

VORSIM

For economic modeling,
try VORSIM!

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VORSIM is an application built in Microsoft Excel which helps the user build and simulate mathematical models. VORSIM can be used to create time series models with lags, static partial equilibrium economic models, engineering process models, business plan projections, or any other type of simultaneous or multi-equation simulation model that can be constructed in a spreadsheet. While the user specifies equations and structure in a model, the framework gives the user powerful software that automates some of the most tedious parts of model building but retains all of the advantages of spreadsheets. VORSIM is especially useful for the construction of large spreadsheet models comprised of standardized equation systems where individual equations are differentiated by parameters. Once a model is constructed, parameters can be changed and equations can be quickly re-initialized. VORSIM models can be repeatedly re-simulated using the Excel solver. Solution values can be examined quickly using Excel pivot tables and filtered lists. All model components and solutions are accessible for viewing and printing. Model documentation can easily be added as model components are built.

Multi-Market, Multi-Region Partial Equilibrium Modeling

- Model = formalized summary of your knowledge and assumptions about a problem
- Start by stating the problem to be addressed
- Gather available data; prepare data set
- Design model given problem and data
- Build model and test its validity, credibility
- Analyze problem; document model, results

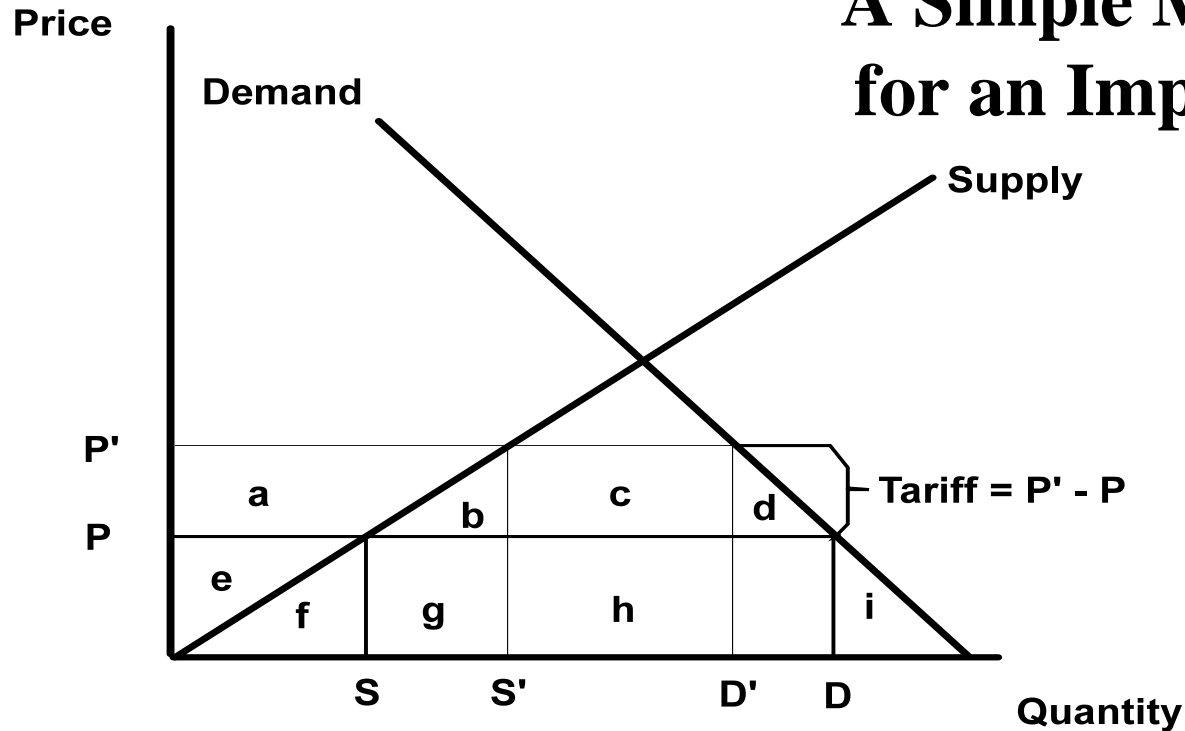
When problems arise where the economic impact of policy or economic changes must be estimated, partial equilibrium economic models offer a reasonable, cost-effective way to provide answers. Even simple mathematical models encourage disciplined thinking about economic problems. They also force the modeler to make explicit assumptions about economic behavior. Too often in informal economic analysis, critical economic assumptions about a problem are overlooked or simply not understood. Therefore, even if the economic impact of a policy is not completely resolved with the use of a model (which is often the case), the problem itself is much better understood following the modeling exercise. When a modeling exercise has been successfully completed, the model builders and clients/users have a better theoretical and qualitative understanding of the problem at hand.

Some Simple Graphical Models

- A Simple Model for an Importer
- Supply/Demand for Importer - a VORPLOT
- A Two-Market Model With Vertical Linkages
- A Two-Region Trade Model
- Flowchart of Linkages for a Simple Two-Market, Two-Region Trade Model
- Equations for a Two-Market, Two-Region Partial Equilibrium Trade Model

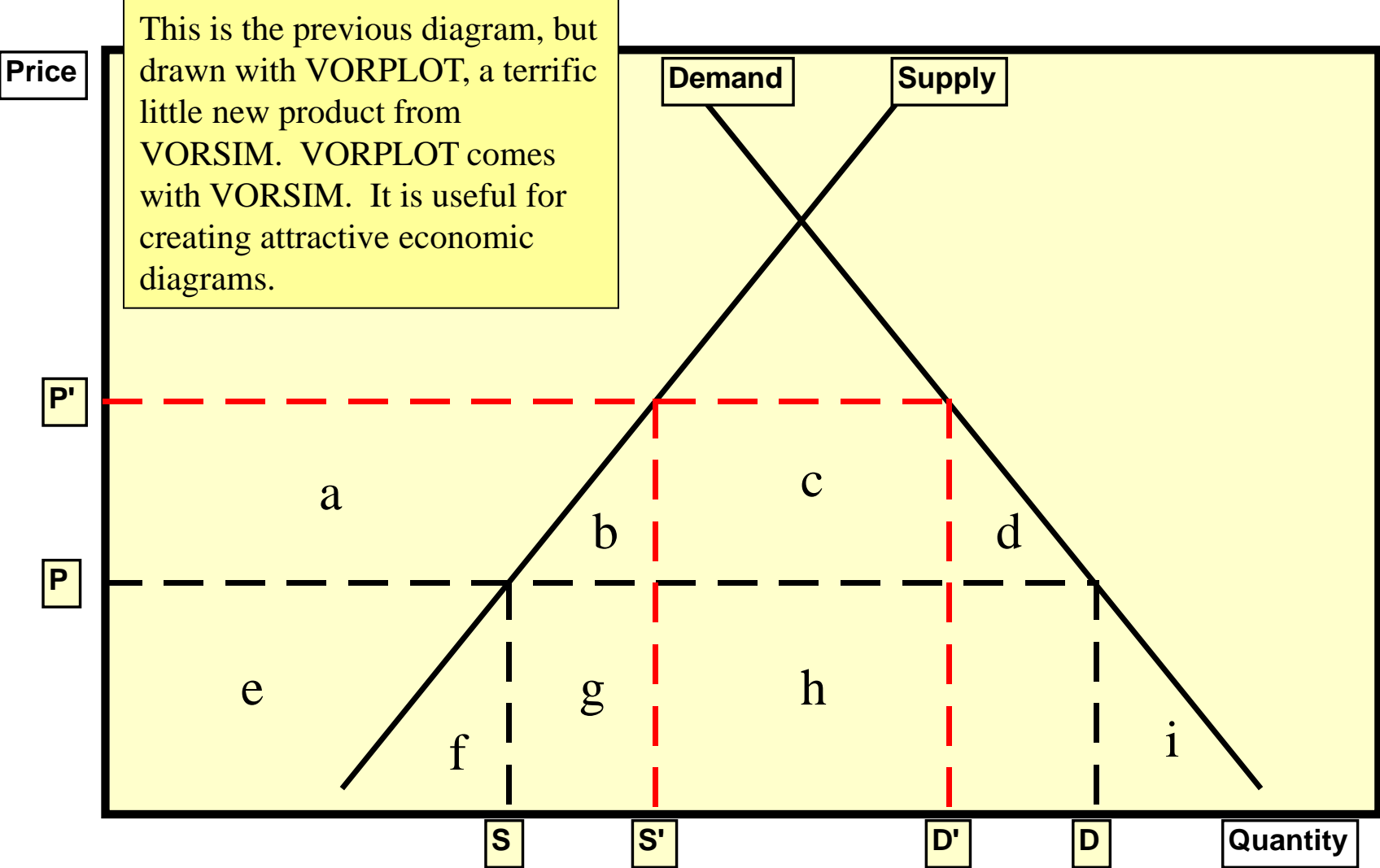
A set of simply partial equilibrium trade models are shown graphically (in pages that follow) to illustrate how to think about models. These models are discussed in “Applied Methods for Trade Policy Analysis – A Handbook”, Chapter 8, edited by Joseph Francois and Kenneth Reinert, published by Cambridge University Press, 1997. This book is a good general reference on economic modeling methods and problems.

A Simple Model for an Importer

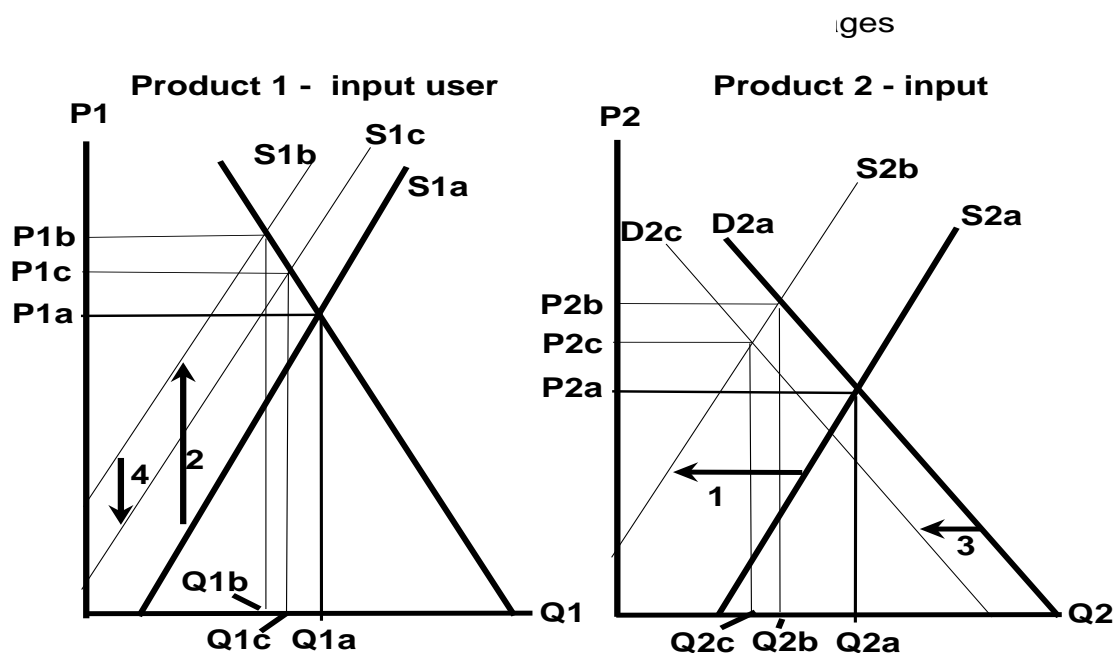


Two equilibrium economic situations are shown. 1. P (price), S (domestic supply), D (domestic demand), and $D-S$ (imports) without protection. 2. P' , S' , D' , and $D'-S'$ with tariff (or equivalent) protection. Situation 2 could be caused by a tariff $= P'-P$ as shown in chart OR by an import quota $= D'-S'$. The economic results would be the same with either policy except the revenue effects: tariff revenue goes to the government while quota rents are shared by importers and foreign exporters. Other policies such as producer subsidies and consumer taxes which shift supply and demand schedules could also produce the same economic results (S' , D') for producers and consumers. Again, the revenue effects would differ.

Supply/Demand for Importer – a VORPLOT

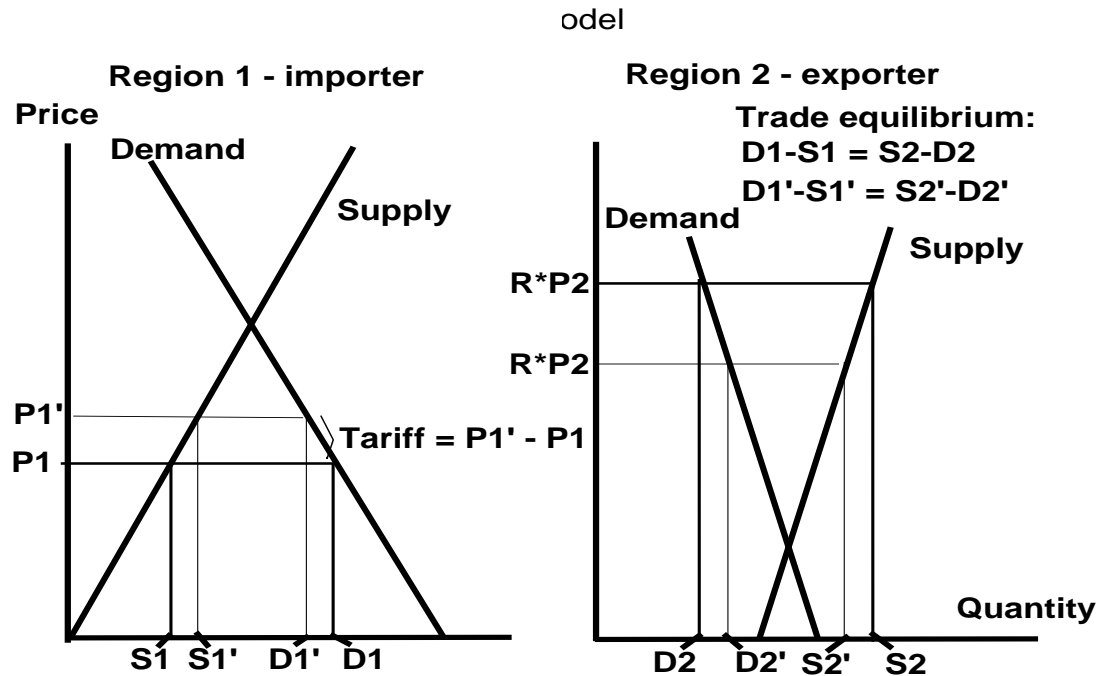


A Two-Market Model With Vertical Linkages



The analysis of a change in the input market impacting both markets can be traced in four steps: Step 1 - An exogenous decrease in input supply shifts the supply curve (S_{2a}) for product 2 to the left (S_{2b}), establishing an initial higher price (P_{2b}) for product 2. Production and consumption of product 2 decreases from Q_{2a} to Q_{2b} . Step 2 - The higher price for the product 2 raises production costs for product 1 which uses product 2 as an input, shifting the supply schedule for product 1 (S_{1a}) upward (S_{1b}). Product 1 production and consumption decrease from Q_{1a} to Q_{1b} . Step 3 - The decrease in production of product 1 causes less demand for input product 2, shifting the demand curve (D_{2a}) in the input market to the left (D_{2c}). This lowers the price of product 2 from P_{2b} to P_{2c} and further decreases the equilibrium quantity from Q_{2b} to Q_{2c} . Step 4 - The lower input price reduces the cost of production of product 1, shifting the supply schedule (S_{1b}) back down (S_{1c}). This lowers the price of product 1 from P_{1b} to P_{1c} and increases production and consumption from Q_{1b} to Q_{1c} . Over an appropriately defined time period, the subsequent changes in steps 2-4 would occur simultaneously leading to the final equilibrium at prices P_{1c} and P_{2c} and equilibrium quantities at Q_{1c} and Q_{2c} , respectively. The exogenous decrease in input supply results in the sharing of impacts via price and quantity changes in both the input market and the market of the product that uses the input. Consumers in both markets pay higher prices and consume less.

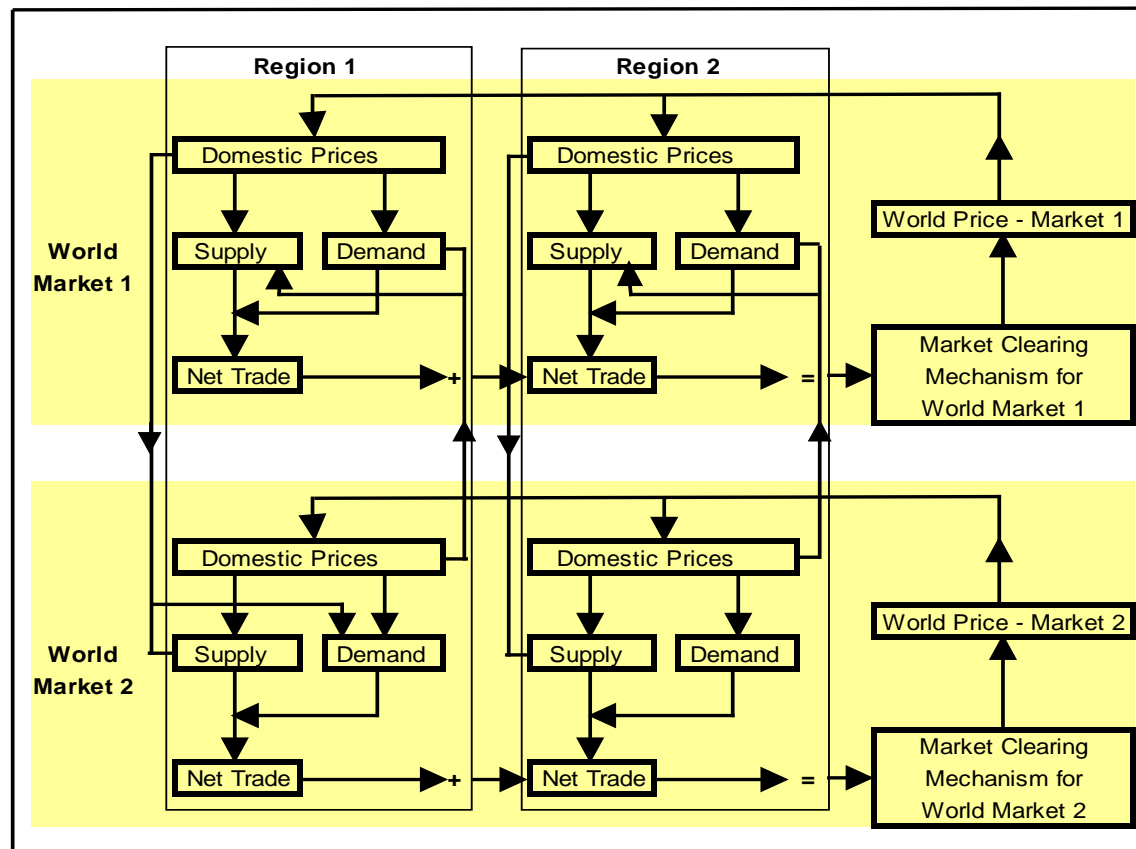
A Two-Region Trade Model



When markets in different countries are linked, multi-region models are required. As an illustration of this process, a simple model for an importing region is made part of a two-region trade model here by adding the supply and demand schedule for the exporting region (2) which provides all the imports for region 1. In the free trade situation, region 1 imports ($D1-S1$) which equals ($S2-D2$), the exports of region 2. The explicit linkage added is that the imports of region 1 always must equal the exports of region 2. The free trade price in region 1 is $P1$ while in region 2, the free trade price is $R*P2$ where R is the exchange rate converting region 2's currency to the currency units of region 1. When region 1 imposes a tariff ($P1'-P1$), its domestic price increases to $P1'$ and its imports decrease to ($D1'-S1'$). Exports of region 2 decline to ($S2'-D2'$) (which equals $D1'-S1'$) at the lower domestic price $R*P2'$. The market conditions are different in regions 1 and 2. In this example, region 2's supply and demand schedules are steeper, requiring a larger price change to clear the market, so the price decline in region 2 is greater than the price increase in region 1. The explicit linkage of these two regions by trade means that any disturbance in the market of one region, such as a demand shift or trade policy change, leads to simultaneous changes in prices, supply, demand, and trade in both regions.

Flowchart of Linkages for a Simple Two-Market, Two-Region Trade Model

The simultaneous nature of a multi-market, multi-region model can be illustrated with a flowchart of linkages for a simple two-market, two-region trade model. Lines and arrows show the direction of the linkages. Each region and market has a set of domestic prices which determine supply and demand quantities. These quantities, in turn, define the net trade for each market in each region.



Domestic prices for one market in a region help determine not only the quantity supplied and demanded in that market, but also in the other market through cross-market price linkages. Each market itself is linked across regions through net trade. The sum of net trade for each market has to equal zero in the equilibrium state because world exports equal world imports. If world net trade for a market is not zero, a new world market clearing price is calculated which in turn, feeds back into the domestic market price structure for each market. In the model, this process continues until both markets are cleared (world net trade in both markets equal zero). The result of all of these simultaneous cross-market, cross-region linkages is that all markets in all regions are connected. Markets are connected domestically through cross-market effects and internationally through trade and world prices. Trade policies typically effect price linkages between world and domestic prices. Domestic policies affect supply and demand schedules themselves but have cross-region effects as well through trade linkages.

Equations for a Two-Market, Two-Region Partial Equilibrium Trade Model

The notation for the model equations: P - domestic Price, Wp - World price, Mt - domestic market for Meat, Cg - domestic market for Coarse grains, S - quantity Supplied, D - quantity Demanded, Nt - quantity of Net trade, Wt - World net trade, 1 - region 1, 2 - region 2, c - constant (intercept) term, Tariff - import Tariff. Variables are named by concatenation of these symbols, e.g. PMt1 is the domestic price of meat in region 1. Equation 5 for region 2 ($PCg2 = cPCg2 + WpCg + TariffCg2$) reads as “the domestic price of coarse grains in the market in region 2 equals a constant term plus the world price of coarse grains plus the tariff on imports of coarse grains into region 2”. An algebraic version of the simple two-market, two-region partial equilibrium model outlined previously, is shown. The algebraic specification of a model requires some mathematical notation to represent model variables and equations.

	Region 1	Region 2
Market 1: Mt	<ol style="list-style-type: none"> $PMt1 = cPMt1 + WpMt + TariffMt1$ $SMt1 = cSMt1*(PMt1 \wedge .7)*(PCg1 \wedge -.2)$ $DMt1 = cDMt1*(PMt1 \wedge -.6)$ $NtMt1 = SMt1 - DMt1$ 	$PMt2 = cPMt2 + WpMt$ $SMt2 = cSMt2*(PMt2 \wedge .5)*(PCg2 \wedge .1)$ $DMt2 = cDMt2*(PMt2 \wedge .8)$ $NtMt2 = SMt2 - DMt2$
Market 2: Cg	<ol style="list-style-type: none"> $PCg1 = cPCg1 + WpCg$ $SCg1 = cSCg1*(PCg1 \wedge .6)$ $DCg1 = cDCg1*(PCg1 \wedge .8)*(SMt1 \wedge .7)$ $NtCg1 = SCg1 - DCg1$ 	$PCg2 = cPCg2 + WpCg + TariffCg2$ $SCg2 = cSCg2*(PCg2 \wedge .4)$ $DCg2 = cDCg2*(PCg2 \wedge .5)*(SMt2 \wedge .3)$ $NtCg2 = SCg2 - DCg2$
Market Clearing:	Market 1: Mt	Market 2: Cg
World Trade Price	$WtMt = NtMt1 + NtMt2$ $WpMt =$ World Mt price that clears the world Mt market by driving WtMt to 0	$WtCg = NtCg1 + NtCg2$ $WpCg =$ World Cg price that clears the world Cg market by driving WtCg to 0

The equations shown follow the notation used for the coding of these same model equations in a spreadsheet. Two specific products, meat and coarse grains (i.e. feed grains such as corn, oats, barley, etc.) make up the two markets in the model. Constant elasticity functions are assumed using the following mnemonic symbols: P - domestic Price, Wp - World price, Mt - domestic market for Meat, Cg - domestic market for Coarse grains, S - quantity Supplied, D - quantity Demanded, Nt - quantity of Net trade, Wt - World net trade, 1 - region 1, 2 - region 2, c - constant (intercept) term, and Tariff - import Tariff. Variables are named by the concatenation of these symbols, e.g. PMt1 is the domestic price of meat in region 1. The equation $PMt1 = cMt1 + WpMt + TariffMt1$ translates as "the domestic price of meat in region 1 equals a constant (intercept) term plus the world price of meat plus the import tariff on meat in region 1". Elasticities are written in the equations as numbers so they are easy to read.

Why do modeling efforts wither?

- Analytical results too late to be useful
- Model too complex to explain and educate
- Builder bogs down in modeling mechanics
- Economic or technical specification errors
- Too much time required to get useful results
- Model not documented, not transferable
- Poor defense against professional critics

Since partial equilibrium modeling is problem focused, its net result should be to clarify and illuminate an economic problem. This means that models and their analytical results should be transparent, not just to the modeler, but also to those using the analysis to make decisions. A modeling package which helps to create and operate a partial equilibrium model does not relieve the economist of the responsibility for learning the economics and mathematics behind the model. "Black box" models created by modeling packages but not fully understood by the user simply do not meet the transparency and credibility goals that underlie the successful application of partial equilibrium analysis to real world problems. Another common modeling mistake is to underestimate the time needed to effectively organize and present the results of a model based analysis. In many cases, the education provided to policy makers from a partial equilibrium modeling analysis is as important as the actual analytical results.

VORSIM can help your your modeling effort!

- **A model can built quickly in VORSIM, even a large model takes only a short time once you learn the system.**
- **A VORSIM-built model is documented as it is built. Because it is in Excel, it is easy to add comments about the model and the simulation results.**
- **VORSIM is designed to simplify the mechanics of model-building. Operations can easily be repeated at the click of a button. You spend more time thinking almost no time repeating complex mechanical tasks.**
- **Although you control model and equation specification and are responsible for mistakes, in VORSIM, your mistakes become apparent sooner and can be corrected much faster.**
- **You can start getting useful results immediately when you have built and simulated your model. VORSIM has many ways of immediately looking at results and generating reports.**

VORSIM is designed to make the model-building and using process easier, leaving you more time for planning, thinking, writing, etc. It does not fix a bad model nor correct poor specifications, but it does expose the 'problem' parts of a model faster. If an equation is invalid in Excel, you find it out right away. If a model does not solve or 'explodes' you will know soon. Furthermore, with the spreadsheet capability, it is easier to diagnose problems and track down the problem. Also, VORSIM has some built in tools which help detect modeling problems.

A VORSIM model is documented, transparent, and can easily be transferred to others

- **You document your VORSIM model as you build it. You can add notes anywhere to document any part of a model. It is easy to print out all or parts of your model. Since a VORSIM-built model and its components are spreadsheets workbooks, they can be read by anyone with Excel. Furthermore, a working model can be transferred to anyone owning a copy of VORSIM.**
- **Because your VORSIM model is documented in a form readable by anyone, it can easily be examined by critics. The transparency of the model and ease of doing simulations means that extra work demanded by a critic can be done quickly. VORSIM does not improve your model by itself, but it does make it easier for you to improve it and therefore deal with criticism.**

A Sample Spreadsheet Model - OKRA

Buttons on the spreadsheet initiate various model preparation, simulation, and solution manipulation options.

In this example, yellow spreadsheet cells hold formulas (equations) while white cells hold exogenous data (numbers that can be changes to get different model solutions). OKRA is built with VORSIM.

OKRA	RO	RT	MC
sfOK	0.0	0.0	
sfOC	0.0	0.0	
qpOK	1550	2650	
qpOC	65	1025	
qsOK	1200	3000	
qsOC	540	550	
qtOK	350	-350	0
qtOC	-475	475	0
pwOK	17.22	21.22	19.22
pwOC	45.45	39.45	49.45
inc	106	103	
t			4

1. Numbers (white cells) to change for model solution View/edit exogenous/variable

2a. Formulas (yellow) to drive to zero for solution 2b. Numbers to 0 in a solution

Model Solver parameters

A spreadsheet is one vehicle for model building and operations activities. Modern spreadsheets provide a structure (sheets in workbook, rows and columns in sheets) that can be used for models; the ability to write equations, and macro commands allows the automation of spreadsheet operations. Microsoft Excel, for example, uses a version of the Basic language for object oriented macro programming. The OKRA model shown above is built with VORSIM which is written in Excel's Visual Basic language. Spreadsheets are not compiled, so model operations and solutions may not be as fast, for example, as the same model written in Fortran and compiled for execution. But spreadsheet models are transparent, use the spreadsheet structure, and can make use of all spreadsheet capabilities.

Sample Equations for the Model OKRA

RO		Update RO equations	Put RO equations in model	Symmet
Domestic Wholesale Price	Price Transm. Elasticity	<p>Equations are written below in a readable form where codes are used to define variable names. VORSIM writes equations using a readable nomenclature as well as in spreadsheet cell notation in the model.</p> <p><u>Equations</u></p> <p>ROqpOK 540.4883*(1+ROsfOK)*ROpwOK^{.4}*ROpwOC^{.07}*ROpw:1OK^{.05}</p> <p>ROqpOC 9.595761*(1+ROsfOC)*ROpwOK^{.1}*ROpwOC^{.5}*ROpw:1OK^{.02}</p> <p>ROqsOK 1974.65*ROpwOK^{.5}*ROpwOC^{.1}*ROinc^{.1}*(1+.02*MCt)</p> <p>ROqsOC 551.7314*ROpwOK^{.04}*ROpwOC^{.3}*ROinc^{.2}*(1+.02*MCt)</p> <p>ROqtOK 0+ROqpOK-ROqsOK</p> <p>ROqtOC 0+ROqpOC-ROqsOC</p> <p>ROpwOK 0.8959417*MCpwOK¹</p> <p>ROpwOC 0.9191102*MCpwOC¹</p>		
pw				
OK	1.00			
OC	1.00			

Here you see equations from the model OKRA written using a user-defined variable notation and Excel mathematical operators. While small spreadsheet models can be built on an ad-hoc basis, larger ones require structure and an understandable variable nomenclature to keep track of things. In VORSIM models for Excel such as OKRA for example, models are organized by sheets and subcategories within sheets. Associated variable codes are used to construct variable names. This leads to fairly readable equations shown above. In VORSIM, a coding scheme is used to create equation templates to hold parameters. Equations are written and updated by the computer using the parameters and base data; this minimizes error-prone equation typing.

System Requirements for Any Model

- Place to store data - database for model
- Place to write and keep equations for model
- Way of solving the model and changing variables to obtain alternative solutions
- System for saving model solutions, comparing solution results, and creating graphs, tables, etc. that convey model results in an easily understandable form.

You have many choices of tools for model building. At one end of the spectrum, you can manually enter model equations into a spreadsheet or write them in a programming language. Alternatively, you can use a model building/estimation software package which provides the base tools needed or systems requirements for model building shown above. Any tool requires some learning time. Tools/model building systems do not, however, do the thinking needed for a model building exercise. The FIRST tool you need for any model building exercise is a pencil and paper where you sketch out your model structure, write sample equations, etc. You also need research to see how others have done it in the past.

VORSIM as a System for Modeling

- Model data is stored in an Excel workbook
- Equations are stored in an equation workbook
- A VORSIM model is solved with an Excel solver
- Exogenous variables can be changed to generate alternative solutions
- Model solutions are saved and a wide range of Excel-based tools (e.g. pivot tables, charts) are readily available for examining results.
- Since all model information (data, parameters, equations, solutions) are kept in the Excel spreadsheet, all Excel tools are available for analysis and presentation of modeling results.

VORSIM and its host Excel, has all of the basics needed for modeling in a user friendly format. However, other modeling systems may be more appropriate for some types of modeling activities. In some cases, it may make sense to do developmental work in another system and to transfer the results to VORSIM for model construction and simulation. In other cases, you might want to develop your model in VORSIM and transfer it to another system for final disposition.

Examples of Other Modeling Systems

- SAS - Econometric, synthetic models
- E-Views - Econometric, synthetic models
- GAMS – Computable general equilibrium models (CGE), partial equilibrium models
- GTAP - CGE models
- Other spreadsheets like Excel
- Programmed models – In languages such as Fortran, Basic, C, etc.; compiled models run very fast. Modeling systems such as SAS and E-Views also provide a structure for modeling and compile a model for fast solution times.

Useful models can be built and with other modeling systems including many that have not been mentioned. In choosing a modeling system, you tend to use something familiar or a system which is designed to handle a particular type of model (e.g. CGE) that you need. In addition you should consider the time required to fully learn how to use the system. When evaluating modeling systems for potential use, be sure to consider how the system will help you to complete all the aspects of model building, including solution troubleshooting, the comparative analysis of solutions, documentation, and the presentation of modeling results to others, including non-modeling policymakers.

The Bottom Line - Model Building

- The model builders' time and skill level – obviously it is easier to work with something you are familiar with
- Consider not only model solution time, but also the time needed for experimentation during model building, the time needed for solving the model and producing, understanding, and explaining various solution scenarios
- VORSIM is a good system for many (but not all) modeling activities. In particular, it can minimize your time required for many parts of the model building and operation process
- For economic modeling, try VORSIM

Model building requires many tradeoffs. Some of them relate to the problem at hand. For example, dynamic modeling requires more data, equation complexity, and solution finesse than static models but if you are dealing with essentially a dynamic problem, you must choose dynamic modeling. The most important modeling constraint is the value of your time. Be sure to consider the amount of time required by you and your staff to accomplish various modeling tasks when you are selecting a modeling system.

A Final Bit of Advice to Model Builders

Start small and get bigger. Construct a small version of a model you want to build to evaluate your thinking, model building technique, and modeling system. If a small version works, you can almost always make a larger version work. But if you spent a long time making a large model which does not work, you have wasted a lot of time and are in TROUBLE. Even if you use other systems, VORSIM may be useful to you as a vehicle for the evaluation of small prototype models. But keep in mind that VORSIM can handle large models with thousands of equations as well.

For more information, visit: www.vorsim.com

A spreadsheet is a good device for building and testing a small version of model even if you are going to use another system. Moreover, if your problem requires only a small model, you might get the entire job done with a small manual-built model. When designing a small model, be sure to think about key components such as data location, equation writing method, model closure, solution method, and the presentation of results. All of these aspects have to be dealt with in any model and can be tested in a small VORSIM-built spreadsheet model.