DIW BERLIN

100

DIW Roundup

Politik im Fokus

Deutsches Institut für Wirtschaftsforschung 2016

CGE-Based Methods to Measure the Impact of Trade Liberalization on Poverty

Isabel Teichmann

CGE-Based Methods to Measure the Impact of Trade Liberalization on Poverty

Isabel Teichmann | iteichmann@diw.de | Department of Energy, Transportation, Environment at DIW Berlin
28 July, 2016

It is heavily discussed whether trade liberalization is good or bad for the poor in a given (developing) country. The answer depends on a wide variety of factors, such as the type of trade barrier removed, the economic and institutional environment in the country, and the characteristics of the poor in that country (Winters 2002; Winters et al. 2004). In addition, the results can also be driven by the specific method used to measure the impact of the trade-policy reform on poverty. For an informed discussion, it is, therefore, important to understand the corresponding empirical methods at hand.

Most generally, empirical studies on trade impacts can be divided into *ex-post* and *ex-ante* analyses. Whereas *ex-post* studies focus on the effects of trade policies that have already been implemented, *ex-ante* analyses simulate the effects of potential future (and actual) trade policies (Piermartini and Teh 2005). In other words, *ex-post* studies have both pre- and post-reform data at their disposal, while *ex-ante* studies rely exclusively on pre-liberalization data. *Ex-post* analyses have the advantage of being grounded on real-world observations; however, their difficulty lies in applying appropriate statistical methods to separate the impact of a given trade-policy reform from any other shock affecting the economy in the observation period (Hertel and Reimer 2005; Piermartini and Teh 2005). This identification problem is absent in *ex-ante* studies, conducting counterfactual analyses, as they allow to explicitly and exclusively simulate the trade-policy shock (Hertel and Reimer 2005). However, simulation studies encounter yet other challenges, namely to verify the assumptions concerning the model specification (e.g., parameters and functional forms) and, thus, to ensure the quality of the results (Piermartini and Teh 2005; Winters et al. 2004). Their strength, in turn, is to reveal possible orders of magnitude of a policy impact, to identify relative winners and losers, and to give insights into the quantitative importance of the mechanisms behind the effects of a given trade-policy reform on poverty (Winters 2003; Winters et al. 2004; Bourguignon et al. 1991).

While examples of *ex-post* methods to analyze the effects of trade liberalization on poverty can be found in Winters et al. (2004), this Roundup gives an overview of some basic *ex-ante* methods available to quantify and evaluate the impact of a trade-policy reform – or, more generally, a macro-economic shock – on the distribution of household income for poverty (and inequality) analysis, i.e. on the micro-economic level. The methods considered here center all around so-called computable general equilibrium (CGE) models. On the one hand, they include the standard CGE approach with (one or) several representative households; on the other hand, they cover macro-micro simulations, subdivided into the top-down approach, the top-down/bottom-up approach, and the integrated approach. For each method, the Roundup provides a brief description, some applications, and a critical assessment.

CGE Models with Representative Household Groups

At an aggregate level, CGE models cover all relevant agents and markets in an economy and respect general-equilibrium conditions. Therefore, they are the natural starting point to analyze macro-economic shocks expected to have economy-wide impacts, such as large-scale trade reforms. However, CGE models usually rely on national-accounts data and representative agents for firm and household behavior. Thus, they lack detail and disaggregation at the micro level. This holds even if they include not just one, but several representative households – such as rural versus urban, wage-earning versus self-employed, skilled versus unskilled households or any other household classification according to socio-economic characteristics.

When standard, representative-household CGE models are applied for poverty analyses of macro-economic shocks – as, e.g., in Adelman and Robinson (1978), de Melo and Robinson (1980), Derviş et al. (1982), de Janvry et al. (1991), Thorbecke (1991), Morrisson (1991), Chia et al. (1994), Dorosh and Sahn (2000), Stifel and Thorbecke (2003), Decaluwé et al. (2005), Zhai and Hertel (2006), Cororaton et al. (2006), and Annabi et al. (2006) –, the poverty impacts are inferred from changes in the average income of the representative household group(s) generated by the CGE model. Thereby, it is often assumed that the income distribution within each household group follows an exogenously given distribution function – such as the lognormal distribution (e.g., Adelman and Robinson 1978; de Melo and Robinson 1980; Derviş et al. 1982; de Janvry et al. 1991; Chia et al. 1994) or the beta distribution (e.g., Stifel and Thorbecke 2003; Decaluwé et al. 2005) –, the parameters of which are estimated from a corresponding household survey. Alternatively, no functional form is specified, but the actual base-year distribution of income within a given group is used (e.g., Cororaton et al. 2006; Annabi et al. 2006). The income of each household in a group is then assumed to change proportionally to the income of the representative household of that group (implying distributional neutrality) or to shift by the same absolute amount (changing intra-group inequality) (cf. Stifel and Thorbecke 2003). No matter which assumption is chosen, however, the counter-factual poverty analysis eventually relies on variations in the incomes *between* representative household groups (Derviş et al. 1982; Bourguignon et al. 2005).

Thus, while the representative-households approach is straightforward and easy to implement, its main drawback is the virtual neglect of potential policy-induced intra-group income variations (Savard 2003; Bourguignon et al. 2005). Usually, all but the first moment of the distribution are assumed to be independent of the shock (cf. de Melo and Robinson 1980; Derviş et al. 1982; Chia et al. 1994). Thus, within-group household heterogeneity is not fully taken into account – despite its empirical importance even within highly disaggregated household groups (cf. Cororaton and Cockburn 2007; Bourguignon et al. 2005) and its relevance in the links between trade and poverty (cf. Winters 2002). Moreover, any change in the intra-group income distributions being based on an exogenous distribution function means that it is guided by a statistical relation rather than by economic behavior of households, in particular, of those around the poverty line (Savard 2003). Finally, the results will crucially hinge on the precise household classifications and, thus, the degree of within-group homogeneity achieved (e.g., de Maio et al. 1999), as well as on the proper choice of the distribution function (cf. Boccanfuso et al. 2008).

Macro-Micro Simulations

To overcome the shortcomings of the standard CGE approach for poverty analysis, macro-micro simulations combine the representative-household CGE model with disaggregated household-survey data to simulate the impact of a trade-policy shock on the entire distribution of household income (or expenditure) rather than just on the average income of one or several representative household groups. Thereby, the CGE model can be linked to the household-survey data with the help of a top-down approach, a top-down/bottom-up approach, or an integrated approach. The first two approaches are sequential in character. They use different ways to couple the CGE model with a so-called household micro-simulation model, which can range from a non-behavioral household income generation model to a micro-econometric model of household behavior with respect to, e.g., consumption, production, or labor supply (cf. Hérault 2010; Bourguignon et al. 2005). Basically, the CGE model delivers trade-policy-induced changes in prices and other macro variables. These are then used by the micro-simulation model to generate the counterfactual household data entering poverty analysis. The integrated approach, in turn, is characterized by the direct inclusion of disaggregated household-survey data into the CGE model and its underlying social accounting matrix (SAM). That is, unlike a CGE model with several representative household groups, the CGE model in the integrated approach models *each* household from a given survey.

The top-down and top-down/bottom-up approaches can be regarded as extensions of pure micro-simulation analyses, which are solely based on micro data, e.g., on micro-econometric household models. More generally, "[m]icrosimulation models use micro-data on persons (or households, or firms or other micro-units) and simulate the effect of changes in policy (or other changes) on each of these units" (Mitton et al. 2000: 1). Micro-simulation was originated by Orcutt (1957) and Orcutt et al. (1961). It has been used in *ex-post* studies to decompose observed changes in the distribution of income (e.g., Bourguignon et al. 2001; Alatas and Bourguignon 2005). Likewise, the estimated household model can be used for *ex-ante* policy simulations, as in Ravallion and van de Walle (1991).

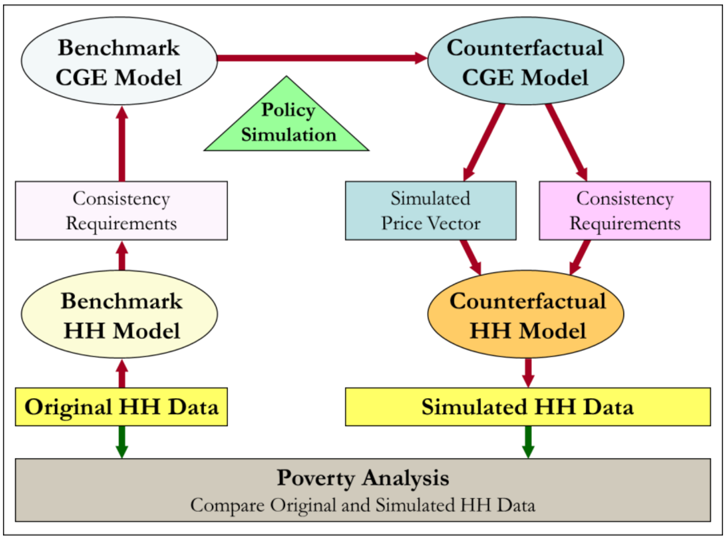
Another method of macro-micro simulation not covered by this overview is the bottom-up approach (cf. Cockburn et al. 2014). It can be used when analyzing micro-level (rather than macro-level) shocks, such as income-tax, pension or social-benefit reforms, on macro-economic (rather than micro-economic) outcomes, like gross domestic product. In this sequential approach, the micro-simulation model is first used to generate changes in micro-economic behavior, such as labor supply. Then, these changes are fed into the CGE model to compute the macro-economic changes. An example includes Boeters et al. (2005) on social-benefit reforms in Germany.

Top-Down Approach

The first sequential macro-micro-simulation method is the top-down approach, also called 'sequential micro-simulation approach' (Savard 2003: 4), 'CGE micro-simulation sequential approach' (Boccanfuso et al. 2008: 151), 'layered approach' (Davies 2009: 53), or 'macro-to-micro modeling strategy' (Hertel et al. 2015: 6). Applications of this approach include, for example, Bourguignon et al. (2005), Vos and de Jong (2003), King and Handa (2003), Chen and Ravallion (2004), Robilliard and Robinson (2006), Arndt (2006), Nicita (2006), Bussolo et al. (2006; 2008), Ivanic (2006), Hérault (2006), Boccanfuso and Savard (2007), Aredo et al. (2012), and Obeng (2015). The first to focus on a behavioral micro model (see above) were Bourguignon et al. (2005). The following description is based on the behavioral approach. For more details on the non-behavioral (or micro-accounting) method, see Hérault (2010) and Cockburn et al. (2014).

In the top-down macro-micro simulation, the CGE model is connected to the micro-simulation model in a two-step procedure running in one direction from the macro to the micro level (Bourguignon et al. 2005; Savard 2003; Figure 1). In the first step, the CGE model simulates the impact of the trade reform on commodity prices, factor prices, and any other relevant macro variables. In the second step, these changes are transmitted to the estimated micro-simulation model to analyze the effects of the macro-economic policy measure on the household level. The output of the micro model, i.e. the simulated post-reform household income or expenditure data, can then be used to perform counterfactual poverty analysis by comparing it to the original, pre-reform household data.

Figure 1: Top-Down Approach



Source: Own illustration based on Bourguignon et al. (2005).

Notes: CGE = Computable General Equilibrium; HH = Household

The reliability of the simulation outcome crucially hinges on the linkage between the macro and micro models and their corresponding data bases (cf. Bourguignon et al. 2005; Savard 2003). A precondition for properly replacing the original price vector in the micro model by the simulated price vector from the CGE model is that both models contain the same sector aggregation, production factors, skill levels, labor-market segments, etc. Moreover, the household behavior from the micro model should be at least partly reflected in the CGE model. For example, both models should use the same demand system or cover similar properties of the labor market, such as the possibility of involuntary unemployment (see, e.g., Savard 2003). Likewise, the behavioral variables introduced in the micro model – i.e. all dependent variables other than accounting identities or defining equations, such as total household income – should also be found in the CGE model, even if at different aggregation levels. Consistency then requires that the behavioral variables in the micro model – once they are aggregated over all households – equal the corresponding aggregates in the CGE model, both in the benchmark and the counterfactual models (Bourguignon et al. 2005). In particular, this means that the counterfactual household model needs to incorporate the changes in the aggregate behavioral variables as derived from the counterfactual CGE model, such as aggregate employment, aggregate wage income, or aggregate self-employment income. As demonstrated by Bourguignon et al. (2005), these post-simulation consistency requirements can be incorporated via adjustments in the estimated coefficients (e.g., constants) of the household model.

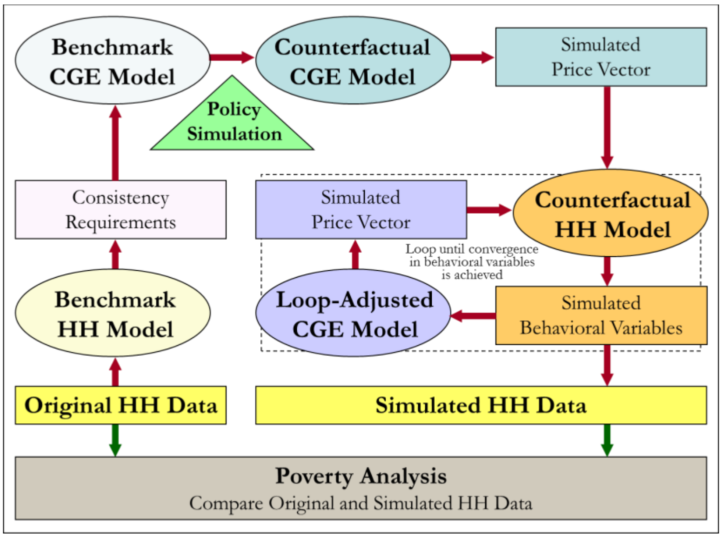
Like all the macro-micro approaches, the top-down method has its strengths and its weaknesses. Starting with its strengths, the separability of the macro and micro models means that there are hardly any restrictions imposed on the household behavior that can be modelled in the micro module (Savard 2003) – apart from those required for model linkage (see above). This allows for more flexibility in the choice of functional forms than in the standard CGE or integrated approaches, where the solution requirements of CGE models put constraints on micro-economic detail (Savard 2003). An example is regime switching, such as a worker's decision to supply a positive amount of labor or to become unemployed depending on his/her reservation wage (Savard 2003). Such a discontinuous function requires the set of equations to be solved to vary according to the specific condition fulfilled and, therefore, cannot be introduced in a usual CGE model, where the solution procedure relies on a fixed set of equations (Savard 2003). Furthermore, while the top-down approach – other than the standard CGE approach – requires data on both household income and expenditure (Decaluwé et al. 2005), it is easier to handle than the integrated approach since it is not necessary to fully reconcile the macro and micro data bases and, thus, to re-scale the household data to the macro data and to balance the income and expenditure data for each household account (Boccanfuso and Savard 2007). As pointed out by Hertel et al. (2015), however, the lower requirements for data reconciliation have both pros and cons: While they reduce biases from arbitrary data adjustments, they do not resolve systematic discrepancies between the micro and macro data, such as the tendency to underreport capital income in household surveys (see Ivanic 2004). Finally, the major weakness of the top-down approach is its neglect of feedback effects from the micro behavior to the macro model due to the uni-directional link running from the macro to the micro level (e.g., Savard 2003; Hertel and Reimer 2005; Hertel et al. 2015). For this reason, second-round price effects – apart from those resulting from aggregate household behavior within the CGE model – are not properly taken into account (Winters et al. 2004). According to Hertel et al. (2015), however, this is only a minor drawback since general-equilibrium price changes tend to be robust to household disaggregation.

Top-Down/Bottom-Up Approach

Another sequential method is the top-down/bottom-up approach, sometimes also referred to as iterative approach (e.g., Cockburn et al. 2014). It has been developed by Savard (2003) and later enhanced by, e.g., Colombo (2010) as well as Boccanfuso and Savard (2012). Examples of applications are provided by de Souza Ferreira Filho and Horridge (2006), Savard (2005; 2010), and Bourguignon and Savard (2008).

The top-down/bottom-up approach involves a bi-directional link from the macro to the micro level and back to the macro level (Savard 2003; Figure 2). In this way, it aims to incorporate at least some of the feedback effects missing in the top-down approach. Indeed, the top-down/bottom-up approach can be regarded as an extension of the top-down approach. Like in the top-down approach, first, a representative-household CGE model is used to generate the commodity- and factor-price changes induced by a macro-economic shock and, second, these changes are transferred to a micro-simulation model. While the top-down approach stops at this stage and imposes the post-simulation consistency requirements, the top-down/bottom-up method continues with an iteration process, now responsible for convergence and, thus, consistency between the macro and micro models. That is, instead of being determined by the counterfactual CGE aggregates, the variables describing simulated household behavior are now calculated endogenously by the counterfactual household model. Then, they are aggregated over all households and imported as exogenous variables into the CGE model, leading to an updated price vector to be used in a subsequent loop. The iteration continues until some pre-determined convergence criteria are met, i.e. until the differences in the behavioral variables from one loop to the other become negligible. Once a converging solution has been found, the simulated household data can be used for counterfactual poverty analysis.

Figure 2: Top-Down/Bottom-Up Approach



Source: Own illustration based on Savard (2003).

Notes: CGE = Computable General Equilibrium; HH = Household

Concerning the strengths of the top-down/bottom-up approach, the bi-directional link between the CGE model and the household model is an improvement over the uni-directional top-down approach since it allows for feedback effects from the micro model to be taken into account in the macro model (Savard 2003). In terms of feedbacks and under certain conditions, Bourguignon and Savard (2008) have even established the equivalence of the top-down/bottom-up approach with the direct inclusion of all surveyed households in the CGE model as in the integrated approach. Furthermore, the top-down/bottom-up approach has the similar advantage like the top-down method that it allows for greater richness in household behavior than the integrated approach (Savard 2003). Finally, it requires less data manipulation than the integrated approach. As in the top-down approach, it is neither necessary to re-scale the household data to the macro data nor to balance the income and expenditure data for each household (Savard 2003; Bourguignon and Savard 2008).

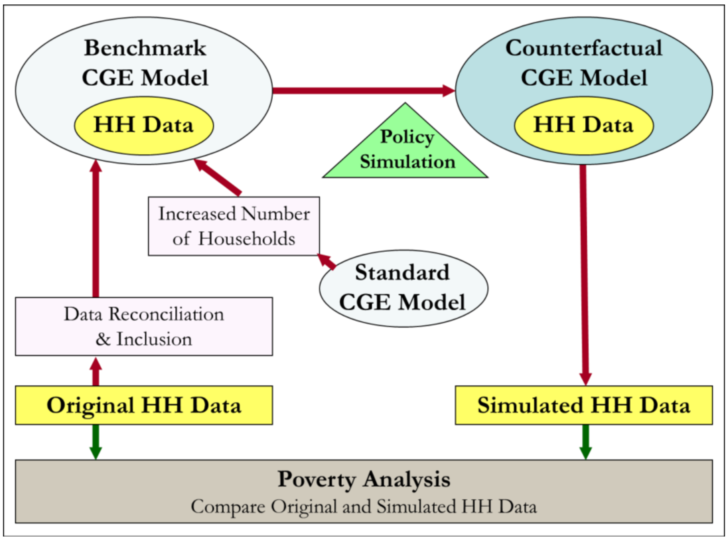
Turning to the drawbacks, the top-down/bottom-up approach is less tractable than the top-down approach (Savard 2003). In particular, to obtain a converging solution, it requires greater consistency in the modelling of household behavior between the macro and micro modules than the top-down approach (Cockburn et al. 2014), constraining the basic flexibility in modelling. Still, convergence might not be achievable at all (Savard 2010). Another important aspect is that the simulation results can be sensitive to the way in which the feedback effects from household behavior are introduced in the CGE part, i.e. to the choice of the behavioral variables which communicate between the macro and micro models and the corresponding selection of exogenous and endogenous variables (closure) used in the counterfactual CGE model (Colombo 2010). Moreover, due to the linkage of two separate models, complete feedback might still be missing in this approach.

Integrated Approach

While the previous types of macro-micro simulations were based on linking separate macro and micro models, the integrated approach is characterized by the direct inclusion of disaggregated household data and, thus, household behavior into the CGE model. Further terminologies for this approach frequently used in the literature are 'integrated multi-households CGE' approach (Savard 2003: 4), 'integrated micro-simulation approach' (Decaluwé et al. 2005: 218), 'fully integrated multi-household CGE model' (Boccanfuso et al. 2008: 160), or 'fully integrated approach' (Cockburn et al. 2014: 4). The method goes back to Decaluwé et al. (1999) and has been applied, for example, by Cockburn (2006), Rutherford et al. (2006), Chitiga et al. (2007), Cororaton and Cockburn (2007), Cogneau and Robilliard (2007), Cockburn et al. (2007), Rutherford and Tarr (2008), as well as Boysen and Matthews (2016).

Instead of relying on one or several representative households as in the standard CGE approach, the CGE model used in the integrated approach explicitly accounts for each individual household from a nationally representative household survey (e.g., Cockburn 2006). This is done by increasing the number of representative households of a standard CGE model up to the number of real households available in the survey (Savard 2003; Cockburn 2006; Figure 3). In this sense, the integrated approach can be regarded as an extension of the standard CGE method – with the difference that the household disaggregation is "complete" and, thus, conventional poverty analysis can be applied. In other words, all changes in the household data needed to perform counterfactual poverty analysis are directly generated within the CGE model. To include the household data in the CGE data base, the micro data have to be fully reconciled with the macro data. This means, in particular, that the income and expenditure data from the household survey have to be balanced for *each* household to bring it into SAM format and that the micro data have to be re-scaled to the macro data (Savard 2003; Hertel and Reimer 2005).

Figure 3: Integrated Approach



Source: Own illustration based on Cockburn (2006).

Notes: CGE = Computable General Equilibrium; HH = Household

The integration of household-survey data into a CGE model has several advantages. Since the full range of observed household heterogeneity is directly introduced in the CGE model, it provides for the detailed modelling of the income distribution of a country within the CGE model and, thus, for the determination of all endogenous variables at the level of individual households rather than a group of representative households (Hertel and Reimer 2005). Compared to standard CGE models, therefore, the integrated approach circumvents any controversies about household aggregation and eliminates the problem of missing intra-group income variations (Savard 2003). Compared to the two sequential approaches, it is further the theoretically soundest macro-micro simulation method: Placing the entire household heterogeneity within the CGE model means that the model is internally consistent and feedback effects of household behavior are fully taken into account (e.g., Decaluwé et al. 2005).

However, the integrated approach has also some disadvantages. The comprehensive data-reconciliation requirements for this approach, i.e. the balancing and re-scaling of the micro data, involve more data manipulation than necessary in the previous approaches. While the stricter data requirements can also be considered as an advantage – especially if the household survey contains systematic discrepancies (such as the underreporting of capital income mentioned above and the corresponding mismatch of the household income and expenditure data) that are removed by the reconciliation with the macro data –, balancing out each household account will inevitably introduce changes in the observed household income or expenditure structure and, thus, bears the risk to bias the results (Savard 2003; Decaluwé et al. 2005; Colombo 2010). Consequently, the approach necessitates good household data on both the income and expenditure sides (Decaluwé et al. 2005). As a further disadvantage of the integrated approach, there is less flexibility in the use of certain functional forms governing household behavior than in the sequential approaches because the CGE framework puts more constraints on non-linearity and model structure (see above). As a consequence, the integrated approach might be less able to appropriately reflect the complexity of household behavior (Colombo 2010). Finally, although the integrated approach is technically easy to implement (Cockburn 2006), the model size can become limited by the numeric solvability of the CGE model (Chen and Ravallion 2004).

Conclusion

Which method to choose when analyzing the effects of a macro-economic shock, such as a trade-policy reform, on poverty and inequality? Comparative studies by Decaluwé et al. (1999) and Savard (2005) show that macro-micro simulations tend to be superior to standard CGE models with a relatively small number of representative households since they are able to account for the intra-group distribution of income. Among the macro-micro approaches, in turn, all the methods have their pros and cons. Comparing the top-down, top-down/bottom-up and integrated approaches, Colombo (2010) favors the top-down/bottom-up approach as it allows both for detailed household behavior to be modelled and for feedback effects to be taken into account. If feedback effects are expected to be important (like in the case of rigid labor markets), Bourguignon and Savard (2008) prefer the top-down/bottom-up and integrated approaches over the top-down approach. Otherwise, they consider the top-down approach to be "satisfactory" (Bourguignon and Savard 2008: 206). Indeed, if feedback effects are of minor importance, the top-down approach seems to be a good compromise between detail and ease of implementation, the latter both in terms of modelling effort and data manipulation (see above). The results obtained by de Souza Ferreira Filho and Horridge (2006), who needed only one loop to obtain model convergence in their top-down/bottom-up approach, indicate that there are cases where feedback effects might be negligible. Finally, Davies (2009) suggests using the top-down approach for analyzing short-term effects and the integrated approach for long-term effects.

References

Adelman, I. and. S. Robinson. 1978. *Income distribution policy in developing countries: A case study of Korea*. Oxford University Press, Oxford. Online available at: http://documents.worldbank.org/curated/en/1978/01/1561290/income-distribution-policy-developing-countries-case-study-korea

Alatas, V. and F. Bourguignon. 2005. The evolution of income distribution during Indonesia's fast growth, 1980-96. In: Bourguignon, F., F. H. G. Ferreira, and N. Lustig (eds). *The microeconomics of income distribution dynamics in East Asia and Latin America*. Washington, DC, World Bank and Oxford University Press: 175-217. Online available at: https://openknowledge.worldbank.org/bitstream/handle/10986/14844/30596.pdf?sequence=1

Annabi, N., B. Khondker, S. Raihan, J. Cockburn, and B. Decaluwé. 2006. Implications of WTO agreements and unilateral trade policy reforms for poverty in Bangladesh: Short- versus long-run impacts. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 429-466. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Aredo, D., B. Fekadu, and S. W. Kebede. 2012. Trade liberalization and poverty: A macro-micro analysis in Ethiopia. MPIA Working Paper 2012-04. Retrieved on 6 June 2016 from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2366950

Arndt, C. 2006. The Doha trade round and Mozambique. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 129-152. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Boccanfuso, D., B. Decaluwé, and L. Savard. 2008. Poverty, income distribution and CGE micro-simulation modeling: Does the functional form of distribution matter? *Journal of Economic Inequality* 6(2): 149-184. Online available at: http://link.springer.com/article/10.1007%2Fs10888-007-9055-y

Boccanfuso, D. and L. Savard. 2007. Poverty and inequality impact analysis regarding cotton subsidies: A Mali-based CGE micro-accounting approach. *Journal of African Economies* 16(4): 629-659. Online available at: http://jae.oxfordjournals.org/content/16/4/629.short

Boccanfuso, D. and L. Savard. 2012. A segmented labour supply model estimation for the construction of a CGE microsimulation model: An application to the Philippines. *Margin – The Journal of Applied Economic Research* 6(2): 211-234. Online available at: http://mar.sagepub.com/content/6/2/211.abstract

Boeters, S., M. Feil, and N. Gürtzgen. 2005. Discrete working time choice in an applied general equilibrium model. *Computational Economics* 26(3-4): 183-211. Online available at: http://link.springer.com/article/10.1007%2Fs10614-005-9001-7

Bourguignon, F., J. de Melo, and A. Suwa. 1991. Modeling the effects of adjustment programs on income distribution. *World Development* 19(11): 1527-1544. Online available at: http://www.sciencedirect.com/science/article/pii/0305750X91900042

Bourguignon, F., M. Fournier, and M. Gurgand. 2001. Fast development with a stable income distribution: Taiwan, 1979-94. *Review of Income and Wealth* 47(2): 139-163. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/1475-4991.00009/abstract

Bourguignon, F, A.-S. Robilliard, and S. Robinson. 2005. Representative versus real households in the macroeconomic modeling of inequality. In: Kehoe, T. J., T. N. Srinivasan, and J. Whalley (eds). *Frontiers in applied general equilibrium modeling*. Cambridge, UK, Cambridge University Press: 219-254.

Bourguignon, F. and L. Savard. 2008. Distributional effects of trade reform: An integrated macro-micro model applied to the Philippines. In: Bourguignon, F., M. Bussolo, and L. A. Pereira da Silva (eds). *The impact of macroeconomic policies on poverty and income distribution – Macro-micro evaluation techniques and tools*. Palgrave Macmillan and World Bank: 177-211. Online available at: https://openknowledge.worldbank.org/handle/10986/6586

Boysen, O. and A. Matthews. 2016. Will Economic Partnership Agreements increase poverty? The case of Uganda. *Review of Development Economics*. Forthcoming. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/rode.12272/abstract

Bussolo, M., J. Lay, and D. van der Mensbrugghe. 2006. Structural change and poverty reduction in Brazil: The impact of the Doha round. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 249-284. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Bussolo, M., J. Lay, D. Medvedev, and D. van der Mensbrugghe. 2008. Trade options for Latin America: A poverty assessment using a top-down macro-micro modeling framework. In: Bourguignon, F., M. Bussolo, and L. A. Pereira da Silva (eds). *The impact of macroeconomic policies on poverty and income distribution – Macro-micro evaluation techniques and tools*. Palgrave Macmillan and World Bank: 61-90. Online available at: https://openknowledge.worldbank.org/handle/10986/6586

Chen, S. and M. Ravallion. 2004. Welfare impacts of China's accession to the World Trade Organization. *World Bank Economic Review* 18(1): 29-57. Online available at: http://wber.oxfordjournals.org/content/18/1/29.short

Chia, N.-C., S. Wahba, and J. Whalley. 1994. Poverty-reducing targeting programmes: A general equilibrium approach. *Journal of African Economies* 3(2): 309-338. Online available at: http://jae.oxfordjournals.org/content/3/2/309.abstract

Chitiga, M., R. Mabugu, and T. Kandiero. 2007. A computable general equilibrium micro-simulation analysis of the impact of trade policies on poverty in Zimbabwe. Working paper 2007-15. University of Pretoria, Department of Economics Working Paper Series. Retrieved on 6 June 2016 from: http://www.up.ac.za/media/shared/61/WP/wp_2007_15.zp39498.pdf

Cockburn, J. 2006. Trade liberalisation and poverty in Nepal: A computable general equilibrium micro-simulation analysis. In: Bussolo, M. and J. I. Round (eds). *Globalisation and poverty: Channels and policy responses*. Routledge, London and New York: 171-194.

Cockburn, J., L. Savard, and L. Tiberti. 2014. Macro-micro models. In: O'Donoghue, C. (ed). *Handbook of microsimulation modelling*. Emerald Group Publishing Limited, UK: 275-304. Online available at: http://www.emeraldinsight.com/doi/book/10.1108/S0573-85552014293

Cockburn, J., I. Fofana, B. Decaluwé, R. Mabugu, and M. Chitiga. 2007. A gender-focused macro-micro analysis of the poverty impacts of trade liberalization in South Africa. In: Lambert, P. J. (ed). *Equity*. Research on Economic Inequality, Volume 15. Emerald Group Publishing Limited: 269 – 305. Online available at: http://www.emeraldinsight.com/doi/abs/10.1016/S1049-2585%2807%2915011-0

Cogneau, D. and A.-S. Robilliard. 2007. Growth, distribution and poverty in Madagascar: Learning from a microsimulation model in a general equilibrium framework. In: Spadaro, A. (ed). *Microsimulation as a tool for the evaluation of public policies: Methods and applications*. Fundación BBVA, Bilbao: 73-111. Retrieved on 6 June 2016 from: http://www.uib.cat/depart/deaweb/webpersonal/amedeospadaro/workingpapers/MicrosimulationBook.pdf

Colombo, G. 2010. Linking CGE and microsimulation models: A comparison of different approaches. *International Journal of Microsimulation* 3(1): 72-91. Online available at: http://microsimulation.org/IJM/V3_1/IJM_20.pdf

Cororaton, C. B. and J. Cockburn. 2007. Trade reform and poverty – Lessons from the Philippines: A CGE-microsimulation analysis. *Journal of Policy Modeling* 29(1): 141-163. Online available at: http://www.sciencedirect.com/science/article/pii/S0161893806001153

Cororaton, C. B., J. Cockburn, and E. Corong. 2006. Doha scenarios, trade reforms, and poverty in the Philippines: A CGE analysis. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 375-402. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Davies, J. B. 2009. Combining microsimulation with CGE and macro modelling for distributional analysis in developing and transition economies. *International Journal of Microsimulation* 2(1): 49-65. Online available at: http://microsimulation.org/IJM/V2_1/IJM_2_1_4.pdf

Decaluwé, B., J.-C. Dumont, and L. Savard. 1999. Measuring poverty and inequality in a computable general equilibrium model. Cahier de recherche du CRÉFA no. 99-20. Université Laval, Québec. Retrieved on 18 August 2015 from: https://ideas.repec.org/p/lvl/laeccr/9926.html

Decaluwé, B., L. Savard, and E. Thorbecke. 2005. General equilibrium approach for poverty analysis: With an application to Cameroon. *African Development Review* 17(2): 213-243. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1017-6772.2005.00113.x/abstract

de Janvry, A., E. Sadoulet, and A. Fargeix. 1991. Adjustment and equity in Ecuador. In: Morrisson, C. (ed). *Adjustment and equity in developing countries*. Development Centre of the Organisation for Economic Co-operation and Development.

de Maio, L., F. Stewart, and R. van der Hoeven. 1999. Computable general equilibrium models, adjustment and the poor in Africa. *World Development* 27(3): 453-470. Online available at:

http://www.sciencedirect.com/science/article/pii/S0305750X98001430

de Melo, J. and S. Robinson. 1980. The impact of trade policies on income distribution in a planning model for Colombia. *Journal of Policy Modeling* 2(1): 81-100. Online available at: http://www.sciencedirect.com/science/article/pii/0161893880900198

Derviş, K., J. de Melo, and S. Robinson. 1982. *General equilibrium models for development policy*. A World Bank research publication. World Bank, Washington, DC. Retrieved on 22 July 2015 from: http://documents.worldbank.org/curated/en/1989/08/440577/general-equilibrium-models-development-policy

de Souza Ferreira Filho, J. B. and M. J. Horridge. 2006. Economic integration, poverty and regional inequality in Brazil. *Revista Brasileira de Economia* 60(4): 363-387. Online available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-71402006000400003

Dorosh, P. A. and D. E. Sahn. 2000. A general equilibrium analysis of the effect of macroeconomic adjustment on poverty in Africa. *Journal of Policy Modeling* 22(6): 753-776. Online available at: http://www.sciencedirect.com/science/article/pii/S0161893898000167

Hérault, N. 2006. Building and linking a microsimulation model to a CGE model for South Africa. *South African Journal of Economics* 74(1): 34-58. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1813-6982.2006.00047.x/abstract

Hérault, N. 2010. Sequential linking of computable general equilibrium and microsimulation models: A comparison of behavioural and reweighting techniques. *International Journal of Microsimulation* 3(1): 35-42. Online available at: https://core.ac.uk/download/files/153/6428820.pdf

Hertel, T. W. and J. J. Reimer. 2005. Predicting the poverty impacts of trade reform. *Journal of International Trade & Economic Development* 14(4): 377-405. Online available at: http://www.tandfonline.com/doi/abs/10.1080/09638190500372404

Hertel, T. W., M. Verma, M. Ivanic, E. Magalhaes, C. Ludena, and A. R. Rios. 2015. GTAP-POV: A framework for assessing the national poverty impacts of global economic and environmental change. GTAP Technical Paper No. 31. Retrieved on 6 June 2016 from: https://www.gtap.agecon.purdue.edu/resources/download/7760.pdf

Ivanic, M. 2004. Reconciliation of the GTAP and household survey data. GTAP Research Memorandum No. 5. Online available at: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1408

Ivanic, M. 2006. The effects of a prospective multilateral trade reform on poverty in developing countries. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 405-426. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

King, D. and S. Handa. 2003. The welfare effects of balance of payments reform: A micro-macro simulation of the cost of rent-seeking. *Journal of Development Studies* 39(3): 101-128. Online available at: http://www.tandfonline.com/doi/abs/10.1080/00220380412331322841

Mitton, L., H. Sutherland, and M. Weeks. 2000. Introduction. In: Mitton, L., H. Sutherland, and M. Weeks (eds). *Microsimulation modelling for policy analysis: Challenges and innovations*. Cambridge University Press: 1-11. Retrieved on 31 August 2015 from: http://assets.cambridge.org/97805217/90062/sample/9780521790062WS.pdf

Morrisson, C. 1991. Adjustment, incomes and poverty in Morocco. *World Development* 19(11): 1633-1651. Online available at: http://www.sciencedirect.com/science/article/pii/0305750X9190010F

Nicita, A. 2006. Multilateral trade liberalization and Mexican households: The effect of the Doha Development Agenda. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 107-128. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Obeng, C. K. 2015. Impact of import liberalisation on poverty: A dynamic computable general equilibrium and microsimulation analysis for Ghana. *UDS International Journal of Development* 2(1): 44-68. Online available at: http://41.66.244.102/handle/123456789/451

Orcutt, G. H. 1957. A new type of socio-economic system. *Review of Economics and Statistics* 39(2): 116-123. Online available at: http://www.jstor.org/stable/1928528?seq=1#page_scan_tab_contents

Orcutt, G. H., M. Geenberger, J. Korbel, and A. M. Rivlin. 1961. *Microanalysis of socioeconomic systems: A simulation study*. Harper and Brothers, New York.

Piermartini, R. and R. Teh. 2005. Demystifying modelling methods for trade policy. WTO Discussion Paper No. 10. World Trade Organization, Geneva. Online available at: https://www.wto.org/english/res_e/publications_e/disc_paper10_e.htm

Ravallion, M. and D. van de Walle. 1991. The impact on poverty of food pricing reforms: A welfare analysis for Indonesia. *Journal of Policy Modeling* 13(2): 281-299. Online available at: http://www.sciencedirect.com/science/article/pii/016189389190015Q

Robilliard, A.-S. and S. Robinson. 2006. The social impact of a WTO agreement in Indonesia. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 319-340. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Rutherford, T., D. Tarr, and O. Shepotylo. 2006. The impact on Russia of WTO accession and the DDA: The importance of liberalization of barriers against FDI in services for growth and poverty reduction. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 467-496. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Rutherford, T. F. and D. G. Tarr. 2008. Poverty effects of Russia's WTO accession: Modeling "real" households with endogenous productivity effects. *Journal of International Economics* 75(1): 131-150. Online available at: http://www.sciencedirect.com/science/article/pii/S002219960700133X

Savard, L. 2003. Poverty and income distribution in a CGE-household micro-simulation model: Top-down/bottom up approach. CIRPÉE Working Paper 03-43. Online available at: http://www.cirpee.org/fileadmin/documents/Cahiers_2003/CIRPEE03-43.pdf

Savard, L. 2005. Poverty and inequality analysis within a CGE framework: A comparative analysis of the representative agent and microsimulation approaches. *Development Policy Review* 23(3): 313-331. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-7679.2005.00289.x/abstract

Savard, L. 2010. Scaling up infrastructure spending in the Philippines: A CGE top-down bottom-up microsimulation approach. *International Journal of Microsimulation* 3(1): 43-59. Online available at: http://microsimulation.org/IJM/V3_1/IJM_28.pdf

Stifel, D. C. and E. Thorbecke. 2003. A dual-dual CGE model of an archetype African economy: Trade reform, migration and poverty. *Journal of Policy Modeling* 25(3): 207-235. Online available at: http://www.sciencedirect.com/science/article/pii/S0161893803000140

Thorbecke, E. 1991. Adjustment, growth and income distribution in Indonesia. *World Development* 19(11): 1595-1614. Online available at: http://www.sciencedirect.com/science/article/pii/0305750X91900086

Vos, R. and N. de Jong. 2003. Trade liberalization and poverty in Ecuador: A CGE macro-microsimulation analysis. *Economic Systems Research* 15(2): 211-232. Online available at: http://www.tandfonline.com/doi/abs/10.1080/0953531032000091180

Winters, L. A. 2002. Trade liberalisation and poverty: What are the links? *The World Economy* 25(9): 1339-1367. Online available at: http://onlinelibrary.wiley.com/doi/10.1111/1467-9701.00495/abstract

Winters, L. A. 2003. Doha and the world poverty targets. In: Pleskovic, B. and N. Stern (eds). *Annual World Bank Conference on Development Economics 2003: The new reform agenda*. Washington, DC, World Bank and Oxford University Press: 91-121. Online available at: http://documents.worldbank.org/curated/en/2003/06/2446553/annual-world-bank-conference-development-economics-2003-new-reform-agenda

Winters, L. A., N. McCulloch, and A. McKay. 2004. Trade liberalization and poverty: The evidence so far. *Journal of Economic Literature* 42(1): 72-115. Online available at: http://www.ingentaconnect.com/content/aea/jel/2004/00000042/00000001/art00002

Zhai, F. and T. W. Hertel. 2006. Impacts of the DDA on China: The role of labor markets and complementary education reforms. In: Hertel, T. W. and Winters L. A. (eds). *Poverty and the WTO: Impacts of the Doha Development Agenda*. Palgrave Macmillan and the World Bank: 285-318. Online available at: http://documents.worldbank.org/curated/en/2005/07/6501491/poverty-wto-impacts-doha-development-agenda

Imprint

DIW Berlin – Deutsches Institut
für Wirtschaftsforschung
Mohrenstraße 58, 10117 Berlin

Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
http://www.diw.de

ISSN 2198-3925