



Núcleo de Economia Regional e Urbana da Universidade de São Paulo

Report on the recent developments of the ARZ Model – An Interregional CGE Model for Lebanon

International Workshop on Regional Modeling São Paulo, November 18, 2011

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The Cedar of Lebanon was **important to various ancient civilizations**.

The trees were used by the Phoenicians for building **commercial** and military ships, as well as houses, palaces, and temples.

Because of its significance the word Cedar is mentioned 75 times (Cedar 51 times, Cedars 24 times) in the Bible, and played **a pivotal role in the cementing of the Phoenician-Hebrew relationship**.

The Lebanon Cedar is the national emblem of Lebanon, and is displayed on the Lebanese flag and Coat of Arms.

Finally, Lebanon is sometimes metonymically referred to as **the Land of the Cedars**.

As a result of long **exploitation**, few old trees remain in Lebanon, but there is now an active program to **conserve and regenerate** the forests.

Source: <u>http://en.wikipedia.org/wiki/Lebanon_Cedar</u>

Outline

✓ Introduction

The ARZ project Structural setting The ARZ model Final remarks

A small country...



Regional setting and sectors in the ARZ model



SECTORS:

- 1. Agriculture and livestock
- 2. Energy and water
- 3. Manufacturing
- 4. Construction
- 5. Transport and communication
- 6. Other services
- 7. Trade
- 8. Administration

Basic regional indicators

	Population	% in population	GRP (in LBP billions)	% in GDP	<i>Per capita GRP (in LBP thousands)</i>	Per capita GRP (in % of national)
Beirut	361.366	9,6	4.169	13,7	11.537,25	142,51
Mount Lebanon Northern Lebanon	1.484.473 763.713	39,5 20,3	13.578 5.329	44,6 17,5	9.147,00 6.977,52	112,99 86,19
Bekaa South Lebanon	489.866 242.877	13,0 6.5	3.154 2.535	10,4 8,3	6.439,04 10.435 <i>.</i> 50	79,54 128 <i>.</i> 90
Nabatieh	416.842	11,1	1.668	5,5	4.001,04	49,42
Lebanon	3.759.137	100,0	30.433	100,0	8.095,76	100,00

Obs. Estimates by the author



Location patterns



Location patterns



Economic Accounts of Lebanon, 2009

Regular publication of the Lebanon's national accounts since 2002 (starting with 1997 estimates) has provided important inputs for models of the Lebanese economy

To our knowledge, initial attempts to model the Lebanese economy are mostly related to accounting-based macro modeling frameworks (e.g. RMSM-X) and national input-output and CGE models

Other sources of data are seldom incorporated in the modeling efforts (e.g. demographic and social statistics – population, labor force and household expenditure surveys)

Renewed attention to the spatial aspects of economic development, both from a theoretical perspective (Regional Science, NEG) and from a policy perspective (WDR 2009 – "Reshaping Economic Geography)

Though small, the Lebanese economy is not homogenous internally, presenting strong variations across sectors and regions

Thus, it is expected that the impact of economic policies varies across different governorates (*mohaafazaat*)

Economic structure of regions vary

- Composition of industry (i.e. allocation among between agriculture, manufacturing, services, government)
- Markets for inputs and products
- Composition and skills of the labor force

Role of infrastructure

- Is the region well-connected with the rest of the country/ rest of the world
- Are there agglomeration economies in physical and human capital senses (presence of universities, institutes of technology)

Role of business and community leaders

Intense interest in regional results

Place-based policies

Policies which are good for nation but bad for one region may not be politically feasible

The ideal: we tell what will happen to economic activity and cost of living in each *mohafazah*

There may exist important trade-offs between efficiency and regional equity

 Understanding the nature of these trade-offs requires to take into account the key linkages between regions using appropriate policy tools

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ARZ: the first fully operational interregional computable general equilibrium model for Lebanon designed for policy analysis. It uses a similar approach to Haddad and Hewings (2005) to incorporate recent theoretical developments in the new economic geography. Experimentation with the introduction of scale economies, market imperfections, and trade costs provide ways of dealing explicitly with theoretical issues related to integrated regional systems

Agents' behavior is modeled at the regional level, accommodating variations in the structure of regional economies

Regarding the regional setting, the main innovation in the ARZ model is the detailed treatment of interregional trade flows in the Lebanese economy, in which the markets of regional flows are fully specified for each origin and destination

The model recognizes the economies of the 6 Lebanese regions (including the capital city, Beirut)

Results are based on a bottom-up approach – i.e. national results are obtained from the aggregation of regional results

The model identifies 8 production/investment sectors in each region producing 8 commodities, one representative household in each region, government demand in each region, and a single foreign area that trades with each domestic region The model is structurally calibrated for 2004-2005; a rather complete data set is available for that year for the estimation of the interregional input-output database (**under conditions of limited information**), facilitating the choice of the base year

The CEER framework includes explicitly some important elements from an interregional system, needed to better understand macro spatial phenomena, namely: (estimated) interregional flows of goods and services, trade costs based on origin-destination pairs, interregional movement of primary factors, regionalization of the transactions of the public sector, and regional labor markets segmentation

The CEER model was developed at the Regional and Urban Economics Lab at the University of Sao Paulo (NEREUS), Brazil

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Given the renewed interest by economists on regional issues, there is a need for the development of regional and interregional models for bringing new insights into the process of regional planning in the country

We do recognize that, at this stage, there are still data limitations

But do you wait until the data have improved sufficiently, or do you start with existing data, no matter how imperfect, and improve the database gradually?

In this project, we have opted for the second alternative

Economic Accounts of Lebanon 2009

- Goods and services input-output tables in current prices (territorial concept, no secondary production)
- Purchaser's prices

Working assumptions:

- Same import coefficients across all the users, by product
- Margins rates proportional to basic flows and do not vary across users (only by product)

Input-output table for Lebanon, 2005 (billion LBP)

					Intermedia	ite uses					Fina	luses			τοτλι
		1	2	3	4	5	6	7	8	Final consumption	GFCF	Exports	Change in inventories	(-) Duty	TOTAL
	1. Agriculture and livestock	94,0	0,0	710,2	1,1	0,0	1,7	0,0	0,0	1236,4	11,3	191,3	-40,0		2206,0
	2. Energy and water	5,4	337,9	143,5	5,9	268,5	100,6	40,3	20,6	420,0	0,0	2,3	0,0		1345,0
Z	3. Manufacturing	104,4	47,5	1322,2	677,6	8,2	269,9	114,9	55,4	4519,4	847,1	1347,3	-51,0		9263,0
Ö	4. Construction	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5030,0	0,0	0,0		5030,0
AS	5. Transport and communication	5,0	9,0	84,0	26,0	697,0	758,0	358,0	23,0	2907,0	0,0	203,0	0,0		5070,0
B	6. Other services	58,0	31,0	413,0	371,0	199,0	355,0	697,0	1371,0	9851,0	0,0	441,0	0,0		13787,0
	7. Trade	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	917,0	0,0		917,0
	8. Administration	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5029,0	0,0	0,0	0,0		5029,0
	1. Agriculture and livestock	39,8	0,0	301,0	0,5	0,0	0,7	0,0	0,0	524,1	4,8	81,1	0,0	-101,0	952,0
	2. Energy and water	15,8	989,3	420,2	17,2	786,1	294,5	118,1	60,4	1229,6	0,0	6,9	0,0	-729,0	3938,0
0	3. Manufacturing	127,7	58,1	1616,7	828,5	10,1	330,0	140,5	67,7	5526,3	1035,9	1647,4	0,0	-1812,0	11389,0
W	4. Construction	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AS	5. Transport and communication	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
B	6. Other services	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	7. Trade	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	8. Administration	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	1. Agriculture and livestock	23,3	0,0	176,1	0,3	0,0	0,4	0,0	0,0	306,6	2,8	47,4	0,0		556,9
	2. Energy and water	0,5	29,0	12,3	0,5	23,0	8,6	3,5	1,8	36,0	0,0	0,2	0,0		115,3
Σ	3. Manufacturing	21,1	9,6	266,8	136,7	1,7	54,5	23,2	11,2	912,1	171,0	271,9	0,0		1879,6
DQ	4. Construction	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
AR	5. Transport and communication	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
Z	6. Other services	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
	7. Trade	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
	8. Administration	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
	1. Agriculture and livestock	9,9	0,0	74,6	0,1	0,0	0,2	0,0	0,0	130,0	1,2	20,1	0,0		236,1
	2. Energy and water	1,4	84,8	36,0	1,5	67,4	25,3	10,1	5,2	105,4	0,0	0,6	0,0		337,7
٩	3. Manufacturing	25,8	11,7	326,3	167,2	2,0	66,6	28,4	13,7	1115,2	209,0	332,5	0,0		2298,4
N	4. Construction	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
IAR	5. Transport and communication	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
ž	6. Other services	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
	7. Trade	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
	8. Administration	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0
VA	Value added	1675,0	-263,0	3359,0	2797,0	3007,0	11521,0	7450,0	3399,0						32945,0
GO	Output	2207,0	1345,0	9262,0	5031,0	5070,0	13787,0	8984,0	5029,0	33848,0	7313,0	5510,0	-91,0	-2642,0	97295,0

Regional aggregates

- Consumption (labor force and mean annual salary, 2004-05)
- Investment (employment in construction, 2004)
- Government (labor force in public sector, 2004)
- Exports (50% national export coefficient + 50% LQ)
- Imports (same as national shares)
- Interregional trade (gravity specification)

Regional gross output by product

Employment shares and "Electricté du Liban"

Regional exports

Regional accounts

Demand by domestic and imported goods

National structure applied for regions

Gravity approach

Matrix of distances (Google maps) + "Horridge formula"

Polarization in Lebanon



Beirut – Tripoli



Baalbek – Tripoli



Baalbek – Nabatieh



Regional accounts – billion LBP

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TempCoeff	1 Beirut	2 MountLebanon	3 NorthernLeba	4 Bekaa	5 SouthLebanon	6 Nabatieh	Total	
1 AGGCON	4660,900	12859,299	3706,300	3108,200	1384,400	3099,900	28819,000	
2 AGGINV	316,400	3049,686	1272,277	616,135	519,485	1634,175	7408,158	
3 AGGOTH5	438,000	2076,600	1105,600	690,500	406,700	311,500	5028,900	
4 C_XSEXP	1572,323	4529,195	1806,601	1942,597	1889,397	429,100	12169,213	
5 e1_C_XSIMP	-1767,829	-4015,006	-1196,064	-1805,448	-759,883	-2624,982	-12169,212	
6 AGGEXP	2429,545	1774,884	716,040	236,282	251,003	102,247	5510,000	
7 e1_IMPORTS	-3480,169	-6696,188	-2081,933	-1633,996	-1156,557	-1284,138	-16332,980	
Total	4169,171	13578,470	5328,821	3154,269	2534,545	1667,802	30433,076	

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Regional accounts – regional shares

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TempCoeff	1 Beirut	2 MountLebanon	3 NorthernLeba	4 Bekaa	5 SouthLebanon	6 Nabatieh	Total					
1 AGGCON	0,162	0,446	0,129	0,108	0,048	0,108	1,000					
2 AGGINV	0,043	0,412	0,172	0,083	0,070	0,221	1,000					
3 AGGOTH5	0,087	0,413	0,220	0,137	0,081	0,062	1,000					
4 C_XSEXP	0,129	0,372	0,148	0,160	0,155	0,035	1,000					
5 e1_C_XSIMP	0,145	0,330	0,098	0,148	0,062	0,216	1,000					
6 AGGEXP	0,441	0,322	0,130	0,043	0,046	0,019	1,000					
7 e1_IMPORTS	0,213	0,410	0,127	0,100	0,071	0,079	1,000					
Total	0,137	0,446	0,175	0,104	0,083	0,055	1,000					

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Regional accounts – composition

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	1 Doirut	2 Mountlehenen	2 Northernlaha	4 Dakaa	E Southlishanan	All	IntDec1	■ All REGDEST		
TempCoen					5 SouthLebanon	o Nabalien				
1 AGGCON	1,118	0,947	0,696	0,985	0,546	1,859	0,947			
2 AGGINV	0,076	0,225	0,239	0,195	0,205	0,980	0,243			
3 AGGOTH5	0,105	0,153	0,207	0,219	0,160	0,187	0,165			
4 C_XSEXP	0,377	0,334	0,339	0,616	0,745	0,257	0,400			
5 e1_C_XSIMP	-0,424	-0,296	-0,224	-0,572	-0,300	-1,574	-0,400			
6 AGGEXP	0,583	0,131	0,134	0,075	0,099	0,061	0,181			
7 e1_IMPORTS	-0,835	-0,493	-0,391	-0,518	-0,456	-0,770	-0,537			
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000			
R001 Size: IntDec1 * REGDEST XSet IntDec1 (AGGCON, AGGINV, AGGOTH5, C_XSEXP, e1_C_XSIMP, AGGEXP										

Structure of interregional trade – sales shares

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R002	1 Beirut	2 MountLebanon	3 NorthernLeba	4 Bekaa	5 SouthLebanon	6 Nabatieh	Total			
1 Beirut	0,655	0,171	0,041	0,016	0,031	0,085	1,000			
2 MountLebanon	0,053	0,748	0,039	0,081	0,021	0,058	1,000			
3 NorthernLeba	0,050	0,133	0,738	0,029	0,013	0,036	1,000			
4 Bekaa	0,018	0,356	0,037	0,564	0,008	0,018	1,000			
5 SouthLebanon	0,083	0,142	0,030	0,013	0,505	0,226	1,000			
6 Nabatieh	0,035	0,096	0,019	0,010	0,061	0,779	1,000			
Total	0,120	0,441	0,158	0,109	0,068	0,104	1,000			
R002 Size: REGSOURCE * REGDEST C_XSFLO(i1,i2);										

Structure of interregional trade – purchase shares

R002 ' R002 ' 1 Beirut 2 MountLebanon 3 NorthernLeba 4 Bekaa 5 SouthLebanon	1 Beirut 0,629 0,201 0,073 0,017	2 MountLebanon 0,045 0,770 0,053	3 NorthernLeba 0,030 0,110	4 Bekaa 0,017 0,338	5 SouthLebanon 0,053	All REC 6 Nabatieh 0,094	Total 0,115	✓ All REGD	EST
R002 · 1 Beirut 2 MountLebanon 3 NorthernLeba 4 Bekaa 5 SouthLebanon	1 Beirut 0,629 0,201 0,073 0,017	2 MountLebanon 0,045 0,770 0,053	<u>3 NorthernLeba</u> 0,030 0,110	4 Bekaa 0,017 0,338	5 SouthLebanon 0,053	6 Nabatieh 0,094	Total 0,115		
1 Beirut 2 MountLebanon 3 NorthernLeba 4 Bekaa 5 SouthLebanon	0,629 0,201 0,073 0,017	0,045 0,770 0,053	0,030 0,110	0,017 0,338	0,053	0,094	0,115		
2 MountLebanon 3 NorthernLeba 4 Bekaa 5 SouthLebanon	0,201 0,073 0,017	0,770 0,053	0,110	0.338					
3 NorthernLeba 4 Bekaa 5 SouthLebanon	0,073 0,017	0,053		-,	0,139	0,252	0,454		
4 Bekaa 5 SouthLebanon	0,017		0,810	0,047	0,034	0,060	0,174		
5 SouthLebanon		0,091	0,026	0,582	0,013	0,020	0,112		
	0,067	0,031	0,018	0,011	0,718	0,209	0,096		
6 Nabatieh	0,014	0,011	0,006	0,005	0,044	0,365	0,049		
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000		
R002 Size: REGSOURCE *	REGDEST C	_XSFLO(i1,i2);)	

Sectoral valued added

Use national coefficients (share of sectoral VA in sectoral output)

TABLO code (IIOAS)

- Interregional Input-Output Adjustment System
- Chenery-Moses approach
- Same (national) sectoral technology across regions

CGE core

Additional data needed

- Labor payments: employment and salary data + national accounts (37,1% of VA)
- Capital payments: capital to labor payments from 1997 national input-output model plus adjustment to reach the target (44,2% of VA)
- K stocks 2,3 times GDP distributed according to sectoral/regional shares in capital payments
 - Underlying assumption: equilibrium in capital market
- Elasticities ("guestimates")

What other simplifying assumptions will be needed?

Get tax data from national accounts

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ARZ Model

Interregional Computable General Equilibrium Model for Lebanon



The University of Sao Paulo Regional and Urban Economics Lab - NEREUS

November 2011



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psflo(REGSOURCE, REGDEST) [%-change]: Price index - interregional trade flows



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Outline

- Introduction
- The ARZ project
- Structural setting
- Simulation results
- ✓ Final remarks

Use establishment data (including location) for disaster analysis (e.g. localized disruption in production)

Use trade linkages for the analysis of infrastructure disruption (e.g. road infrastructure)

Use dynamic setting for forecasting exercises (e.g. financial crisis) – to be implemented

Simulate TFP-enhancing policies

Population displacement analysis

Other usual CGE applications...