

AFRI – World Net Trade Model - Fifty Two African Countries

AFRI is a working world trade model which calculates the impact of changes in applied tariffs. The model is constructed to calculate the impact of various trade liberalization scenarios including world free trade, common market formation, and the implementation of free trade agreements. The user can specify varying states of the world for countries and regions in the model, including the degree of non-competitiveness of import markets (allowing the exploration of the added impact of trade liberalization on less than competitive markets). On the export side, equations can be engaged which simulate productivity gains as liberalization proceeds. These added “states of the world” allow you to explore possible explanations for trade liberalization gains (which “gravity models” indicate are larger than most static models would suggest).

AFRI is a static model; world trade (exports and imports) starts out in an equilibrium state where world exports equal world imports and the trade balance of payments for each country equal capital flows. Then applied tariffs are changed and world prices and country exchange rates are changed by the model to restore world trade balances and country balance of payments equilibrium. The differences between the two equilibrium states can then be compared in terms of changes in trade flows, producer and consumer benefits, and economic welfare.

Design of this synthetic (non-econometric) model focuses on simple export supply and import demand equations and prices modified by applied tariffs. Model equations have an identical form for all countries but are differentiated by equation parameters and intercepts based on country data. Variables are included in equations to easily form common markets or free trade agreements among countries in the model. The design emphasis is to create a practical useful model that can estimate a variety of changes in trade and other policies in countries. Generally, the specification of model equations and indicators is as simple as possible on the grounds that key tariff and sector elasticity data is not robust enough to warrant anything more complicated.

AFRI uses balanced world trade data centered on 2005 for 77 countries/regions. Twenty five of the largest economies, all 52 countries on the African continent, and a rest of the world region are included. Export and import data come from United Nations’ data sets while applied tariff data comes from World Trade Organization and United Nations sources. Data is organized into 21 product groups using the one digit HS chapter classification. Actual trade data was supplemented by mirrored data in some cases and adjustment in rest of the world trade so that world exports equaled world imports for all product groups. The model contains simple constant elasticity export supply and import demand equations with world prices clearing world product markets and exchange rates maintaining the balance of payments for each country/region in the model.

Default supply and demand elasticities are all set at values often used by the World Bank but the user can supply their own elasticities and change them at will (VORSIM allows you to re-write equations with new parameters with the click of a button). As a tool, the AFRI model allows the user to input assumptions about economies and then calculate the

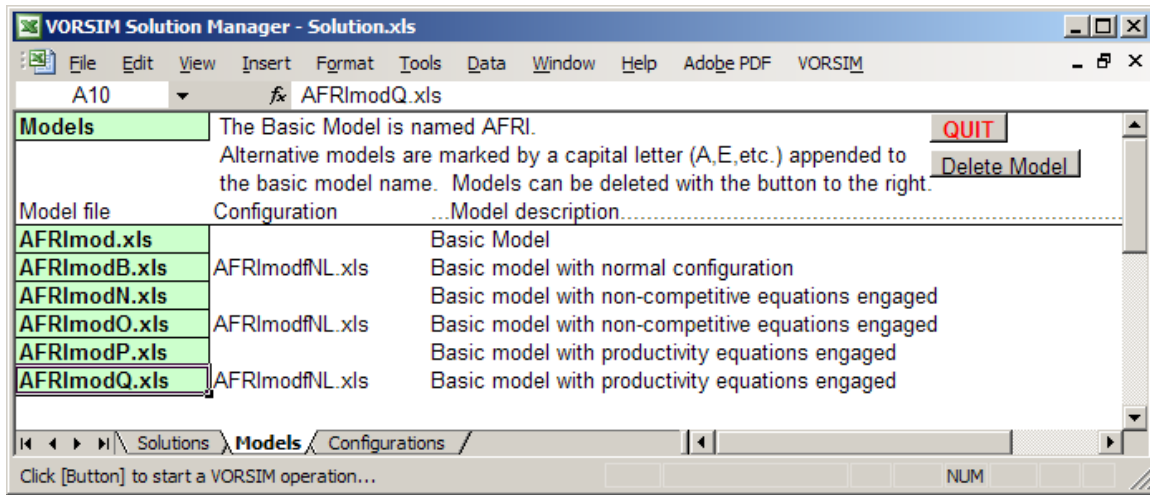
results of policy changes. Policy changes can include tariff changes for one or many or all countries, the imposition of a common tariff in the formation of a common market, and the estimate of the impact of the formation of a free trade agreement among countries in the model. In addition, exogenous supply and demand shocks can be modeled as well as exogenous changes in capital flows. Parameters can be set to emulate non-competitive domestic markets, less than perfect transmission of world prices to domestic markets, and export productivity increases in response to trade liberalization. Once parameters are and data values are reset for a model, equations can be re-written and a new model re-constructed. AFRI comes with a basic static model, a model where productivity equations have been engaged (made operable), and a model where non-competitiveness has been assumed everywhere (configured models have been used to generate solutions; unconfigured versions are for the user). Parameters for these alternative models were arbitrarily set for demonstration purposes; a serious setting of non-competitive parameters requires judgment about sectors of a country's the economy. While we know the basic world equilibrium embedded in the data, we may not know the economic structure that determined the existing equilibrium. However we can make assumptions about the economies that created that equilibrium. Are they competitive or non-competitive or do they respond strongly in terms of productivity gains or not if export prices increase? Are the rules set so that world prices fully or only partially transmit to domestic prices? We can then set model parameters to reflect these assumptions and then calculate the impact of liberalization. Results of a non-competitive option along with productivity response are reflected in two models and their solutions. The basic model contains an assumption of competitiveness and no extra productivity response. Scenario solutions and reports derived from them are included to show the potential of the AFRI model. The scenarios shown in the solutions and reports provided are for illustration purposes only, although a world free trade scenario does provide a global viewpoint of trade liberalization benefits.

AFRI requires that VORSIM be installed on your computer. The model makes extensive use of all of VORSIM's facilities. Before a typical user starts to use AFRI, they should experiment with the static demonstration models (STAT, LUMP) that come with VORSIM and they should try to build their own small static model. Since AFRI is a large model (13,939 equations), it is important to have experience with VORSIM models before starting with AFRI. Once you understand how to work with and build a small static model in VORSIM, it is relatively easy to scale up to a model the size of AFRI. AFRI is large and therefore complex even if the equation structure is simple. It shows the potential of what can be done with spreadsheet modeling with VORSIM.

AFRI comes with 3 unconfigured models and 3 models configured for solution. They are listed on the Model sheet of the Solutions workbook accessed with the [Manage Solutions, Models] button on the Solution Manger control screen (below).

The models with no configuration are the ones you can use once they have been configured for solution with the configuration AFRImodfNL.xls (your only choice on the menu that appears when you click the [Option: USE PREVIOUS CONFIGURATION]

button). Remember that configuration for solution means telling the model where the Solver is located on your computer, a process automatically done when VORSIM



attaches the Solver to a model on your computer during installation. When you want to change structural parameters for counties' competitiveness or productivity response, the following procedure does the job.

1. Change any parameters in the equation workbook and save the workbook.
2. Change the NCI, ESS, or SONOFF parameters in the green cells on the definition workbook. Calculated the workbook will apply the same parameters to all countries. If you want to have different parameters among countries, put numbers in the gray cells to replace the formulas there. Then save the definition workbook (these parameters determine the degree of non-competitiveness and productivity response – NCI=0 means competitive, SONOFF=0.000001 means no productivity response).
3. From the Report Writer control screen, load the Movelist Setfxs.rpt and Click the [Update source..] button to move parameters you have set in the definition workbook to the data and equation workbooks (save them after you look over them). Follow the same procedure with the SetNCI.rpt
4. Load the equation workbook and click the [Update Basedata...] button on the Basedata sheet to bring in the new parameters from the data workbook.
5. Re-write all model equations and create a new model with your new parameters (you may want to save it as an alternative model).
6. Configure your new model using the AFRImodfNL configuration
7. Simulate your new model, add indicators, and pull results into pre-make reports

Files Associated With the AFRI Net Trade Model and Model Considerations

The AFRI model is designed to explore trade policy changes for AFRIAS countries in the context of a world net trade model. AFRIAS is the Economic Community of West African States - Benin, Burkina Faso, Cabo Verde, Cote D'ivoire, Gambia, Ghana,

Guinee, Guinee Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togolese.

Data files – Key data sources for the AFRI model.

Alltariffnumbers.xls – A workbook of 2 digit SITC tariffs from World Bank and UN tariff data sources. Applied (AHS) tariffs from this file are transferred to the AFRI data workbook (AFRIdata.xls) with the Movelist program Tariffs.rpt. The tariff workbook also contains most favorite nation (MFN) and bound (BND) tariffs for countries/regions in the model.

AtradeM – Workbook of constructed world bilateral trade flow matrices for each 2 digit SITC or HS product code and aggregates of imports and exports. An example for the 2 digit SITC product group ALIVE (live animals) is shown below. A complete as possible trade flow matrix has

2005	USA	EUUN	JPN	CHN	CAN	KOR	BRA	IND	MEX	RUS	BEN	BFA	CPV	CIV	GMB	GHA	GIN	GNB	LBR	MLI	NER	NGA	SEN	SLE	TGO	OAFRA	ROW	World		
USA		216229	87650	16732	74785	13991	561	206	61769	466	7					1						31	2			3719	195012	671162		
EUUN	217900		50529	9842	15214	9548	4719	663	4153	73803	72	29	317	829												124299	1584992	2100315		
JPN	948	11012		1342	32	4394			825	1																0	2070	20624		
CHN	23619	9426	8492		3874	3289		39	5	13												1				3	281740	330501		
CAN	1230906	8771	24466	1283		922	387			5564	408					475										467	6049	1279696		
KOR	505	12	161	179	1											30										1	2513	3400		
BRA	7499	1350	15		6	3			7		172			25									164			549	18195	27984		
IND	30	322	33	53	0					3																161	10444	11045		
MEX	518916	466	20		477		0																			0	7740	527619		
RUS	981	963	344	312	141	66		7																		0	3344	6180		
BEN	356	75							22																	4	4	463		
BFA											137					831					5	3159			12		1823	6007		
CPV													40														0	0		
CIV	1	119	30						13	3	9					7				5	4		1			11	556	756		
GMB																											0	0		
GHA	770	437	49		49				19								4			2		2	3		11	5	19	1370		
GIN		706	54		17				12	7														2		23	142	964		
GNB		5	7																								0	13		
LBR			90																								492	582		
MLI	86	673			12				3																	40	36	10	51	920
NER	37		13		46						834	153	28		26							39111		19	809	19	809	24	41099	
NGA	3	18	3	0	0																					9	5	588	623	
SEN		501	2		1				8				5	1	0	6		0	1							23	179	128	854	
SLE		82			0																							1	83	
TGO	646	401	26		8				2																		1	6	1090	
OAFRA	14902	23094	728	523	387	4	10	6	331	244	7			17	44						0	9	24	90			200955	241375		
ROW	63037	378633	54695	79099	3806	6689	976	512	78559	2769	0	0	16	0	0	2	0	0	0	0	0	176	7	0	0	24838	0	693795		
World	2081140	653294	227407	109364	98857	38886	6654	1433	151295	77714	1238	190	334	939	26	3131	48	31	167	129	73	43167	926	17	78	155124	2316839	13003396		

been prepared from UN trade flow data by a sequence of fill-in steps: First, we inserted import data for 2005 or previous years if necessary. Second if import data was not available, we inserted partner country's export data for 2005 or earlier years. Then the ROW (rest of world) region row and column data (red numbers) were calculated as a residual between world totals and the sum of country/region trade (exports read across the matrix and imports read down the matrix). If a ROW figure was negative, it was set to zero and world total was raised accordingly. Finally, inter-regional trade was removed (EUUN – the EU 25 for example). This procedure produced a complete estimate of balanced trade flows for each 2 digit SITC product group, filling in missing data for some countries. The total exports and imports for products from these matrices were then consolidated into exports and import sheets which in turn, were transferred to the AFRIdata.xls model data workbook with the Movelist program Trade.rpt. The AtradeM matrices can be used for bilateral trade flow analysis, these matrices could be used to constrict Armington bilateral trade flow models for example. While they do not contain exact trade flows (because of missing data), they do provide a useful balanced estimate of

trade flows between countries as well as a more robust estimate of countries' exports and imports where data are missing.

Model files - The core of the AFRI model is the set of model files summarized below.

AFRIdata.xls – Model data workbook containing tariffs, trade, and constructed model data.

AFRIdef.xls – Model definition workbook containing descriptive lists of countries/regions and modeling sheets, products, and variables. AFRI countries are broken out separately in the AFRI model and ECOWAS (Economic Community of West African States) members are marked. Countries with major impacts on world markets are included while other non-AFRI small countries are aggregated into the rest of world region. Trade supply and demand elasticities used in the model are also shown in the definition workbook as well as the name of all of the variables created in the model.

AFRIeqp.xls – Model equation workbook containing equations for all of the countries/regions and for the calculations of model equilibrium.

AFRIexog.xls – Workbook of exogenous data for the model.

AFRIind.xls – Workbook of indicators which can be added to model solutions to generate useful analytical numbers. Indicators include producer and consumer benefits (surplus) and welfare as well as trade changes. Indicators are also listed in the definition workbook.

AFRImod.xls – The basic AFRI model workbook. Scenarios are generated by changing tariffs or selecting common market or free trade area membership for countries.

AFRImodfNL.xls – This is the normal configuration file for the AFRI model. World product and country/region balance of payments are cleared with world prices and exchange rates. Bounds are placed on the market clearing variables to avoid unacceptable solutions and encourage faster solution times.

Report files – Sample reports have also been created showing results from selected scenarios. These reports are accessed from the Report Writer control screen using the [Load Movelist....] button. Some reports are really report generators where you can change the country and solution(s) being reported.

AgBenefit.xls – This report gives the aggregate producer, consumer, welfare benefits, and trade changes for the countries/regions in the model (including AFRI members) for a selected scenario. You may change the scenario to view the aggregate results for other scenarios.

Details.rpt – This report presents detailed scenario results at the 1 digit HS chapter level in a series of workbook sheets. There are 4 sheets for the selected AFRI country giving

producer benefits, consumer benefits, welfare, and changes in exports and imports for 2 different solutions. Three free trade scenarios are shown – one basic one, one assuming productivity responses to export price changes, and one assuming the status quo is non-competitive. As expected, liberalization expands benefits by making sectors competitive as they liberalize.

Drawsupdem.rpt – This report available for any VORSIM model, gives a graphical and numerical presentation of simulation results for a chosen 1 digit HS product group for a selected scenario and country in the AFRI model. By changing the country and solution name in the Movelist page, you can generate a new report.

Compare.rpt – This report gives aggregate results for all AFRI countries/regions members from the three scenarios listed in the Details.rpt.

Scenarios – Several scenarios (solutions) from AFRI models are listed below.

The screenshot shows the VORSIM Solution Manager window with a menu bar (File, Edit, View, Insert, Format, Tools, Data, Window, Help, Adobe PDF, VORSIM) and a toolbar. The main area displays a table of solutions with columns for Model(-*), Indicators, Rounded, and Brief solution description. Buttons for 'QUIT', 'Add Indicators to Solution', 'Delete Sol.', 'Round All Numbers in Solution', and 'Add Indicators, Round all Numbers - ALL Solutions' are visible. The table lists various scenarios like 'base', 'free', 'cmm2', 'fta2', 'efre', 'ecmm', 'efta', 'freO', 'freQ', 'cm2O', 'cm2Q', 'efrO', 'efrQ', 'ecmO', and 'ecmQ'.

Solution	Model(-*)	Indicators	Rounded	Brief solution description.....
base	AFRI	(+Ind.)	Round#s	base equilibrium
free	AFRI	(+Ind.)	Round#s	world free trade - all applied tariffs removed
cmm2	AFRI	(+Ind.)	Round#s	USA, KOR common market using average tariff
fta2	AFRI	(+Ind.)	Round#s	USA, KOR free trade agreement
efre	AFRI	(+Ind.)	Round#s	ECOWAS free trade - ECOWAS members unilaterally remove all applied tariffs
ecmm	AFRI	(+Ind.)	Round#s	ECOWAS common market using average applied tariff of members
efta	AFRI	(+Ind.)	Round#s	ECOWAS free trade agreement
freO	AFRI-O	(+Ind.)	Round#s	world free trade
freQ	AFRI-Q	(+Ind.)	Round#s	world free trade
cm2O	AFRI-O	(+Ind.)	Round#s	USA, KOR common market using average tariff
cm2Q	AFRI-Q	(+Ind.)	Round#s	USA, KOR common market using average tariff
efrO	AFRI-O	(+Ind.)	Round#s	ECOWAS free trade - unilateral liberalization
efrQ	AFRI-Q	(+Ind.)	Round#s	ECOWAS free trade - unilateral liberalization
ecmO	AFRI-O	(+Ind.)	Round#s	ECOWAS common market
ecmQ	AFRI-Q	(+Ind.)	Round#s	ECOWAS common market

World free trade (free) – Tariffs (applied) of all countries in the model were set to zero and the model was solved. AFRI is a static model so this free trade scenario is then compared to the base equilibrium situation. This scenario generally benefits all countries (including AFRI members) the most although benefits do differ among product groups. Decreases in protection in the major trading countries generally benefits AFRI countries by changing world prices. This scenario which maximizes world benefits, serves as a basis of comparison for all other scenarios with less liberalization. Free trade scenarios were also done with the O (non-competitive) and Q (productivity) models (freO and freq, respectively). A scenario is included with ECOWAS free trade (efre).

USA-Korea (cmm2, cm2O, cm2Q) and ECOWAS common markets (ecmm, ecmO, ecmQ) – In lieu of a negotiated common tariff, the AFRI average tariff was used. Product groups in countries with lower than the average in effect instituted a higher tariff

and those with higher than average product tariffs received a lower tariff. Since ECOWAS countries are a small part of world markets, scenarios involving ECOWAS protection changes do not significantly impact world prices. Here country exchange rates serve as the main re-balancing variable for ECOWAS countries. The main thing to watch for in any common market scenario is which countries and products have producer and consumer gains or losses. This type of information is useful for the negotiation of the common tariff itself.

Free trade agreements (FTAs) (USA and Korea - fta2, ECOWAS – efa) – Here the idea is that FTA members might divert their exports to the FTA market to take advantage of member's tariffs. If competitive conditions apply, they will fill the market of the highest tariff member first, the second highest next, etc. until either all exports are diverted or exports continue to go to world markets after filling FTA demand. The operative price is assumed to be the marginal price when the last FTA market is filled. This price could be zero if the FTA as a whole is a net exporter after the free trade agreement is implemented; the actual price should be determined as part of the solution of the model. However this latter determination is too complex to implement and therefore the free trade agreement price used was the world price plus the minimum FTA tariff averaged with a zero tariff on exports. Practically, this meant a fairly low tariff for most sectors and a zero tariff for some, and larger gains for FTA members than the common market scenario. Viewing an FTA this way implies that FTA's reduce protection very much; this is an added incentive for them in addition to their relative ease of negotiation (compared to multilateral liberalization in the World Trade Organization).

Other files – Several other types of model related files also reside in the AFRI model directory; *.bak file appendices mark backup files, *.eqa files indicate equation creation matrices in the equation databank, *.sol files are saved solutions, *.lst files are pivot tables created from subsets of solutions, *.rpt (listed above) are reports, and *.txt are backup files of data sheet and model definition contents.

Model configuration – Base equilibrium world prices and country/region exchange rates are all initialized at a value of 1. To generate a scenario, policy variables are changed and the Solver clears world markets and balances of payments with changed world prices and exchange rates. The model is set up so that lower and upper bounds are imposed for world prices and country/region exchange rates. These bounds are maintained during the solution process (speeding it up) but none of them are binding in the solution. Adding bounds on change variables does not count as a model constraint (100 constraints are allowed for non-linear models).

AFRI solution considerations – Since AFRI is a large model, solution problems may be more frequent and solution times longer. The normal configuration includes bounds on change variables which speed up solution times. However, very often the first solution attempt does not clear markets and you have to solve again. On first click, the Solver drives variables away from equilibrium but the second click usually finds equilibrium, so be patient. FTA scenarios are the most difficult to solve followed by common market scenarios. Free trade (global or for selected countries) tend to be easier to solve.