Appendix

Methodology for "Can liberalizing trade reduce the US consumer price index? Insights from an economywide analysis," RealTime Economic Issues Watch blog, Peterson Institute for International Economics

Sherman Robinson (PIIE) and Karen Thierfelder (US Naval Academy)

Computable general equilibrium (CGE) models simulate the operation of a market economy, solving for equilibrium relative commodity and factor prices that clear all commodity and factor markets.[1] They typically specify perfect competition and an efficient solution that captures comparative advantage gains from trade.

The models solve only for relative prices; the solution values for all real variables are independent of any measure of the aggregate price level. These models assume some price or price index to be fixed, in order to provide an anchor for the price system, defining the benchmark (numeraire) against which relative prices are measured. In many models, some aggregate index, such as the consumer price index (CPI), is chosen as the anchor price. For our analysis, we follow the standard practice in trade theory models by specifying the nominal exchange rate in each country as the anchor price.[2] The model then solves for changes in prices in domestic markets relative to this anchor.

The global model also solves only for relative world prices, so we must specify a global numeraire exchange rate index that anchors the global system. We specify that a weighted average of exchange rates for a selected set of OECD countries (the United States, Japan, and selected countries in Europe) is fixed.

All CGE models include a mechanism for determining the equilibrium balance of international trade in goods and nonfactor services. In all scenarios, we assume no changes in the trade balances of all countries, which must sum to zero. Macroeconomic forces operating in asset markets are the main determinant of trade balances. We focus on trade in commodities and nonfactor services. CGE models do not include assets and are therefore not well suited to explore asset flows.

Given the assumption that the trade balance is fixed exogenously, CGE models include real exchange rate variables (explicit or implicit) whose value determines the average prices of traded good (exports and imports) relative to the average price of nontraded goods sold on the domestic market. The mechanism can be described with the following equations:[3]

---

[1] We assume no change in aggregate employment, so there is virtually no change in real GDP or real wages.

[2] The GTAP model, for example, uses a nominal exchange rate numeraire. Other CGE models use a CPI numeraire. As the focus of this study is the effect of tariffs on prices, we use a nominal exchange rate numeraire and report changes in the CPI.

[3] This presentation is for a single-country model in which world prices are fixed. The focus is on the link between a fixed trade balance, *B*, and the nominal exchange rate, *ER*. In a global model, world prices are flexible, and change in response to changes in supply and demand in bilateral markets. However, the relationships between *B*, the *ER*, and domestic prices (*PD*) still hold.

$PM = (1 + tm) \cdot ER \cdot PWM$ (domestic price of imports)
$PE = ER \cdot PWE$ (domestic price of exports)
$B = PWM \cdot M - PWE \cdot E$ (balance of trade in foreign currency units)
$E/D = f(PE/PD)$ (upward-sloping export supply function)
$M/D = g(PM/PD)$ (downward-sloping import demand function)
$PX \cdot X = PE \cdot E + PD \cdot D$ (value of aggregate production)
$PQ \cdot Q = PM \cdot M + PD \cdot D$ (value of aggregate demand)
$PQ \cdot Q = PX \cdot X + B \cdot ER$ (expenditure/income balance)

where *PWM* = world price of imports in foreign currency, *PWE* = world price of exports in foreign currency, *PM* = domestic price of imports, *PE* = domestic (border) price of exports, *PD* = domestic price of nontraded goods, *ER* = exchange rate, *tm* = tariff rate, *E* = real exports, *M* = real imports, *D* = real nontraded goods, *B* = balance of trade (value of imports minus exports in foreign currency), *X* = aggregate real production (GDP), *Q* = aggregate real demand ("absorption"), *PX* = price of production (e.g., GDP or producer price index), and *PQ* = price of aggregate demand (e.g., CPI).

If the trade balance, *B*, and world prices, *PWE* and *PWM*, are all assumed fixed, and the nominal exchange rate variable, *ER*, is chosen as the numeraire and is also assumed to be fixed, then the relative prices of traded and nontraded commodity aggregates in the domestic economy (which defines the real exchange rate) will adjust to ensure that the trade balance constraint is met. The equilibrating mechanism is through changes in relative prices (*PE/PD* and *PM/PD)*. As world prices and the nominal exchange rate are fixed, *PE* and *PM* are fixed. *PD* is then the equilibrating variable. For example, a general tariff raises *PM* and *PM*/*PD*, reducing imports. Given the fixed trade balance, it will also raise *PD* (by less than the increase in *PM*), lowering *PE*/*PD*, which generates lower exports. The result is a new equilibrium with lower imports and lower exports and the same balance of trade.

CGE models often set either the producer price index or the consumer price index as the anchor price, defining the numeraire. In this case, the exchange rate variable is the equilibrating variable, ensuring that the trade balance constraint is met, and some other price is chosen as the price anchor and is fixed. The equilibrating mechanism is the same—changes in the relative prices of traded to nontraded goods.

Aggregate imports and the domestic goods and services that compete with them are imperfect substitutes; imports from different trading partners are also imperfect substitutes. For this analysis, we use constant elasticity of substitution functions with an elasticity of substitution of five.