, choose the folder to save such graphs and select among alternative graph options.

Point and click 13

User > WELCOM > Market concentration > Market concentration and >Graph options



- *Graphs: Select the graphs to be produced*

This option allows the user to save only selected graphs by indicating the code of each graph. The list of codes with the titles of the graphs can be seen by clicking on the question mark button "?". For example, if the user wishes to produce only Graphs 1, 2 and 4, the user will simply type "1 2 4" (no commas, one space between numbers).

- *Select the folder of graph results*

This option allows the user to select the directory where the saved graphs should be stored. Note that all graph files are saved in three formats: .gph. .pdf and .wmf. will save a folder with the name "Graphs" in the directory selected.

- *Graph options*

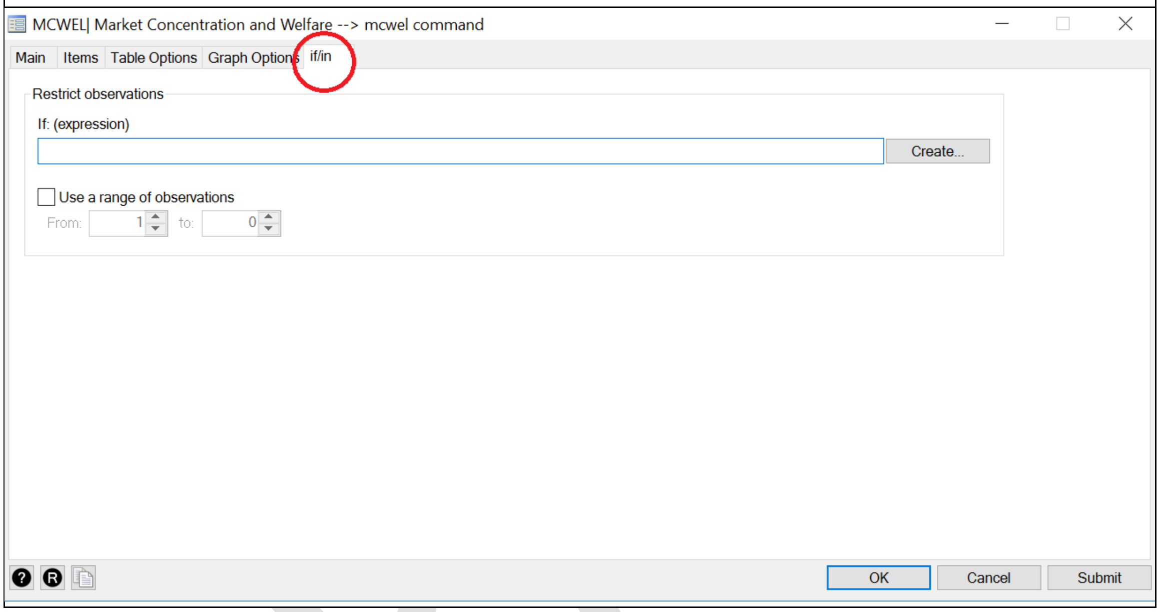
For each graph, the user can select options regarding the y-axis scale (min and max) and other two-way graphs options as indicated in the Stata graph help files. For example, users may want to limit the range of the graphs to a specific interval like between 10 and 80. This can be done by indicating min and max values. Or users may want to omit titles of the graphs to add these titles separately in the report. This can be done by adding the Stata graph option "title ("")". Note that each of the displayed graphs is automatically saved in three formats in the previously indicated folder ("Graph"). The three formats the saved graphs are: (i) *.gph; (ii) *.wmf; and (iii) *.pdf.

g. The "if/in" tab

The "in/in" tab includes a single command box to select a relevant subsample from the database on memory to perform the analysis.

Point and click 14

User > WELCOM > Market concentration > Market concentration and welfare>if/in



- *Restrict observations*

Note that, as shown by the **Point and click 09** box below, the mcwel tool offers two main ways to restrict the observations to a smaller subsample. The first alternative is to select observations conditional on a specific if expression or criteria. The second alternative implies restricting the analysis to a predetermined range of observations.

3.3 The mcwel outputs

After launching the computation, a series of results (tables and figures) are displayed. The main results tables provided are:

a. The estimated market parameters

In table 1, the price change, the adjusted elasticity and the rest of used or estimated parameters of the market structure are reported.

b. The descriptive statistics on household expenditures

In table 2, the average per capita to expenditures and that on the product of interest are reported for each population group. Also, it is displayed the expenditure shares.

c. The impact of the market concentration on household welfare

In table 3, the price change implied by the moving from a market without concentration to that with concentration is reported. In addition, table 3 reports the average impact of the price change on household welfare, and this by population groups.

d. The impact of the market concentration on poverty

In table 4, the three popular poverty indices are reported for the cases of with and without market concentration. Also, the impact of the market concentration on poverty is reported.

e. The impact of the market concentration on inequality:

In table 5, four inequality indices are reported for the cases of with and without market concentration. Also, the impact of the market concentration on the inequality is reported. The inequality indices are:

- The Gini index;
- The Atkinson index;
- The generalized entropy index;
- The Quantiles ratio index (Q(p=0.1)/Q(p=0.9)).

Note: The full information on the sampling design of the survey is used to assess the standard error of the different statistics.

The Figure results are:

- The expenditures share on the product of interest, per the welfare percentile;

- The per capita impact on welfare according to the welfare percentile;
- The Lorenz curve of welfare and the concentration curve of the product of interest.

3.4 Examples of WELCOM

Example 01:

We first run the first example from the help manual. We only have one item of interest (Combustible) and we assume that the market is a partial collusive oligopoly. We would like to estimate the impact of moving from the concentrated market to the competitive market. Please refer to Annex I for the full list of commands to recreate this exercise.

```
#delimit ;

use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace;

mcwel pc_income, hsize(hhhsize) pline(pline) gvimp(1) inisave(mcwel_example_01) nitems(1) it1( sn(Combustible) vn(pcexp_comb) el(-0.904) st(3) si(0.4231) ) move(-1) epsilon(.5)  opgr2( min(0) max(0.9) )opgr3( min(0) max(0.9) ) xfil(myexample2)  folgr(Graphs)

;
```

Table 1.1: Models and parameters

Item: Combustible	Market type : Partial Collusive Oligopoly		
Step	Market size (in%)	Elasticity	Price
Concentrated Market	42.310	-0.9040	1.879809
Competitive Market	0.000	-0.3379	1.000000

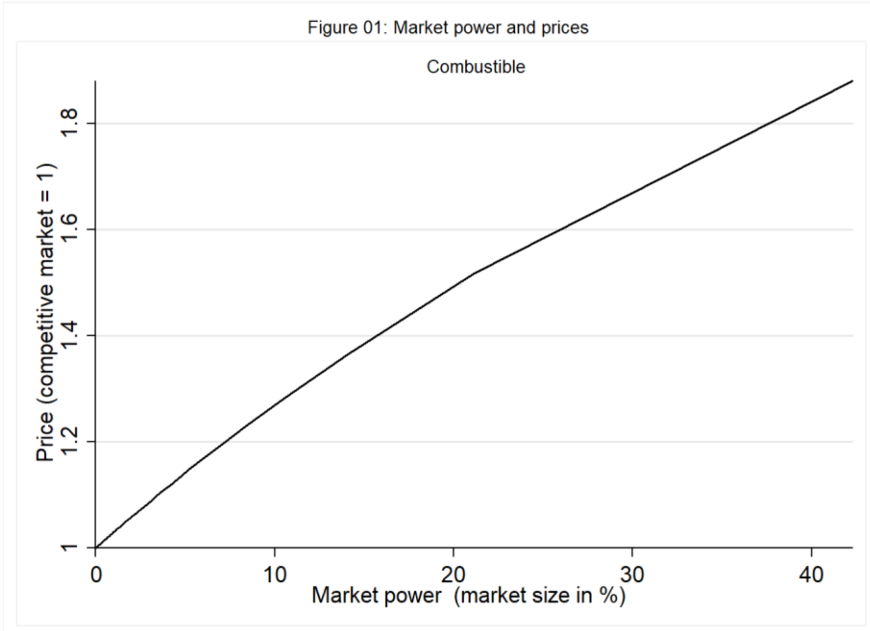
For combustibles we have initially a PCO market structure, and where the market share of the oligopoly firms is 42.31 %. In the adjustment toward the competitive market, the market share is reduced to 0%. Table 1.1 also shows the corresponding elasticities and prices.

Table 1.3 gives some descriptive statistics on the population and the expenditures

Table 1.3: Population and expenditures (in currency)

	Population	Number of households	Household size	Total expenditures	Total expenditures per capita	Total expenditures per household
Quintile 1	24,009,490	4,854,708	4.95	18,849,142,784	785.07	3,882.65
Quintile 2	23,958,312	5,402,162	4.43	35,458,871,296	1,480.02	6,563.83
Quintile 3	23,982,586	5,894,251	4.07	52,534,333,440	2,190.52	8,912.81
Quintile 4	23,986,720	6,734,927	3.56	80,423,206,912	3,352.82	11,941.21
Quintile 5	23,969,206	8,784,954	2.73	232,294,957,056	9,691.39	26,442.37
Total	119,906,312	31,671,002	3.79	419,560,521,728	3,499.07	13,247.47

Figure 01 gives more refined results similar to those of table 1.1:



The WELCOM tool estimates the different statistics for each step of adjustment. For instance, for the impact on the poverty headcount, the first table shows the level of poverty with the concentrated market (53.352%), and then with only the partial adjustment of the combustible market (52.28). The last line shows the impact of the partial adjustment in the three markets (51.43). The table 5.1 is reproduced for each adjustment step.

Table 5.1: The market power and the poverty headcount ||
Concentrated to competitive: Full adjustement

	Poverty level	The change in poverty	Standard error	P-Value
Concentrated Market	53.352	.	.	.
Combustible	51.041	-2.311	0.147	0.000
Competitive Market	51.041	-2.311	0.147	0.000

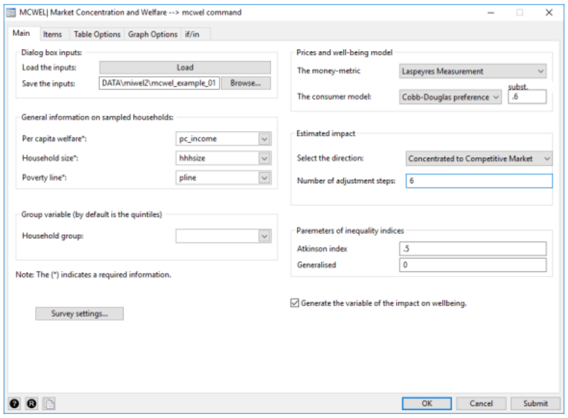
Example 02:

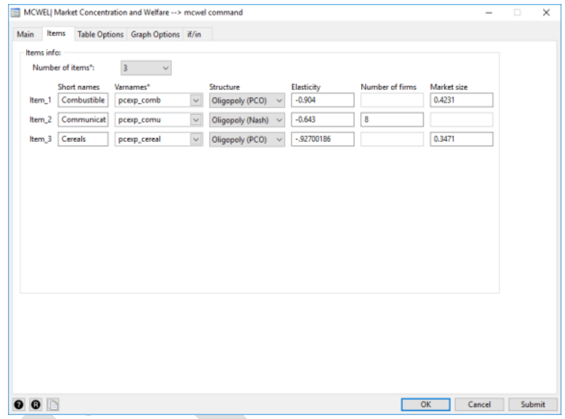
Load MCWEL's helpfile and click on "(example 2: click to run in dialog box)" to run the example from the dialog box. Please refer to Annex II for the full list of commands to recreate this exercise.

```
#delimit ;

use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace;

mcwel pc_income, hsize(hhhsize) pline(pline) gvimp(1)  inisave(mcwel_example_01) nitems(3)  it1( sn(Combustible) vn(pcexp_comb) el(-0.904) st(3) si(0.4231) ) it2( sn(Communication) vn(pcexp_comu) el(-0.643) st(2) nf(8) ) it3( sn(Cereals) vn(pcexp_cereal) el(-.92700186) st(3) si(0.3471) )
```

mpart(6) move(-1) epsilon(.5) opgr2(min(0) max(0.9)) opgr3(min(0) max(0.9)) xfil(myexample2) folgr(Graphs)

;





In this example, we would like to produce the tables 1.1 and 1.2, as well as the figure 01. We have three items of interest, and their three corresponding market structures are already indicated in the TAB items of the dialog box. As we can remark in the box *estimated impact*, we would like to estimate the impact of moving from the concentrated market to the competitive market. Further, we would like to estimate the impacts of a six partial moving toward the competitive markets.

Table 1.1: Models and parameters

Item: Combustible	Market type : Partial Collusive Oligopoly		
Step	Market size (in%)	Elasticity	Price
Concentrated Market	42.310	-0.9040	1.879809
Step : 1	21.155	-0.6210	1.516716
Step : 2	14.103	-0.5266	1.365767
Step : 3	10.578	-0.4794	1.283072
Step : 4	8.462	-0.4511	1.230875
Step : 5	7.052	-0.4323	1.194930
Step : 6	6.044	-0.4188	1.168670
Competitive Market	0.000	-0.3379	1.000000
Item: Communication	**Market type : Oligopoly: Nash Equilibrium**		
Step	# of firms	Elasticity	Price
Concentrated Market	8.000	-0.6430	1.162760
Step : 1	12.000	-0.5821	1.125223
Step : 2	16.000	-0.5517	1.101755
Step : 3	24.000	-0.5213	1.074013
Step : 4	32.000	-0.5061	1.058158
Step : 5	40.000	-0.4970	1.047897
Step : 6	48.000	-0.4909	1.040714
Competitive Market	.	-0.4604	1.000000
Item: Cereals	**Market type : Partial Collusive Oligopoly**		
Step	Market size (in%)	Elasticity	Price
Concentrated Market	34.710	-0.9270	1.598550
Step : 1	17.355	-0.6787	1.343533
Step : 2	11.570	-0.5960	1.240897
Step : 3	8.677	-0.5546	1.185481
Step : 4	6.942	-0.5298	1.150793
Step : 5	5.785	-0.5132	1.127035
Step : 6	4.959	-0.5014	1.109745
Competitive Market	0.000	-0.4305	1.000000

For instance, for the combustible item, we have initially a PCO market structure, and where the market share of the oligopoly firms is 42.31 %. In the first step of the adjustment toward the competitive market, the market share is reduced, by the half, and then by two thirds and so on. Table 01 also shows the corresponding elasticities and prices.

Table 1.1 gives some descriptive statistics on the population and the expenditures

Table 1.2: Population and expenditures (in currency)

Groups	Population	Number of households	Household size	Total expenditures	Total expenditures per capita	Total expenditures per household
Quintile 1	24009490	4854708	4.95	18849142784	785.07	3882.65
Quintile 2	23958312	5402162	4.43	35458871296	1480.02	6563.83
Quintile 3	23982586	5894251	4.07	52534333440	2190.52	8912.81
Quintile 4	23986720	6734927	3.56	80423206912	3352.82	11941.21
Quintile 5	23969206	8784954	2.73	232294957056	9691.39	26442.37
Total	119906312	31671002	3.79	419560521728	3499.07	13247.47

Figure 01 gives more refined results similar to those of table 1.1:

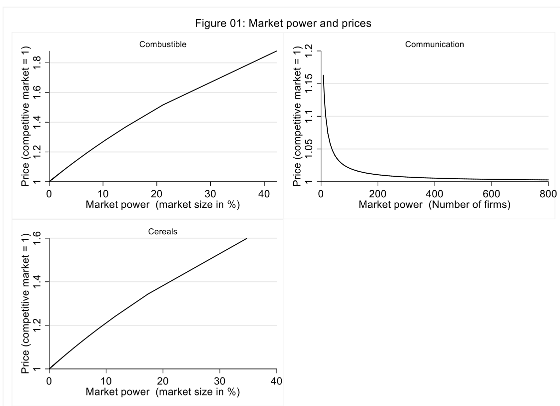


Table 5.1 gives the impacts on poverty headcount by item and by step.

Step 1

Table 5.1: Price changes and poverty headcount

Step	Poverty level	The change in poverty	Standard error	P-Value
Concentrated Market	53.352	.	.	.
Combustible	52.280	-1.072	0.101	0.000
Communication	53.195	-0.157	0.041	0.000
Cereals	52.566	-0.786	0.083	0.000
Competitive Market	51.377	-1.975	0.133	0.000

Notes:
[1] - Concentrated Market : Refers to the base line case (the case before price changes);
[2] - Item name : Refers to the case with only the price change of the item of interest;
[3] - Competitive Market : Refers to the case with price changes of all item(s).

Step 2

Table 5.1: Price changes and poverty headcount

Step	Poverty level	The change in poverty	Standard error	P-Value
Concentrated Market	53.352	.	.	.
Combustible	51.923	-1.429	0.114	0.000
Communication	53.075	-0.277	0.060	0.000
Cereals	52.273	-1.079	0.097	0.000
Competitive Market	50.633	-2.719	0.159	0.000

Notes:
[1] - Concentrated Market : Refers to the base line case (the case before price changes);
[2] - Item name : Refers to the case with only the price change of the item of interest;
[3] - Competitive Market : Refers to the case with price changes of all item(s).

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Competetive market

Table 5.1: Price changes and poverty headcount

Step	Poverty level	The change in poverty	Standard error	P-Value
Concentrated Market	53.352	.	.	.
Combustible	51.041	-2.311	0.147	0.000
Communication	52.749	-0.603	0.082	0.000
Cereals	51.557	-1.795	0.124	0.000
Competitive Market	48.938	-4.414	0.200	0.000

Notes:
[1] - Concentrated Market : Refers to the base line case (the case before price changes);
[2] - Item name : Refers to the case with only the price change of the item of interest;
[3] - Competitive Market : Refers to the case with price changes of all item(s).

For the poverty and inequality, the Figures 05 and 06 will show the partial impacts in a refined way.

Figure 06: Market power and inequality

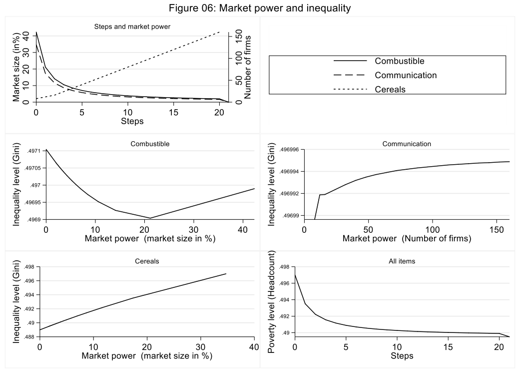
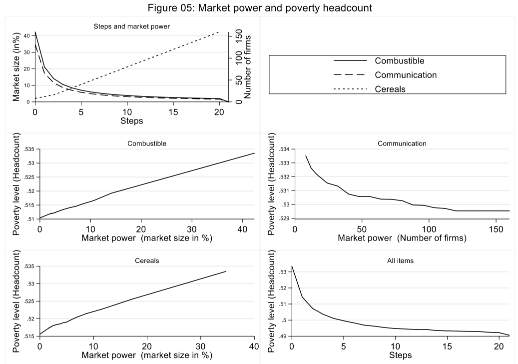


Figure 05: Market power and poverty headcount



Also, all of the tables are stored in an *.xml file that can be edited by Excel.

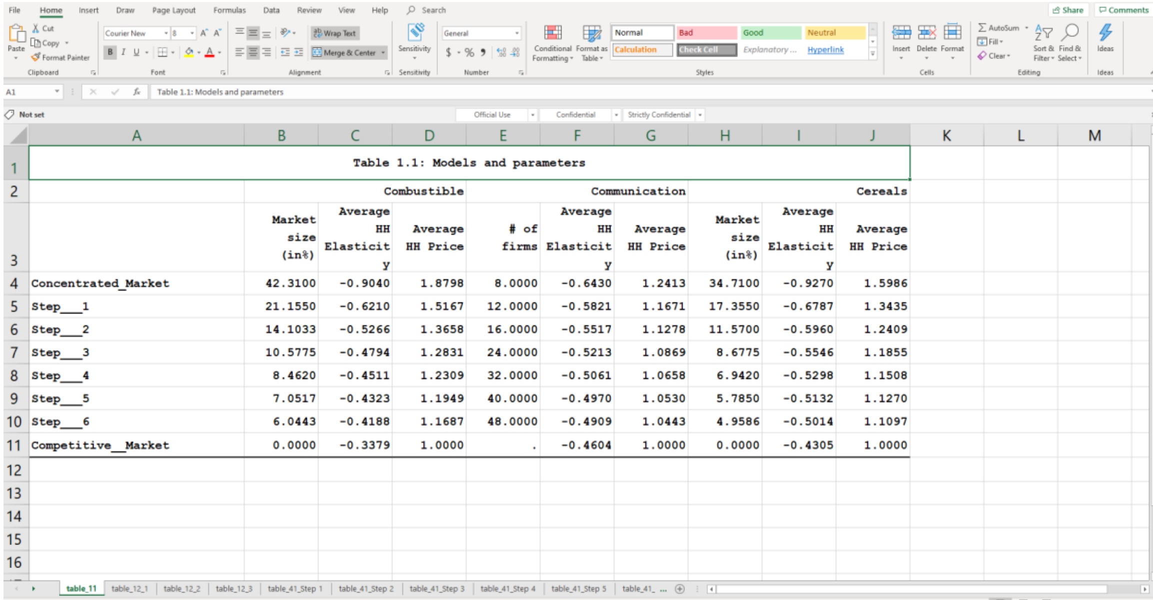


Table 1.1: Models and parameters

	Combustible			Communication			Cereals		
	Market size (in%)	Average HH Elasticity	Average HH Price	# of firms	Average HH Elasticity	Average HH Price	Market size (in%)	Average HH Elasticity	Average HH Price
Concentrated_Market	42.3100	-0.9040	1.8798	8.0000	-0.6430	1.2413	34.7100	-0.9270	1.5986
Step___1	21.1550	-0.6210	1.5167	12.0000	-0.5821	1.1671	17.3550	-0.6787	1.3435
Step___2	14.1033	-0.5266	1.3658	16.0000	-0.5517	1.1278	11.5700	-0.5960	1.2409
Step___3	10.5775	-0.4794	1.2831	24.0000	-0.5213	1.0869	8.6775	-0.5546	1.1855
Step___4	8.4620	-0.4511	1.2309	32.0000	-0.5061	1.0658	6.9420	-0.5298	1.1508
Step___5	7.0517	-0.4323	1.1949	40.0000	-0.4970	1.0530	5.7850	-0.5132	1.1270
Step___6	6.0443	-0.4188	1.1687	48.0000	-0.4909	1.0443	4.9586	-0.5014	1.1097
Competitive__Market	0.0000	-0.3379	1.0000	.	-0.4604	1.0000	0.0000	-0.4305	1.0000

4. WELCOM and demand system models

One of the most important determinants of market power is the consumers' response to changes in prices. Thus, information on price elasticities is essential to understand the impacts of market power on welfare. Empirical researchers have approached the issue of estimation of the demand and elasticities in applied contexts in different ways. This section focuses in providing a basic overview of homogeneous product demand estimation, and of the estimation of demand elasticities. In principle, the user could rely on available information from comparable empirical studies or estimate the required price elasticities using WELCOM. More precisely, an important contribution of the WELCOM package is to introduce the option to estimate demand system models and provide the user-friendly interface for such estimations. During the last decades, there has been a significant progress in developing flexible demand system models, as the AIDS/QUIDS or the EASI models.

Because of the specific details of each demand system model, it is helpful to start by introducing each of the available models and then discuss the options of the WELCOM Stata module to estimate them. The rest of this section will discuss three of these models: (i) Deaton's Unit Value Model, (ii) The Almost Ideal and Quadratic Almost Ideal Demand Systems (AIDS and QUAIDS, respectively), and (iii) the Exact Affine Stone Index (EASI).

4.1 Deaton's (1988) Unit Value Model

- *Deaton's theoretical model*

Estimating a demand system requires information on the household expenditures at different price levels. The price can vary spatially or temporally. However, it is not common to have accurate price-data. This scarcity of data justifies using a *unit value model*. For instance, in the case of large consumption groups with weak separability, Deaton (1988) proposed a model to estimate price and income elasticities using unit values, allowing the model to compensate for quality effects.

Following Deaton (1988), assume a main set of expenditures, where each of them is composed of a predetermined group of items. Then, let E_c denotes the household expenditures on the group of items c, such that:

$$E_c = p_c q_c \tag{4.1}$$

where p_c and q_c are vectors denoting the prices and the quantities of the group c. Within the group of commodities c, let λ_c denotes the proxy unique price of the commodities c, let v_c be the indicator of quality, and let Q_c represent the aggregate number of units (or items) in group c, then:

$$E_c = \lambda_c v_c Q_c \tag{4.2}$$

For the same level of expenditures E_c the aggregated quantity within the group c (given by Q_c)[19] will depend on the quality of purchased goods, v_c. More importantly, the estimated unit value $V_c = \frac{E_c}{Q_c} = \lambda_c \cdot v_c$ will depend on the product of proxy unique price (λ_c) and quality (v_c). Based on this model, the price elasticity is defined as follows:

$$e_c = \frac{\partial Q_c}{\partial \lambda_c} = \frac{\partial \ln Q_c}{\partial \ln V_c} \cdot \left(1 + \frac{\partial \ln v_c}{\partial \ln \lambda_c}\right) \tag{4.3}$$

In addition, Deaton (1988) proposes the adoption of the weak separable utility function with demands:

$$q_c = f_c\left(\frac{E_c}{\lambda_c}, p_c^*\right) \tag{4.4}$$

[19] Assume that the group c refers to the cereals and it is composed of two items maize and wheat, such that: $q_c = (2, 1)$; $p_c = (1, 1.2)$. Then, $Q_c = 2+1 = 3$; and, $E_c = 3.2$. Q_c refers to the sum of quantities (2kg + 1klg = 3kg in our example).

The consumer selects in the first stage the normalized—budget $\frac{E_c}{\lambda_c}$ that is allocated to the group c. After that, and depending on the vector of prevailed prices according to the quality (p_c^*), the consumer selects the levels of expenditure on the different items of the group c. In addition, the assumption of weak separability leads to:

$$\frac{\partial \ln v_c}{\partial \ln \lambda_c} = \frac{\frac{\partial \ln v_c}{\partial \ln x} \cdot \frac{\partial \ln Q_c}{\partial \ln \lambda_c}}{\frac{\partial \ln Q_c}{\partial \ln x}} \tag{4.5}$$

Where x denotes the total income/expenditure.

- *The empirical implementation and estimation*

We start with the case of the standard unit value model, where we assume that the quality effect is nil or can be neglected. As suggested by Deaton (1988), the simple model with the weak separability assumption is:

$$w_{c,i} = \alpha_0 + \beta_0 \cdot x_i + \gamma_0 \cdot z_i + \phi_0 \cdot \ln(V_{c,i}) + u_{0,i} \tag{4.6}$$

where:

$w_{c,i}$: Budget share of group c.

x_i : Total household income.

z_i : Household characteristics (e.g., household size, urban/rural, education of the head)

$V_{c,i}$: Unit value of group c.

Then, we have that:

$$\frac{\partial \ln Q_c}{\partial \ln V_c} = \frac{\frac{\partial \ln w_c}{\partial \ln V_c}}{w_c} - 1$$

$$e_c = \frac{\partial Q_c}{\partial \lambda_c} = \left(\frac{\frac{\partial \ln w_c}{\partial \ln V_c}}{w_c} - 1 \right) \cdot \left(1 + \frac{\partial \ln v_c}{\partial \ln \lambda_c} \right) \tag{4.7}$$

For the standard unit value model and assuming that the quality is uncorrelated with the price change (i.e., $\frac{\partial \ln v_c}{\partial \ln \lambda_c} = 0$), we have that:

$$\hat{e}_c = \left(\frac{\hat{\phi}_0}{\overline{w}_c} - 1\right) \tag{4.8}$$

In the case where $\frac{\partial \ln v_c}{\partial \ln \lambda_c}$ is not nil and assuming weak separability, we have that:

$$e_c = \frac{\boldsymbol{\partial Q_c}}{\boldsymbol{\partial \lambda_c}} = \left(\frac{\frac{\partial \ln w_c}{\partial \ln V_c}}{w_c} - 1\right)\left(1 + \frac{\frac{\partial \ln v_c}{\partial \ln x} \cdot \frac{\boldsymbol{\partial \ln Q_c}}{\boldsymbol{\partial \ln \lambda_c}}}{\frac{\partial \ln Q_c}{\partial \ln x}}\right) \tag{4.9}$$

Deaton (1988) recommends three steps to estimate the parameters and the elasticities:

Step 1: using a simultaneous equations model, estimate the components $\frac{\partial \ln v_c}{\partial \ln x}$ and $\frac{\partial \ln Q_c}{\partial \ln x}$:

$$w_{c,i} = \alpha_1 + \beta_1 \cdot x_i + \gamma_1 \cdot z_i + f_c + u_{1,i} \tag{4.10}$$

$$\ln\left(V_{c,i}\right) = \alpha_2 + \beta_2 \cdot x_i + \gamma_2 \cdot z_i + f_c + u_{2,i} \tag{4.11}$$

Where f_c is the fixed effect of group c.

Step 2: estimate the component $\frac{\partial \ln w_c}{\partial \ln V_c}$ using the average predicted values of $\widetilde{w}_{c,i}$ and $\tilde{V}_{c,i}$ at the cluster level using the following model:

$$\widetilde{w}_c = \alpha_3 + \phi_3 \cdot \ln\left(\tilde{V}_{c,i}\right) + u_3 \tag{4.12}$$

Notice that the standard errors in this second stage correspond to the errors from an OLS regression but corrected by the correlation between the first stage residuals. Deaton (1988) uses the correlation between the first stage residuals to estimate the severity of the measurement error. This is used to adjust the estimates and to correct for the structural correlation between quantity and unit value.

Step 3: solving equation (4.9) for the argument $\frac{\partial Q_c}{\partial \lambda_c}$.

4.2 AIDS & QUAIDS Demand System Models

- *The Almost Ideal Demand System theoretical model (AIDS)*

To present the AIDS model, we start by defining the PIGLOG model.[20] This model can be represented via an expenditure function $c(\mathbf{P}, U)$ that defines the minimum level of expenditure to reach a predetermined level of utility given prevailing prices:

$$\log(c(p,U)) = (1-U)\log(a(p)) + U\log(b(p)) \tag{4.14}$$

where U is the utility located between 0, the level of subsistence, and 1, the maximum total utility or "bliss" point. The function $a(p)$ is found through the TRANSLOG form:

$$\log(a(p)) = \alpha_0 + \sum_{i=1}^{K} \alpha_i \log(p_i) + \sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{i,j}^{*} \log(p_i)\log(p_j) \tag{4.15}$$

The component $b(p)$ is defined as :

$$\log(b(p)) = \log(a(p)) + \beta_0 \prod_{i=1}^{K} {p_i}^{\beta_i} \tag{4.16}$$

Thus, we find that:

$$\log(c(p,u)) = \alpha_0 + \sum_{i=1}^{K} \alpha_i \log(p_i) + \sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{i,j}^{*} \log(p_i)\log(p_j) + u\beta_0 \prod_{i=1}^{K} {p_i}^{\beta_i} \tag{4.17}$$

Using Shephard's Lemma ($\partial c(p,u)/\,\partial p_k = x_k$), the expenditure share on good i becomes:

$$w_i = \alpha_i + \sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{i,j} \log(p_j) + \beta_i u \beta_0 \prod_{i=1}^{K} {p_i}^{\beta_i} \tag{4.18}$$

and

$$\gamma_{i,j} = \frac{1}{2}\left(\gamma_{i,j}^{*} + \gamma_{j,i}^{*}\right) \tag{4.19}$$

Expenditure shares also simplify as:

$$w_i = \alpha_i + \sum_{j=1}^{K} \gamma_{i,j} \log(p_j) + \beta_i \log(m/a(p)) \tag{4.20}$$

where $a(p)$ can be perceived as a price index, such that:

$$\log(a(p)) = \alpha_0 + \sum_{i=1}^{K} \alpha_i \log(p_i) + \sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{i,j}^{*} \log(p_i)\log(p_j) \tag{4.21}$$

The additional conditions of the model are:

$$\begin{array}{lll} I: & \sum_{i=1}^{K} \alpha_k = 1 & \textit{Sum of expenditures shares is } 1 \\ II: & \sum_{i=1}^{K} \gamma_{i,j} = 0 \ \forall j \ \textit{ and } \ \sum_{i=1}^{K} \beta_i = 0 & \textit{Homogeneity of degree } 0 \textit{ of demand functions} \\ III: & \gamma_{i,j} = \gamma_{j,i} & \textit{Symmetry of the Slutsky matrix} \end{array} \tag{4.22}$$

[20] The PIGLOG is a demand system characterized by price independent generalized linearity where the expenditure enters linearly and as a log function.

- *The Quadratic Almost Ideal System theoretical model (QUAIDS)*

Banks Blundell and Lewbel (1997) have proposed the Quadratic Almost Ideal System (QUAIDS) model that adds the quadratic logarithmic income term to the AIDS specification of Deaton and Muellbauer (1980). This was proposed to take into account the potential quadratic form of the Engel curve behaviour for some durable and luxury goods. The specification is as follows:

$$w_i = \alpha_i + \sum_{j=1}^{K} \gamma_{i,j}\log(p_j) + \beta_i\log(m/a(p)) + \frac{\lambda_i}{b(p)}\log(m/a(p))^2 \quad (4.23)$$

The price index is given by:

$$\log(a(p)) = \alpha_0 + \sum_{i=1}^{K} \alpha_i\log(p_i) + \sum_{i=1}^{K}\sum_{j=1}^{K} \gamma_{i,j}^{*}\log(p_i)\log(p_j) \quad (4.24)$$

The price aggregator is given by:

$$b(p) = \prod_{i=1}^{K} p_i^{\beta_i} \quad (4.25)$$

The income and demand elasticities are defined as follows:

$$\begin{array}{lll} I: & e_i = \mu_i/w_i - 1 & \mathit{Income\ \ elasticity} \\ II: & e_{i,j}^{nc} = \mu_{i,j}/w_i - \delta_{i,j} & \mathit{Non\ \ compensated\ \ elasticity} \\ III: & e_{i,j}^{c} = \mu_{i,j}/w_i - e_i w_i & \mathit{Compensated\ \ elasticity} \end{array} \quad (4.26)$$

where:

$$\mu_i = \frac{\partial w_i}{\partial \log(m)} = \beta_i + 2\lambda_i \log\left(\frac{m}{a(p)}\right)$$

$$\mu_{i,j} = \frac{\partial w_i}{\partial \log(p_j)} = \gamma_{i,j} + \mu_i\left(\alpha_j + \sum_{k=1}^{K}\gamma_{k,j}\log(p_k)\right) - \frac{\lambda_i\beta_j}{b(p)}\left\{\log\left(\frac{m}{a(p)}\right)\right\}^2$$

Remark:

The Stata module for the estimation of the AIDS and the QAIDS models is already available and well developed by Brian Poi (2012).

- *Poi, Brian P., (2012), Easy demand-system estimation with quaids, Stata Journal, 12, issue 3, p. 433-446*

4.3 Exact Affine Stone Index (EASI)

- *The EASI theoretical model?*

Lewbel and Pendakur (2009) use the Shephard's lemma to approximate real income to deal with the empirical nonlinear form of the Engel curve and allow for a more flexible model. This linear approximation implies the use of the Stone price index (SPI), as in the case of the Linear Approximate Almost Ideal Demand System (LA/AIDS). Even with this restriction, the EASI model allows to use a higher order of the polynomial for the real income, which enables to better fit the Engel function. Formally, the approximated EASI model can be defined through the implicit Marshallian budget share as follow:

$$w_i = \sum_{r=1}^{o} b_r \tilde{y}^r + \sum_{j=1}^{K} a_k \log(p_k) + \sum_{k=1}^{K} b_k \log(p_k)\tilde{y} + \tilde{\varepsilon}$$

With the matrix format, one can write:

$$w_i = \sum_{r=1}^{o} b_r \tilde{y}^r + Ap + Bp\tilde{y} + \tilde{\varepsilon} \tag{4.27}$$

where $\tilde{y}$ denotes here the log of the approximated real income:

$$y \approx \tilde{y} = log(m) - \sum_{k=1}^{K} w_k \log(p_k).$$

The parameter o is the polynomial order of the real income and the parameter $\tilde{\varepsilon}$ is simply the error term of the estimation. For simplicity, and compared to the Lewbel and Pendakur (2009) presentation of the model, we omit the household characteristic determinants. Based on the Shephard's lemma and the cost function, Arthur and Pendakur (2009) show that the exact real income is equal to:

$$y = \frac{m - p\prime w + p\prime Ap}{1 - 0.5 * p\prime Bp} \tag{4.28}$$

Thus, the exact EASI model can be defined as follows:

$$w_i = \sum_{r=1}^{o} b_r \left(\frac{m - p\prime w + p\prime Ap}{1 - 0.5 * p\prime Bp}\right)^r + Ap + Bp\left(\frac{m - p\prime w + p\prime Ap}{1 - 0.5 * p\prime Bp}\right) + \varepsilon \tag{4.29}$$

As was the case for the AIDS or the QAIDS models, additional conditions are imposed:

$$\begin{array}{lll} I: & \sum_{i=1}^{K} a_{i,j} = 0\ \forall j \quad and \quad \sum_{i=1}^{K} b_i = 0 & Homogeneity\ of\ degree\ 0\ of\ demand\ functions \\ II: & a_{i,j} = a_{j,i} & Symmetry\ of\ the\ Slutsky\ matrix \end{array} \tag{4.30}$$

Among the recommended econometric methods to estimate the model is the nonlinear three stages least squares (3SLS). Let p_c denotes the vector of the log of prices after the change.

5. Demand estimation using WELCOM

This section of the user manual shows a step-by-step guide to the use of the three main models available in WELCOM to estimate demand and elasticities. Notice that each of these models have different data requirements and offers different levels of complexity. The system of demand discussed is the Deaton's Unit Value Model (DUVM), that requires a database with information on expenditure at the household level to estimate the demand and elasticities. In addition, WELCOM allows to estimate demand and elasticities using two popular systems of demand, AIDS and QUAIDS. In contrast with the DUVM model, these approaches not only require information on the expenditure share in each good category, but also need information on household incomes and price level by good category. Finally, a third alternative to estimate systems of demand using the EASI model is available. This method requires information on expenditure shares in good and services, household income, category prices and access to the statistical software R.

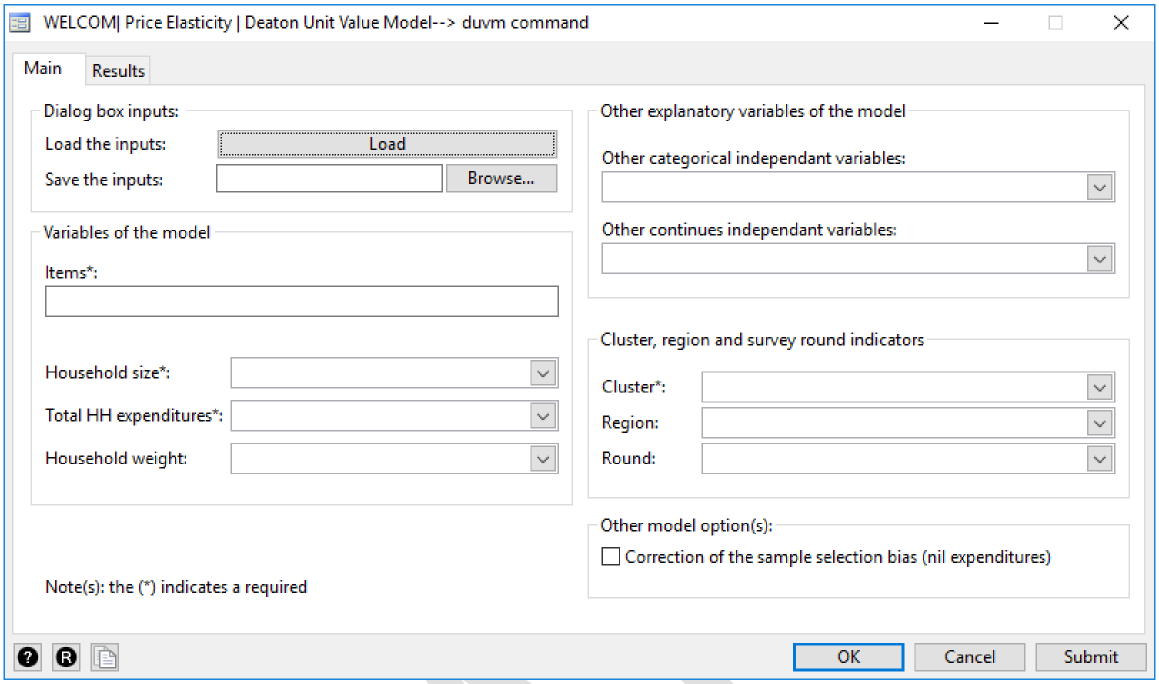
5.1 The DUVM Stata module

Deaton (1997) discusses whether the unit value data from household surveys was a reliable source of information to estimate the behavioral response of changes in prices. Deaton (1997) includes a detailed program for Stata (dofile) to estimate the unit value model. The WELCOM package starts from this program and updates it, to perform the estimation of the unit value models. Our main contribution was to update the Stata code to produce a concise Stata .ado file, which will be easier to implement for the practitioner. Among the improvements, we find:

1. Add the possibility of using sampling weights to consider the level of representativeness of each observation.
2. Allow for nil expenditures using the Heckman approach, or in short, the "inverse of Mills' ratio" (IMR) component in the estimation.
3. Producing elasticities for different population groups.
4. The use of a "dialog box", and the option of saving the information of the dialog box;
5. Exporting results in Excel format.

The following examples show how some of these contributions are used to estimate elasticities. The name of the new Stata command is **duvm**.

Figure 4.1: The DUVM dialog box



The DUVM module follows the basic syntax:

duvm **namelist, [options]**

The **namelist** should contain the names of items of expenditures. Note that the data must contain two variables for each item in the **namelist**. The name of the first variable is composed of the letter **w** (a reference of the share of weight of this item in the total budget or expenditure) followed by the name of the item. The name of second variable is composed of the word **luv** (as a reference of the logarithm of the "unit value") and the name of the item. For instance, if the name is of the item is *flour*, we must have the two variables: *wflour* and *luvflour*, which refers to the expenditure share and the log of the unit value of the flour item respectively. The options of the **duvm** command are (required in **bold**):

inisave To save the duvm dialog box information. Mainly, all-important information in the dialog box will be saved in this file. In another session, the user can open the project using the command duvm_db_ini followed by the name.

hhsize Household size.

expend Household expenditures.

hgroup Variable that captures a socio-demographic group. For example, this variable could equal 1 for rural households and 2 for urban ones.

indcat	List of independent variables that are categorical.
indcon	List of continuous independent variables.
cluster	The cluster is required in an intermediate step to estimate the derivative of the log(exp_share) with regards to the log(unit value).
region	The region area.
subround	Round of the surveyed household.
csb	Correction for Selection Bias. In the case of csb(1), for each item, the routine estimates the beforehand IML ratio based on the binary model (consumption is not nil), and then, it uses the IMR variable in models of the first stage.
hweight	Sampling weight of the variable.
boot	Number of replications to estimate the standard errors of the price elasticities.
xfil	Indicates the name of Excel file, which will be used to save the results (*.xml format).
dec	Indicates the number of decimals of the displayed results.
sname	Indicates the short names of items.
dregres	Display the regression results.

- *Examples of DUVM module*

The data

For the ENIGH Mexican data of 2014, we have four groups of expenditures on the ***cereal products***: *corn*, *wheat*, *rice* and *other_cereals*. The size of the full dataset is 19,477 observations/households. By using the data on expenditures and quantities, we can remark that:

- The household may or may not consume a part of the sub items, or even the item/group c;
- Each group (or item) c can be composed of a set of sub items (c, j);

CORN
A001 Grain corn
A002 Maize flour
A003 Mass of corn
A004 Corn tortilla
A005 Toast
A006 Other maize products

WHEAT
A007 Wheat flour
A008 Flour tortilla

A009 Pasta for soup
A010 Sweet cookies
A011 Crackers
A012 White bread: bolillo, telera, baguette, etc.
A013 Sweet bread in pieces
A014 Sweet bread packaged
A015 Bread for sandwich, hamburger, hot-dog and toasted
A016 Cakes and pastries in pieces or in bulk
A017 Packaged cakes and pastries
A018 Other Wheat Products

RICE
A019 Rice grain
A020 Other rice products

OTHER CEREALS
A021 Corn, wheat, rice, oat, granola, etc. cereal
A022 Botanas: fritters, popcorn, Cheetos, Doritos et cetera (except potatoes)
A023 Instant soups
A024 other cereals

For each group c, we need two pieces of information (for each household): (i) the unit value and (ii) the expenditure share. The household expenditure share is easy to be computed, and it ranges between 0 and 1. For the unit value, the Laspyers index is usually used.

$$V_{c,i} = \sum_{i=1}^{J_c} w_{c,j,i} V_{c,j,i} \tag{4.13}$$

In the case where the household does not consume any item of the group, we can attribute to this household the average unit value of the group *c* at the level of his cluster. This can be justified by the fact that the household will have the same consumption habits and prices of the other households living in the same cluster. In addition, for this example we exclude some observations where the expenditure share (relative to the current income) exceeds the 95%. After finishing working with the raw data, the data file (15866 observations) will contain the following variables, among others:

The variable	**The definition**
cluster	Primary sampling unit
hh_current_inc	Current income of the household
hhsize	Household size
sweight	sampling weight
sex	Sex of household head
age	Age of household head
psu	Primary sampling unit
education	Diploma of the household head

wcorn	expenditures share of corn
wwheat	expenditures share of wheat
wrice	expenditures share of rice
wother	expenditures share of the rest of cereals
luvcorn	log of the unit val of flour
luvwheat	log of the unit val of semolina
luvrice	log of the unit val of couscous
luvother	log of the unit val of pasta

For more information on the treatment of data, type the following Stata command:

view http://dasp.ecn.ulaval.ca/welcom/examples/ds/example_cereals_data.do

Example I-1

```
#delimit ;
use http://dasp.ecn.ulaval.ca/welcom/examples/ds/Mexico_2014_Cereals.dta , replace;
duvm corn wheat rice other,  hhsize(hhsize) expend(hh_current_inc) hweight(sweight) cluster(psu) region(rururb)
 inisave(ex1_duvm_db)  indcat(sex educ)  indcon(age)   xfil(myfile) dregres(1) hgroup(decile) boot(50) ;
```

After executing the line command, a series of results are displayed.

Part_1: Estimations of the first stage.

```
. #delimit ;
delimiter now ;
. use http://dasp.ecn.ulaval.ca/welcom/examples/ds/Mexico_2014_Cereals.dta , replace;

.  duvm corn wheat rice other,  hhsize(hhsize) expend(hh_current_inc) hweight(sweight) cluster(psu) region(rururk
>  inisave(ex1_duvm_db)  indcat(sex educ)  indcon(age)   xfil(myfile) dregres(1) hgroup(decile) boot(50) ;
(note: file ex1_duvm_db.duvm not found)
The cluster fixed effect regression(s)
```

	(1) luvcorn	(2) luvwheat	(3) luvrice	(4) luvother
Log of expenditures	0.0138***	0.00629**	-0.000234	0.0108***
Log of hhsize	-0.0637***	-0.0122***	-0.00508	-0.00581*
Age of head of hou~d	-0.000402***	-0.000169	-0.000333**	-0.0000884
sex==1	0.00646	-0.00431	0.00826*	-0.00239
educ==2	-0.0632	-0.000972	-0.0269	0.00988
educ==3	0.00283	0.00512	0.00733	-0.00158
educ==4	0.00459	-0.00343	0.00848	-0.00106
educ==5	0.000119	-0.0112	-0.0182	-0.00520
educ==6	0.0105	0.00276	-0.00335	-0.00702
educ==7	0.0208**	0.0113*	0.00496	-0.00373
Constant	2.725***	3.792***	2.725***	3.897***
Observations	15375	15340	13172	12166
R-squared	0.911	0.928	0.797	0.958

* p<0.05, ** p<0.01, *** p<0.001

The budget shares regression(s)

	(1) wcorn	(2) wwheat	(3) wrice	(4) wother
Log of expenditures	-0.0171***	-0.00797***	-0.000674***	0.000189***
Log of hhsize	0.0126***	0.00526***	0.000866***	0.000145**
Age of head of hou~d	0.0000642***	-0.0000181	0.00000121	-0.00000966***
sex==1	-0.000223	-0.000653*	-0.0000224	-0.0000792
educ==2	0.0149***	0.00905**	0.00106	-0.000679
educ==3	0.00259***	0.00246***	0.000190	0.0000395
educ==4	0.00203**	0.00379***	0.000228*	0.000242*
educ==5	0.00111	0.00443***	0.000561***	0.000227
educ==6	0.00239**	0.00480***	0.000144	0.000195
educ==7	-0.0000400	0.00407***	0.0000706	0.000262*
Constant	0.162***	0.0800***	0.00654***	-0.000619
Observations	15866	15866	15866	15866
R-squared	0.503	0.336	0.274	0.224

* p<0.05, ** p<0.01, *** p<0.001

Part_2: Average expenditure shares, income and quality elasticities.

Table 01: Average expenditures shares (in %)

	corn	wheat	rice	other
AV_share	2.317	1.497	0.153	0.100

Table 02: Expenditure elasticities

	corn	wheat	rice	other
Elasti~y	0.250	0.461	0.560	1.178

Table 03: Quality elasticities

	corn	wheat	rice	other
Elasti~y	0.014	0.006	-0.000	0.011

In this first example, the elasticity of quality is very low. This is explained by the nature of goods. For instance, the quality of the flour group cannot vary largely.

Part_3: Price elasticities.

Table 04: Price elasticities: without quality correction | without symmetry restricted estimators

	corn	wheat	rice	other
corn	-0.877	0.059	-0.019	-0.010
wheat	0.075	-0.813	0.178	0.016
rice	-0.111	0.089	-1.108	-0.095
other	0.110	0.126	-0.039	-0.720

Table 05: Price elasticities: without quality correction | with symmetry restricted estimators

	corn	wheat	rice	other
corn	-0.877	0.056	-0.013	-0.004
wheat	0.081	-0.809	0.069	0.014
rice	-0.203	0.676	-1.152	-0.101
other	-0.107	0.192	-0.156	-0.710

Table 06: Price elasticities: with quality correction | without symmetry restricted estimators

	corn	wheat	rice	other
corn	-0.869	0.059	-0.019	-0.010
wheat	0.073	-0.800	0.175	0.016
rice	-0.111	0.089	-1.108	-0.095
other	0.110	0.126	-0.039	-0.720

Table 07: Price elasticities: with quality correction | with symmetry restricted estimators

	corn	wheat	rice	other
corn	-0.869	0.055	-0.013	-0.004
wheat	0.080	-0.796	0.068	0.013
rice	-0.203	0.676	-1.152	-0.101
other	-0.107	0.192	-0.156	-0.710

Table 08: Standard errors: with the bootstrap method

	corn	wheat	rice	other
corn	0.003	0.003	0.020	0.048
wheat	0.002	0.004	0.021	0.034
rice	0.001	0.002	0.008	0.007
other	0.002	0.002	0.005	0.010

Treatment of hgroups : 1:2:3:4:5:6:7:8:9:10:

Table 09: Own Price Elasiticies by hgroups

	corn	STE	wheat	STE	rice	STE	other	STE
Decile_1	-0.708	0.012	-1.060	0.014	-1.830	0.054	-1.261	0.049
Decile_2	-0.953	0.007	-0.982	0.009	-1.351	0.029	-1.512	0.064
Decile_3	-0.882	0.007	-1.087	0.010	-1.131	0.026	-0.633	0.049
Decile_4	-0.987	0.007	-0.890	0.012	-1.076	0.034	-0.925	0.047
Decile_5	-1.040	0.006	-0.887	0.012	-1.317	0.024	-0.863	0.034
Decile_6	-0.936	0.006	-0.937	0.010	-1.384	0.027	-0.780	0.031
Decile_7	-0.984	0.006	-0.803	0.009	-1.163	0.029	-0.841	0.024
Decile_8	-0.964	0.006	-0.794	0.013	-0.866	0.029	-0.623	0.029
Decile_9	-1.016	0.006	-0.671	0.012	-1.409	0.032	-0.553	0.015
Decil~10	-0.751	0.009	-0.407	0.011	-0.756	0.040	-0.231	0.021

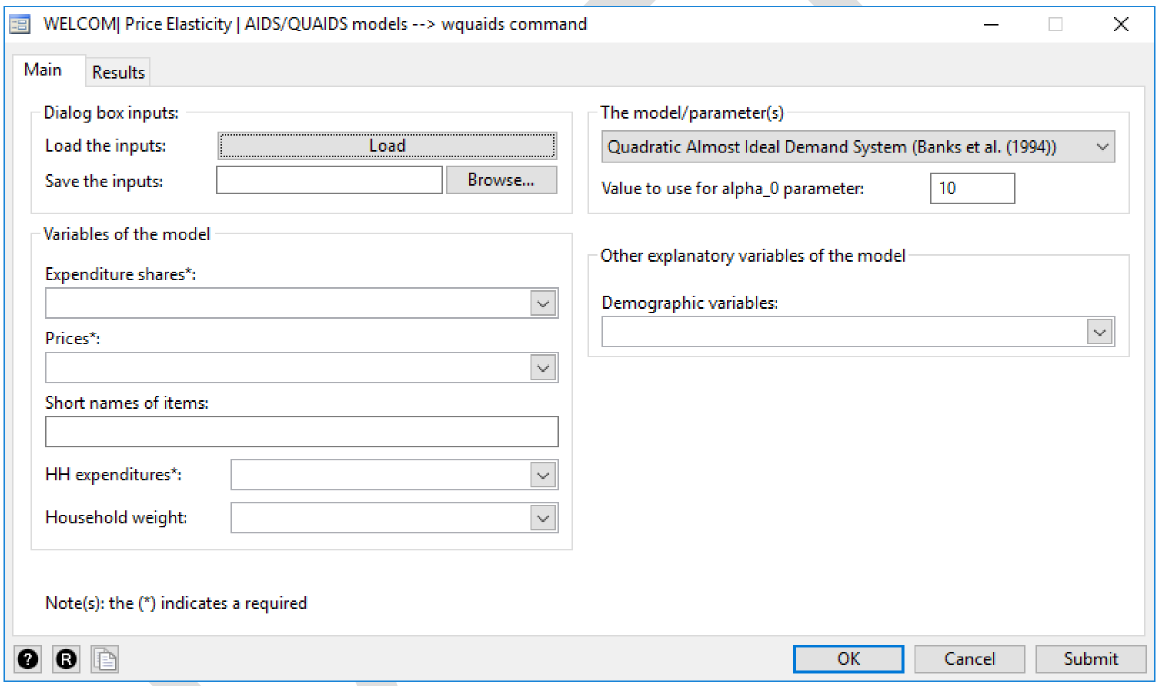
The price elasticity may vary largely across deciles. It is important to consider this empirical result to assess accurately the impact of price changes on the poor group.

5.2 The AIDS/QUAIDS Stata Module

The module **wquaids** uses implicitly the Brian Poi quaids Stata command (or its updated version wquaids), but including the following improvements:

1. Option to use the sampling weight to consider the level of representativeness of each observation;
2. Use of dialog box, saving the information of the dialog box;
3. Saving results in the Excel format;

Figure 4.2: the dialog box of the AIDS/QUAIDS models



- *Practical exercise: The QUAIDS model*

The data

We use the same data of the DUVM example (see the subsection 4.1). For simplicity, we consider unit values as the observed prices.

```
/* The Stata code  */

#delimit ;
use http://dasp.ecn.ulaval.ca/welcom/examples/ds/Mexico_2014_Cereals.dta , replace;
 wquaids wcorn wwheat wrice wother wcomp,
```

```
anot(9.5)
prices(pcorn pwheat price pother pcomp)
snames(Corn Wheat Rice Other_cereal Rest)
expend(hh_current_inc)
hweight(sweight)
model(1)
 inisave(ex1_quaids_db)
demographics(sex educa2- educa7 age)
dregres(1) dislas(0) xfil(myfil);
```

Remarks:

- The command *wquaids* is followed by the expenditure share variables. The variables *wcomp* is the expenditure share on the rest of items (outside the cereal products). The sum of the expenditure shares must be equal to one.
- The option anot() is the initial level of the parameter alpha_0 of the AIDS/QUAIDS model. It can be approximated to the log of the min(household income).
- The option model (1) is for the QUAIDS model. (2) is for the AIDS model.
- The option dislas (0) indicates that the results of the last item (complement or rest of items) will not be displayed.

The results:

QUAIDS MODEL	Standard DUV MODEL

Income elasticities

QUAIDS MODEL:

	Corn	Wheat	Rice	Other_ce~l
Elasticity	0.4455	0.6109	0.7575	1.4826

Standard DUV MODEL:

	corn	wheat	rice	other
Elasti~y	0.2405	0.4569	0.5480	1.1811

Uncompensated price elasticities

QUAIDS MODEL:

	Corn	Wheat	Rice	Other_ce~l
Corn	-0.9771	0.0451	-0.0136	-0.0022
Wheat	0.0682	-0.8793	0.0119	0.0010
Rice	-0.2254	0.1139	-1.2268	-0.1680
Other_cereal	-0.0803	-0.0023	-0.2364	-0.7818

Standard DUV MODEL:

	corn	wheat	rice	other
corn	-0.8699	0.0558	-0.0114	-0.0007
wheat	0.0810	-0.7955	0.0682	0.0123
rice	-0.1788	0.6667	-1.1300	-0.1058
other	-0.0390	0.1756	-0.1648	-0.7132

As we can remark, the two-demand system models give close estimates of the price elasticities.

5.3 Computational tools to estimate the EASI model

In what follow, we introduce briefly the different tools, which can be used to estimate the EASI model and the elasticities. Mainly, we suggest three tools:

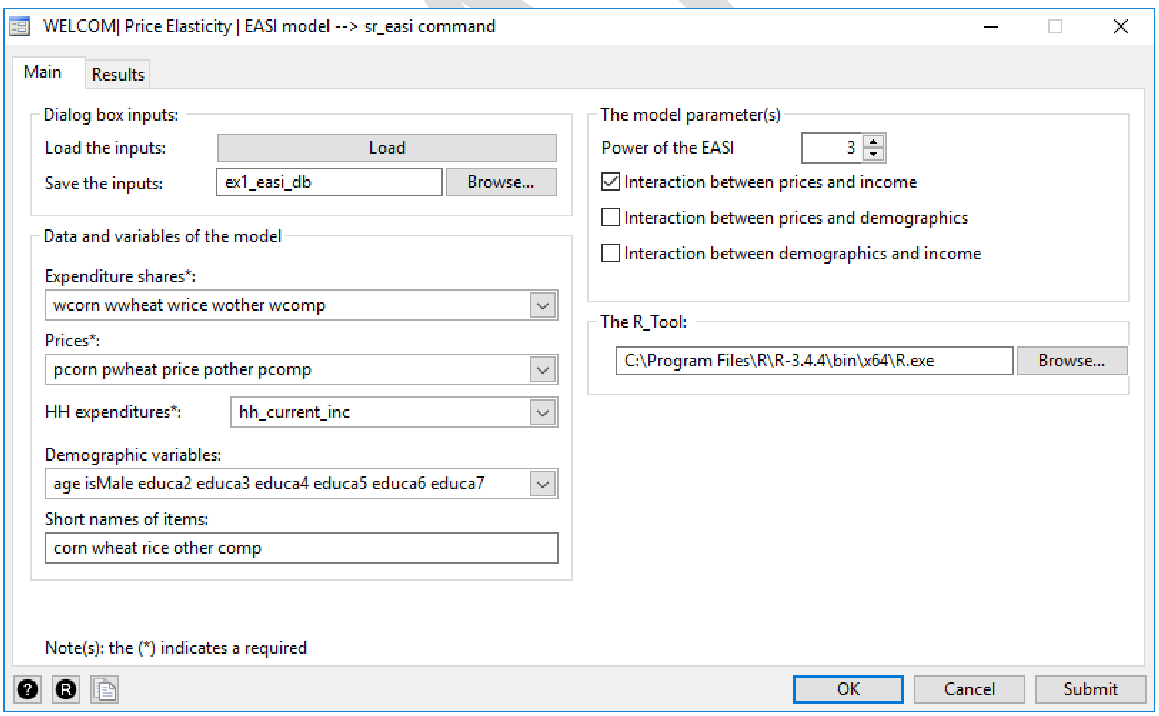
1- *A set of Stata do files*: **EASI demand system with no interactions** and **EASI demand system with interactions** (Lewbel, A. (2009)).

2- *Estimating EASI in R* (by Stephane Hoareau, Guy Lacroix, Mirella Hoareau, Luca Tiberti (2012)) easi-r.

3- *Estimating EASI in R with Stata*: the ***sr_easi*** Stata module (Araar, A. (2018)).

The first two tools may require more skill in Stata and R. The third, enables to estimate the EASI model in an easy way, but it uses intermediately the easi R package.

Figure 4.3: The dialog box of the sr_easi module



- *Practical exercise: The EASI model*

The data

This section uses the same data of the DUVM example (see the subsection 4.2). For simplicity, consider unit values as the observed prices. For this practical example, I simply use a random subsample of 8000 observations of *the Mexican national household survey of 2014* (INEGI-2014) to estimate the elasticities of the he cereal products (corn, wheat, rice and other cereals). Thus, we have four cereals variable shares in addition to the complement share of expenditures on the rest of goods. Further, for the comparison purpose, we will estimate the income and price elasticities using the DUVM and the QUAIDS models.

The Stata code

```
/****** THE DATA******************/
#delimit ;
use http://dasp.ecn.ulaval.ca/welcom/examples/ds/Mexico_2014_Cereals.dta , replace;
set seed 4321;
bsample 8000;

/****** THE DUVM MODEL******************/
duvm corn wheat rice other , hhsize(hhsize) expend(hh_current_inc)
cluster(psu) indcon(age isMale educa1-educa10 nocup1-nocup4)
csb(0) boot(0)  xfil(myres1);

/****** THE QUAIDS MODEL******************/
wquaids wcorn wwheat wrice wother wcomp, anot(6)
prices(pcorn pwheat price pother pcomp)
expenditure(hh_current_inc)
demographics(hhsize age isMale educa1-educa10 nocup1-nocup4)
snames(corn wheat rice other complement) dislas(0)  xfil(myres2) ;


/****** THE EASI MODEL******************/
sr_easi wcorn wwheat wrice wother wcomp,  prices(pcorn pwheat price pother pcomp)
snames(corn wheat rice other comp)
expenditure(hh_current_inc)
demographics(hhsize age isMale educa1-educa10 nocup1-nocup4)   dec(4) dregres(1) dislas(0)
inpy(0) inpz(0)   inzy(0)  power(5) xfil(myres3);
```

The results:

Income elasticities

	corn	wheat	rice	other
EASI	0.4375	0.5654	0.6920	1.2910
QUAIDS	0.3702	0.5042	0.6769	1.3472
DUVM	0.2763	0.4789	0.5607	1.2162

Price elasticities

	EASI			
	corn	**wheat**	**rice**	**other**
corn	-0.8993	0.0910	-0.1513	0.0199
wheat	0.0611	-0.9290	0.1263	0.0249
rice	-0.0041	0.0176	-1.2443	-0.1754
other	0.0078	0.0065	-0.1332	-0.7849
	QUAIDS			
	corn	**wheat**	**rice**	**other**
corn	-0.923	0.105	-0.009	0.029
wheat	0.166	-0.982	0.047	-0.028
rice	-0.155	0.464	-1.310	-0.152
other	0.606	-0.395	-0.213	-0.865
	DUVM			
	corn	**wheat**	**rice**	**other**
corn	-0.781	0.068	0.004	-0.001
wheat	0.106	-0.819	0.085	0.033
rice	0.055	0.844	-1.223	-0.147
other	-0.054	0.450	-0.206	-0.647

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Annex I

Reproducing main results from Example 1

```
/*  Basic information:
# We use the ENIGH Mexican data of 2014. Main variables
 - pcexp     : Per capita expenditures
 - pcexp_comu  : Per capita expenditures on communication
 - hhsize      : Number of household members
 - sweight     : Household Expansion Factor
 - pline       : Poverty line
 - elas1       : Price-elasticity (-0.904 for the communication item)
# Also, we assume a partial oligopoly market structure of communication, and
  where large collusive firms represent 42.31% of the total combustible market.

*/
version 14
cd "C:\Users\wb535806\OneDrive - WBG\RGO\WELCOME_V2\NEW_7_29\EXCEL"
#delimit ;
use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace;
mcwel pc_income, hsize(hhsize) pline(pline) gvimp(1)
inisave(mcwel_example_01) nitems(1)
it1( sn(Combustible) vn(pcexp_comb) el(-0.904) st(3) si(0.4231) )
move(-1) epsilon(.5)
opgr2( min(0) max(0.9) )
opgr3( min(0) max(0.9) )
xfil(myexample1)  folgr(Graphs) gjobs(off)
;

use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace
scalar theta        =  0.4231  // PCO Market size
scalar p_comp       =  1       // Normalized price at competitive market
scalar elas_pco     = -0.904

/****** TABLE 1.1 */
scalar p_pco        = 1/(1+(theta/(elas_pco))) // PCO price
dis _col(17) "The PCO price = " %9.4f p_pco

/* Proportion of increase in price the with the PCO market power */
scalar dp = p_pco - p_comp
```

```
/* The price elasticity in a competitive market */
scalar elas_comp  = elas_pco/(1+dp*(1-elas_pco))
dis _col(17) "The elasticity in  competitive markets = " %9.4f elas_comp

/*******TABLE 1.2 */
xtile Quintile = pc_income [aweight = sweight*hhsize], nquantiles(5) // generating the
quintile variable
lab def dnt 1 Quintle_1 2 Quintle_2 3 Quintle_3 4 Quintle_4 5 Quintle_5
lab val Quintile qnt
gen nhh = 1  // Number of households by observation
gen hh_income= pc_income* hhsize
table  Quintile  [pw=sweight]  ,  c(sum  hhsize  sum  nhh  mean  hhsize  mean  hh_income)
format(%20.2f)  row
table Quintile [pw=sweight*hhsize] , c(sum pc_income mean pc_income) format(%20.0f)  row

/*******TABLE 2.1 2.2 and 2.3 */
gen hhexp_comb= pcexp_comb* hhsize
table Quintile [pw=sweight*hhsize] , c( sum  pcexp_comb) format(%20.2f)  row
table Quintile [pw=sweight] ,        c( mean hhexp_comb) format(%20.2f)  row
table Quintile [pw=sweight*hhsize] , c( mean pcexp_comb) format(%20.2f)  row

/*******TABLE 3.1 3.2 and 3.3 */
gen nn_cons = (pcexp_comb>0)  // household with non nil expenditures on combustible
ratio  pcexp_comb/pcexp_comb  [iweight  =  sweight*  hhsize],over(Quintile)  cformat(%9.4f)
// Table 3.1
ratio  pcexp_comb/pc_income   [iweight  =  sweight*  hhsize],over(Quintile)  cformat(%9.4f)
// Table 3.2
mean nn_cons [aweight = sweight* hhsize]                , over(Quintile) cformat(%9.4f)
// Table 3.3

/*******TABLE 4.1 */
gen pc_impact = -1*(-dp*pcexp_comb) // From PCO to Comptitivetitive market
table Quintile [pw=sweight*hhsize] , c(sum   pc_impact   ) format(%20.0f)   row   // Table
4.1

/*******TABLE 4.2 */
gen size_times_pc_impact = hhsize *pc_impact
qui svy: ratio (size_times_pc_impact /hhsize) ,over(Quintile) cformat(%9.4f)        //
Table 4.2
matrix res =  r(table)'
matrix list res,  noheader  format(%10.2f)

/*******TABLE 4.3 */
```

```
ratio pc_impact/pc_income  [iweight = sweight* hhsize],over(Quintile) cformat(%9.4f)   // Table 4.3

/*******TABLE 4.4 */
qui  svy  linearized,  subpop(if  nn_cons==1)  :  ratio  (size_times_pc_impact/hhsize), over(Quintile)   // Table 4.4

*qui  svy  linearized,  subpop(if  nn_cons==1)  :  ratio  (size_times_pc_impact/hhsize), over(Quintile) fvwrap(1)   // Table 4.4
matrix res =  r(table)'
matrix list res,  noheader  format(%10.2f)

/*******TABLE 5.1 5.2 and 5.3 */
gen cp0_0 = hhsize*(pc_income<pline)*100
gen cp0_1 = hhsize*((pc_income + pc_impact) <pline)*100
gen dif0  =   cp0_1- cp0_0

gen cp1_0 = hhsize*max(0,((pline-pc_income)/pline)              )*100
gen cp1_1 = hhsize*max(0,((pline-(pc_income+pc_impact))/pline)  )*100
gen dif1  = cp1_1 - cp1_0

gen cp2_0 = hhsize*max(0,((pline-pc_income)/pline)            )^2*100
gen cp2_1 = hhsize*max(0,((pline-(pc_income+pc_impact))/pline))^2*100
gen dif2  = cp2_1 - cp2_0

qui svy: ratio (Headcount_0: cp0_0/hhsize)  (Headcount_1: cp0_1/hhsize) (DIF_Headcount: dif0/hhsize) , cformat(%9.2f)       // Table 5.1
matrix res =  r(table)'
qui  svy:  ratio  (PG_0:  cp1_0/hhsize)   (PG_1:  cp1_1/hhsize)  (DIF_PG:  dif1/hhsize)  , cformat(%9.2f)                            // Table 5.2
matrix res =  res\r(table)'
qui  svy:  ratio  (SPG_0:  cp2_0/hhsize)   (SPG_1:  cp2_1/hhsize)  (DIF_SPG:  dif2/hhsize)  , cformat(%9.2f)                         // Table 5.3
matrix res =  res\r(table)'
matrix list res,  noheader  format(%10.3f)

 /*******TABLE 6.1 : Inequality Gini Index   */
gen pc_income1 = pc_income+ pc_impact
/* With digini DASP command (can produce the p-val of the test of difference == 0 */
digini pc_income pc_income1 , hsize1(hhsize) test(0) hsize2(hhsize)

/* With the bocode Stata command fastgini (cannot produce the STE or the P-VAL) */
fastgini pc_income  [pw= sweight*hhsize ], nocheck
```

```
fastgini pc_income1 [pw= sweight*hhsize ], nocheck

/*******TABLE 6.2 : Inequality Atkinson Index */
scalar epsilon = 0.5
gen catk0 =  pc_income^(1-epsilon)
gen catk1 =  pc_income1^(1-epsilon)
qui mean   catk0  pc_income catk1 pc_income1 [iweight = sweight* hhsize]
dis "Atkinson_0 = "  %9.4f 1-((el(r(table),1,1))^(1/(1-epsilon)))/el(r(table),1,2)
dis "Atkinson_1 = "  %9.4f 1-((el(r(table),1,3))^(1/(1-epsilon)))/el(r(table),1,4)

/* With digini DASP command (can produce the p-val of the test of difference == 0 */
diatkinson pc_income pc_income1 , hsize1(hhsize) test(0) hsize2(hhsize)

/*******TABLE 6.3 : Generalized Entropy Index  */
qui mean    pc_income pc_income1 [iweight = sweight* hhsize]
scalar mu0 = el(r(table),1,1)
scalar mu1 = el(r(table),1,2)
gen double et0 =  log(mu0/pc_income)
gen double et1 =  log(mu1/pc_income1)
qui mean    et0 et1 [iweight = sweight* hhsize]
dis "Entropy_0 = "  %9.8f el(r(table),1,1)
dis "Entropy_1 = "  %9.8f el(r(table),1,2)

/* With digini DASP command (can produce the p-val of the test of difference == 0 */
dientropy pc_income pc_income1 , hsize1(hhsize) test(0) hsize2(hhsize) theta(0)

/*******TABLE 6.4 : Inequality Ratio Index  */
/* With digini DASP command (can produce the p-val of the test of difference == 0 */
dinineq pc_income pc_income1, hsize1(hhsize) p1(0.1) p2(0.9) hsize2(hhsize)
```

Annex II

Reproducing main results from Example 2

```
clear
cd "C:\Users\wb535806\OneDrive - WBG\RGO\WELCOME_V2\NEW_7_29\EXCEL"
version 14
use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace
mcwel pc_income, hsize(hhsize) pline(pline) gvimp(1) gvpc(0) inisave(mcwel_example_02)
nitems(3) mpart(6) gscen(0) ///
it1( sn(Combustible) vn(pcexp_comb) el(elas1) st(3) si(0.4231) ) ///
it2( sn(Communication) vn(pcexp_comu) el(elas2) st(2) nf(8) ) ///
```

```
it3( sn(Cereals) vn(pcexp_cereal) el(elas3) st(3) si(0.3471) ) ///
move(-1) epsilon(.5) opgr2( min(0) max(0.9) )opgr3( min(0) max(0.9) ) xfil(myexample2)
gjobs(off) folgr(Graphs) tjobs(11 41 42 43 44 51)

/*  Basic information:
# We use the ENIGH Mexican data of 2014. Main variables
 - pcexp          : Per capita expenditures
 - pcexp_comu     : Per capita expenditures on communication
 - pcexp_comb     : Per capita expenditures on combustible
 - pcexp_cereals  : Per capita expenditures on cereals

 - hhsize      : Number of household members
 - sweight     : Household Expansion Factor
 - pline       : Poverty line
 - elas1       : Price-elasticity (-0.9040 for the communication item)
 - elas2       : Price-elasticity (-0.6430 for the combutible item)
 - elas3       : Price-elasticity (-0.9270 for cereals item)
# Also, we assume:
1-  a partial oligopoly market structure of communication, and
    where large collusive firms represent 42.31% of the total communication market.
2-  a Nash equilibrium market struture of Combustible with 8 firms.
3-  a partial oligopoly market structure of cereals, and
    where large collusive firms represent 34.710% of the total combustible market.
# We assume a six gradual movings toward competitive markets
*/

clear
version 14
use http://dasp.ecn.ulaval.ca/welcom/examples/mc/Mexico_2014.dta , replace
scalar comb_theta_pco             = 0.4231  // PCO Market size
scalar commu_nfirm_nash            = 8        // Nash Market size (number of oligopoly
firms)
scalar cere_theta_pco             = 0.3471  // PCO Market size
scalar pri_comb_comp      =  1.000          // Normalized price at competitive market
scalar elas_comb_pco      = -0.904
scalar pri_comb_commu     =  1.000           // Normalized price at competitive market
scalar elas_commu_pco     = -0.6430
scalar pri_cere_comp      =  1.000           // Normalized price at competitive market
scalar elas_cere_pco      = -0.9270

forvalues i=1/6  {
if (`i' == 1)  dis as result "COMBUSTIBLE:"
if (`i' == 1)  {
```

```
    dis as text "Status : " _col(15) "Size"   _col(25) "Elasticity"   _col(35)"Price "
    scalar pri_comb                  =    1/(1+(comb_theta_pco/(elas_comb_pco))) // PCO
price
       scalar dp_comb = pri_comb  - 1
    scalar ela_comb               =    elas_comb_pco/(1+(pri_comb-1)*(1-elas_comb_pco))
       dis as text "Initial : " _col(10) %10.2f  comb_theta_pco*100    _col(20) %10.4f
elas_comb_pco  _col(30) %10.4f pri_comb
}
scalar comb_theta_step`i'                     =  comb_theta_pco/(`i'+1)  // PCO Market
size
scalar  ela_comb_step`i'                       =      ela_comb*(comb_theta_step`i'+1)-
comb_theta_step`i'
scalar pri_comb_step`i'                =    1+(1/(1+(comb_theta_step`i'/ela_comb_step`i'
))-1) // PCO price
dis  "STEP  `i'    :  "  _col(10)  %10.2f    comb_theta_step`i'*100      _col(20)  %10.4f
ela_comb_step`i'  _col(30) %10.4f pri_comb_step`i'
if (`i' == 6)  dis "Final    : " _col(10) %10.2f  0*100     _col(20) %10.4f  ela_comb
_col(30) %10.4f  1
}

forvalues i=1/6  {
scalar etas =  (elas_commu_pco*commu_nfirm_nash+1)/(commu_nfirm_nash+1)
if (`i' == 1)  dis as result "COMMUNICATION:"
if (`i' == 1)  {
    dis as text "Status : " _col(15) "# firms"    _col(25) "Elasticity" _col(35) "Price
"
       scalar    ela_commu                                                           =
(elas_commu_pco*commu_nfirm_nash+1)/(commu_nfirm_nash+1)
    scalar pri_commu                =    1-1/(1+(commu_nfirm_nash*elas_commu_pco))
       scalar dp_commu = pri_commu  - 1
       dis  as  text  "Initial  :  "  _col(10)  %10.4f   commu_nfirm_nash   _col(20)  %10.4f
elas_commu_pco   _col(30) %10.4f pri_commu
}
           scalar commu_nfirm_step`i'        =  commu_nfirm_nash*`i'
if `i' == 1 scalar commu_nfirm_step`i'        =  commu_nfirm_nash*1.5
scalar  ela_commu_step`i'                        =      (etas*(commu_nfirm_step`i'+1)-
1)/(commu_nfirm_step`i')
scalar pri_commu_step`i'            =    1-1/(1+(commu_nfirm_step`i'*ela_commu_step`i'))
dis "STEP `i'  : " _col(10) %10.4f commu_nfirm_step`i'  _col(20) %10.4f  ela_commu_step`i'
_col(30) %10.4f pri_commu_step`i'
if (`i' == 6)  dis "Final    : " _col(14) %10.4f  "Infini."     _col(20) %10.4f  etas
_col(30) %10.4f  1
}

forvalues i=1/6  {
```

```
if (`i' == 1)  dis as result "CEREALS:"
if (`i' == 1)  {
    dis as text "Status : " _col(15) "Size"   _col(25) "Elasticity"   _col(35)"Price "
    scalar pri_cere                  =    1/(1+(cere_theta_pco/(elas_cere_pco))) // PCO
price
       scalar dp_cere = pri_cere  - 1
    scalar ela_cere                =    elas_cere_pco/(1+(pri_cere-1)*(1-elas_cere_pco))
       dis as text "Initial : " _col(10) %10.2f  cere_theta_pco*100    _col(20) %10.4f
elas_cere_pco  _col(30) %10.4f pri_cere
}
scalar cere_theta_step`i'                      =  cere_theta_pco/(`i'+1)  // PCO Market
size
scalar  ela_cere_step`i'                        =      ela_cere*(cere_theta_step`i'+1)-
cere_theta_step`i'
scalar pri_cere_step`i'                =    1+(1/(1+(cere_theta_step`i'/ela_cere_step`i'
))-1) // PCO price
dis  "STEP  `i'    :  "  _col(10)  %10.2f    cere_theta_step`i'*100      _col(20)  %10.4f
ela_cere_step`i'  _col(30) %10.4f pri_cere_step`i'
if (`i' == 6)  dis "Final    : " _col(10) %10.2f   0*100     _col(20) %10.4f   ela_cere
_col(30) %10.4f  1
}

/*******TABLE 1.3 */
xtile Quintile = pc_income [aweight = sweight*hhsize], nquantiles(5) // generating the
quintile variable
lab def dnt 1 Quintle_1 2 Quintle_2 3 Quintle_3 4 Quintle_4 5 Quintle_5
lab val Quintile qnt
cap drop nhh
gen nhh = 1  // Number of households by observation
cap drop hh_income
gen hh_income= pc_income* hhsize
table  Quintile  [pw=sweight]  ,  c(sum  hhsize  sum  nhh  mean  hhsize  mean  hh_income)
format(%20.2f)  row
table Quintile [pw=sweight*hhsize] , c(sum pc_income mean pc_income) format(%20.0f)  row

/*******TABLE 2.1 2.2 and 2.3 */
cap drop hhexp_comb
gen hhexp_comb =  pcexp_comb* hhsize
cap drop hhexp_comu
gen hhexp_comu = pcexp_comu* hhsize
cap drop hhexp_cere
gen hhexp_cere = pcexp_cereal* hhsize
```

```
table Quintile [pw=sweight*hhsize] , c( sum  pcexp_comb sum  pcexp_comu sum  pcexp_cereal)
format(%20.2f)  row
table Quintile [pw=sweight] ,       c( mean hhexp_comb mean hhexp_comu  mean  hhexp_cere)
format(%20.2f)    row
table  Quintile  [pw=sweight*hhsize]  ,  c(  mean  pcexp_comb  mean    pcexp_comu  mean
pcexp_cereal) format(%20.2f)  row

/*******TABLE 3.1 3.2 and 3.3 */
cap drop pc_exp3item
gen  pc_exp3item = pcexp_comb + pcexp_comu + pcexp_cereal
cap drop nn_cons1
gen nn_cons1 = (pcexp_comb>0)      // household with non nil expenditures on combustible
cap drop nn_cons2
gen nn_cons2 = (pcexp_comu>0)     // household with non nil expenditures on communication
cap drop nn_cons3
gen nn_cons3 = (pcexp_cereal>0)    // household with non nil expenditures on cerealrs
cap drop nn_cons_all
gen nn_cons_all = (pc_exp3item>0)  // household with non nil expenditures on at least one
item
qui     ratio               (pcexp_comb/pc_exp3item)          (pcexp_comu/pc_exp3item)
(pcexp_cereal/pc_exp3item)    ///
          (pc_exp3item/pc_exp3item)      [pweight  =  sweight*  hhsize],  over(Quintile)
cformat(%9.4f)
capture matrix drop tmp
matrix tmp = e(b)
matrix aa = tmp[1..1,1..5]\tmp[1..1,6..10]\tmp[1..1,11..15]\tmp[1..1,16..20]
matrix rownames aa = COMBUSTIBLE COMMUNICATION CEREALS All_ITEMS
matrix colnames aa = Q1 Q2 Q3 Q4 Q5
matrix aa = aa'*100
matrix list aa, format(%9.2f)    // Table 3.1

qui ratio    (pcexp_comb/pc_income)   (pcexp_comu/pc_income)    (pcexp_cereal/pc_income)
///
          (pc_exp3item/pc_income)       [pweight  =  sweight*  hhsize],  over(Quintile)
cformat(%9.4f)
capture matrix drop tmp
matrix tmp = e(b)
matrix aa  = tmp[1..1,1..5]\tmp[1..1,6..10]\tmp[1..1,11..15]\tmp[1..1,16..20]
matrix rownames aa = COMBUSTIBLE COMMUNICATION CEREALS All_ITEMS
matrix colnames aa = Q1 Q2 Q3 Q4 Q5
matrix aa = aa'*100
matrix list aa, format(%9.2f)  // Table 3.2

qui mean   nn_cons1  nn_cons2  nn_cons3 nn_cons_all   ///
```

```
   [pweight = sweight* hhsize], over(Quintile) cformat(%9.4f)
capture matrix drop tmp
matrix tmp = e(b)
matrix aa  = tmp[1..1,1..5]\tmp[1..1,6..10]\tmp[1..1,11..15]\tmp[1..1,16..20]
matrix rownames aa = COMBUSTIBLE COMMUNICATION CEREALS All_ITEMS
matrix colnames aa = Q1 Q2 Q3 Q4 Q5
matrix aa = aa'*100
matrix list aa, format(%9.2f)  // Table 3.3

/* For the rest, we focus on the final step */

/*******TABLE 4.1 */
cap drop pc_impact_comb
gen pc_impact_comb = -1*(-dp_comb*pcexp_comb)  // From PCO to Comptitivetitive market
cap drop  pc_impact_comm
gen pc_impact_comm = -1*(-dp_commu*pcexp_comu) // From PCO to Comptitivetitive market
cap drop  pc_impact_cere
gen pc_impact_cere = -1*(-dp_cere*pcexp_cereal) // From PCO to Comptitivetitive market
cap drop  pc_impact_all
gen pc_impact_all = pc_impact_comb+pc_impact_comm +pc_impact_cere

table  Quintile  [pw=sweight*hhsize]  ,  c(sum   pc_impact_comb  sum  pc_impact_comm  sum
pc_impact_cere sum pc_impact_all  ) format(%20.0f)  row  // Table 4.1



/*******TABLE 4.2 */

table  Quintile  [pw=sweight*hhsize]  ,  c(mean   pc_impact_comb  mean  pc_impact_comm  mean
pc_impact_cere mean pc_impact_all  ) format(%10.2f)  row  // Table 4.1

/*******TABLE 4.3 */

qui     ratio              (pc_impact_comb/pc_income)         (pc_impact_comm/pc_income)
(pc_impact_cere/pc_income)   ///
          (pc_impact_all/pc_income)    [pweight   =   sweight*   hhsize],   over(Quintile)
cformat(%9.4f)
capture matrix drop tmp
matrix tmp = e(b)
matrix aa  = tmp[1..1,1..5]\tmp[1..1,6..10]\tmp[1..1,11..15]\tmp[1..1,16..20]
matrix rownames aa = COMBUSTIBLE COMMUNICATION CEREALS All_ITEMS
matrix colnames aa = Q1 Q2 Q3 Q4 Q5
matrix aa = aa'*100
matrix list aa, format(%9.2f)  // Table 4.3
```

```
/*******TABLE 4.4 */

qui  mean     (pc_impact_comb)     [pweight  =  sweight*  hhsize]  if  pc_impact_comb>0,
over(Quintile)
capture matrix drop tmp
matrix tmp = e(b)
matrix aa =  tmp[1..1,1..5]
qui  mean     (pc_impact_comm)     [pweight  =  sweight*  hhsize]  if  pc_impact_comm>0,
over(Quintile)
matrix tmp = e(b)
matrix tmp =  tmp[1..1,1..5]
matrix aa = aa\tmp
qui  mean     (pc_impact_cere)     [pweight  =  sweight*  hhsize]  if  pc_impact_cere>0,
over(Quintile)
matrix tmp = e(b)
matrix tmp =  tmp[1..1,1..5]
matrix aa = aa\tmp
qui  mean     (pc_impact_all)       [pweight  =  sweight*  hhsize]  if  pc_impact_all>0,
over(Quintile)
matrix tmp = e(b)
matrix tmp =  tmp[1..1,1..5]
matrix aa = aa\tmp
matrix rownames aa = COMBUSTIBLE COMMUNICATION CEREALS All_ITEMS
matrix colnames aa = Q1 Q2 Q3 Q4 Q5
matrix aa = aa'
matrix list aa, format(%9.2f)  // Table 4.4
```