Bayesian estimation in NTA frameworks

Details of a data study in progress

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Links to parallel paper on "Analyzing Wealth: The case of the Netherlands"

- This presentation uses the same data and concepts as used in the parallel paper presented in this meeting by the authors

- The links between SNA and NTA and also concepts used in this presentation are explained the parallel paper

- The paper does not deal with non-market output beyond the SNA production boundary, or with intra-HH transfers. It also does not measure transfer wealth. These topics are all dealt with in the parallel paper

- The presentation is a progress report on the work of Bayesian estimates in an NTA framework and does not yet include quantitative results

Keywords

- Frameworks

- Bayesian estimation

Frameworks are

- Sets (vectors, matrices and tables) of (generally, a very large number of) variables, with

- Interrelationships (identities and ratios) defined between the variables

- Data are generally available on a limited data set and/or are inconsistent; identities do not hold between them

- Reliabilities of values of data and ratios are set as priors by statisticians, using their detailed statistical knowledge and experience

- Data, ratios, identities and reliabilities are used to arrive at comprehensive estimates, covering all variables of the framework
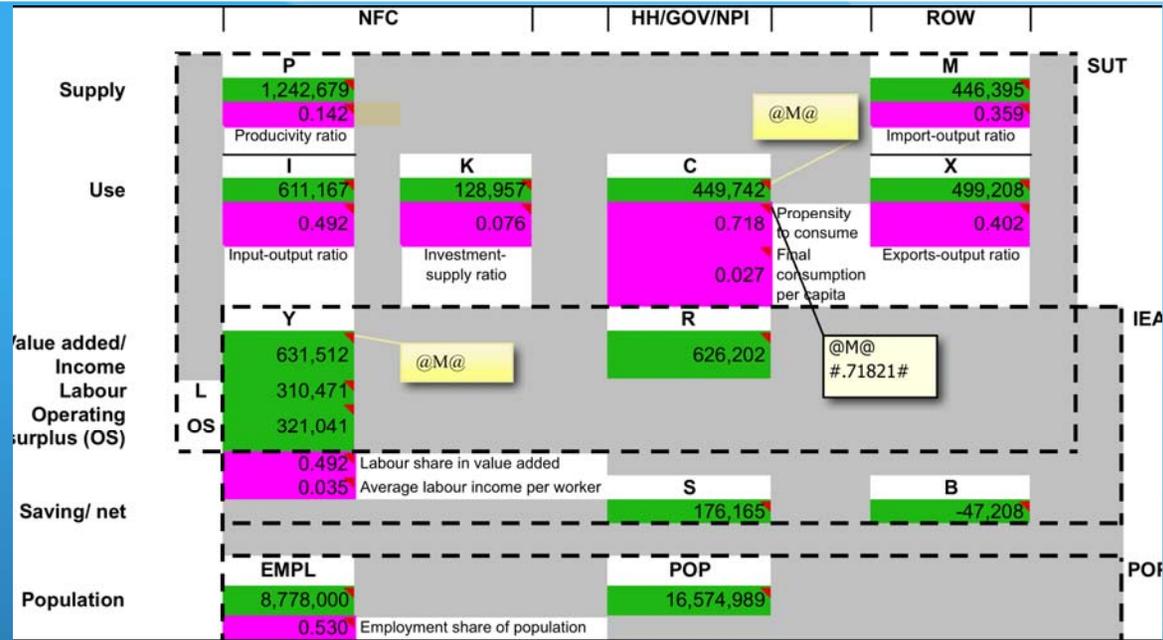
Examples of frameworks

- National accounts, with only monetary data

- Health and education accounts, with monetary and demographic data

- Environmental accounts, monetary data with data on emissions, mineral resources, water and land use

- Framework for demographic projections, with demographic data only

- NTA, with monetary and demographic data

Frameworks define analysis through:

- Selection of variables and data: In NTA economic and demographic data and variables are selected for analysis

- Definition of concepts: In NTA defined concepts are
  - HH actual final consumption
    - Including individual consumption of GOV and NPI, in order to show total consumption of the population on education, health, housing and other, whether financed or not by HH's
    - In basic prices, excluding production taxes less subsidies, in order to assess age impact of production taxes and subsidies
  - Transfers in kind, assessing the age impact on transfers of GOV and NPI individual consumption of education, health, housing and other
  - Adjustments for changes in pension and other entitlements that define the link between transfers in the flow accounts and transfer wealth in the balance sheets
  - Transfer wealth covering the present value of claims that HH's have on future wealth

- Balancing items constituting main aggregates: life cycle, transfer and asset-based income deficits/surpluses

- Ratios: age profiles of selected transactions, compensation of employees and mixed income per worker, social premiums and benefits per worker, final consumption per individual, etc.

Simple Frame-work

		NFC		HH/GOV/NPI		ROW	
Supply	P	1,242,679			@M@	M	446,395	SUT
		0.142					0.359	
		Producivity ratio					Import-output ratio	
Use	I	611,167	K	128,957	C	449,742	X	499,208
		0.492		0.076		0.718		0.402
		Input-output ratio		Investment-supply ratio		Propensity to consume Final consumption per capita 0.027		Exports-output ratio
Value added/ Income Labour Operating Surplus (OS)	Y	631,512	@M@		R	626,202	@M@ #.71821#	IEA
	L	310,471						
	OS	321,041						
		0.492	Labour share in value added					
		0.035	Average labour income per worker					
Saving/ net					S	176,165	B	-47,208
Population	EMPL	8,778,000			POP	16,574,989		POP
		0.530	Employment share of population					

| Ratios	Definition	Value	
Input-output ratio	I / P	0.492	0.492
Investment-supply ratio	K /(P+M)	0.076	0.076
Import-output ratio	M / P	0.359	0.359
Propensity to consume	C/R	0.718	0.718
Exports-output ratio	X / P	0.402	0.402
Producivity ratio	P/EMPL	0.142	0.142
Final consumption per capita	C/POP	0.027	0.027
Employment share of population	EMPL/POP	0.530	0.530
Labour share in value added	L/Y	0.492	0.492
Average labour income per worker	L/EMPL	0.035	0.035

J.W. van Tongeren:
External adjustment for pension entitlements

Identities	Definition	
Value added	Y = P - I	0
Saving	S = R - C	295
External deficit to be financed	B = -(X - M)	-5,605
Income distribution	Y = R	5,310
Finance of capital formation	K = S + B	0
Supply equals use	P + M = I + C + K + X	0
Value added, income components	Y=L+OS	0
Value added-expenditure	Y=C+K+(X-M)	0

J.W. van Tongeren:
Flows of the ROW, resources less uses, re: Compensation of employees, Production taxes less subsidies, Taxes on income and wealth, Social contributions and benefits, Other current transfers

Elements of framework
Variables: 14
Data: 14
Ratios: 10
Identities: 8 (2 dependent)

Information items: 30

Bayesian estimation, simple example
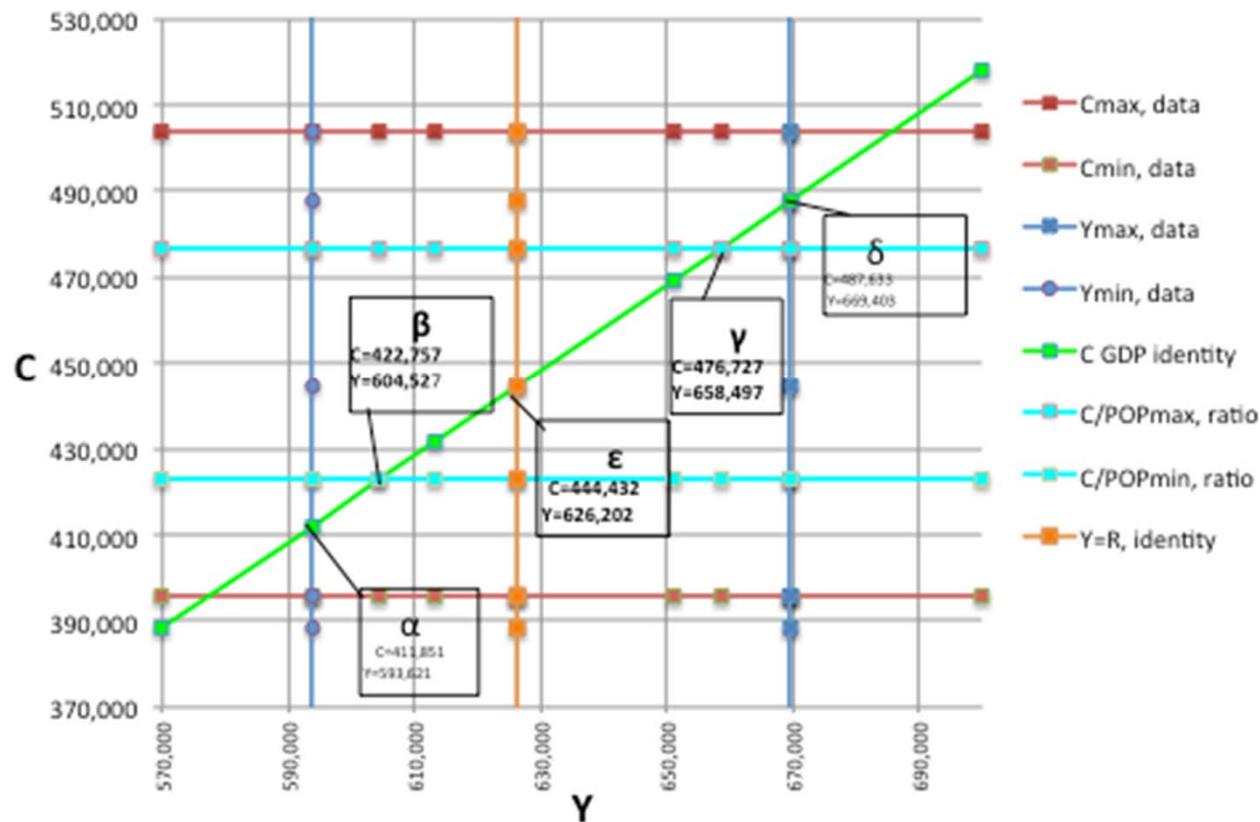
The graph illustrates the two-dimensional estimation of C and Y, under conditions of identities, ratios and fixed reliability intervals of data and ratios.

Legend:
- Cmax, data
- Cmin, data
- Ymax, data
- Ymin, data
- C GDP identity
- C/POPmax, ratio
- C/POPmin, ratio
- Y=R, identity

β
C=422,757
Y=604,527

γ
C=476,727
Y=658,497

ε
C=444,432
Y=626,202

α
C=411,851
Y=591,021

δ
C=487,633
Y=669,403

It shows how minima and maxima of data (C and Y $_{min/max}$), ratios (C/POP $_{min/max}$) and identities (C Supply=Use) limit posterior intervals of variables C and Y (between points β and γ) and may even result in exact estimates (point ε), if an additional restriction (Y=R) is added

Bayesian, formalized approach

- The Bayesian estimation applied in our approach uses a normal distribution of the reliability of data values instead of fixed reliability intervals

- The method is equivalent to the generalized least-square $\sum_{i=1}^{n}\frac{1}{\sigma_i^2}\left(X_i - \overline{X}_i\right)^2$ estimates of X_i (i=1,2,....n), by minimizing under conditions of j (1,2,…,m) identities $f_j(X_1,X_2,.....,X_n)=0$

- X_i are the variables to be estimated, $\overline{X}_i$ e the prior values of the data, σ_i are the prior standard deviations of the data

- Ratios are linearized and are added as linear restrictions to the identities

- Posterior values of X_i and σ_i are estimated as a result of the Bayesian estimation approach

NTA framework (i) sector accounts

	A B C D E F	BI	BJ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ
2		Households		Households, Micro data, sector accounts					Households, Micro data, sector accounts				
3				Households, Micro data, sector accounts					Households, Micro data, sector accounts				
4	Data source: Statistics Netherlands, 2010 final data												
5	mln euro												
6		SNA											
7		Receipts	Disburse-ments			Receipts					Disbursements		
8	**LIFE CYCLE ACCOUNT**			0-4	5-24	25-64	65+	Total	0-4	5-24	25-64	65+	Total
9	Final consumption expenditure, total		331,328						19,683	99,680	190,243	89,847	399,4
24	Labour income	355,057		0	28,690	488,679	52,142	569,512					
27	**Life cycle surplus (+)/ deficit (-)**		**23,729**						-19,683	-70,990	298,437	-37,705	170,
28	**TRANSFER ACCOUNT**												
29	Taxes less subsidies on products and production		62,036						2,446	13,434	44,168	17,091	77,
30	Current taxes on income, wealth, etc.		54,587						0	468	37,067	5,667	43,
31	Net social contributions	531	143,613	0	0	0	0	0	0	21,506	432,942	26,569	481,
40	Social benefits other than social transfers in kind	109,728	531	0	4,106	74,066	81,893	160,066					
54	Social transfers in kind	116,170		10,535	53,659	43,594	43,322	151,110					
55	Other current transfers	14,802	19,633	790	4,330	14,405	4,687	24,211	789	4,330	14,560	4,711	24,
59	**Transfer surplus/deficit**		**-39,169**						8,089	22,357	-396,672	75,864	-290,
60	**ACCOUNT FOR ASSET BASED REVENUES**												
61	Operating surplus, gross	5,543		0	115	8,787	2,411	11,313					
62	Property income	48,263	12,795	0	4,380	211,117	85,111	300,608	0	1,467	61,066	4,503	67,
70	Capital transfers	6,658	7,185	-4	504	24,000	1,042	25,542	0	9	424	18	
74	Adjustment for the change in pension entitlements (SNA)	15,856	0	0	834	32,760	-17,738	15,856					
75	Adjustment for the change in other social entitlements (NTA imputation for Transfer Net Worth)												
76	**Net Asset Based Revenues, incl. Capital transfers**		**15,440**						11,594	48,633	98,235	-38,160	120,
77	**DEMOGRAPHICS**												
78	Size of (sub-) population		16,655,799						923,106	4,025,442	9,112,305	2,594,946	16,655,
79	Nr. of employees		12,684,000						0	724,000	11,960,000	0	12,684,
80	Nr. of own account workers		2,100,000						0	34,000	2,066,000	0	2,100,
81	**SNA ADJUSTMENT AND SNA/NTA BALANCING ITEMS**												
83	Depreciation		26,189						2	16,294	928,089	242,838	1,187,
84	GDP												
85	External balance of goods and services (imports - exports)												
86	Primary/ National Income, gross		396,068						0	31,718	647,518	135,161	814,
87	Disposable income, gross		418,935						10,536	67,509	295,014	228,116	601,
88	Saving, gross		41,427						-11,594	-44,771	93,363	103,440	140,
89	Changes in net worth due to saving and capital transfers		14,711						-11,600	-60,570	-811,149	-138,374	-1,021,
90	Net lending		7,311						-11,602	-75,993	-1,710,487	-379,354	-2,177,

NTA Framework, sector accts. = Extended HH sector accts., incl. NPI's
Comprehensive NTA framework, sector accts. incl. non-HH sector accts.

NTA framework (ii) balance sheets

	A	B	C	D	E	F	BE	BF	BG	BH	BI	BJ	BK
206	BALANCE SHEETS AND CHANGES IN BALANCE SHEETS												
207										Households			
208										NTA Adjusted			
209								Assets			Liabilities		
210							Opening balance	Capital and Financial transactions	Other Changes in Assets	Closing balance	Opening balance	Capital and Financial transactions	Other Changes in Liabilities
211	Non-Financial assets						1,632,112	7,400	-28,472	1,611,040			
212		Produced non-financial assets					834,276	7,445	8,021	849,742			
213													
214		Non-produced non-financial assets					797,836	-45	-36,493	761,298			
215	Financial assets/liabilities						1,576,910	30,338	86,550	1,693,798	796,546	23,484	-345
216		Insurance, pension and standardized guarantee schemes					900,094	12,061	80,718	992,873	0	0	0
217			Non-life Insuranceschemes				12,877	-494	-377	12,006	0	0	0
218			Life Insuranceschemes				153,814	-3,441	5,584	155,957	0	0	0
219			Pension schemes				732,149	15,856	75,511	823,516	0	0	0
220			Standardized guarantee schemes				1,254	140	0	1,394	0	0	0
221	Other social support schemes (NTA imputations for Transfer Net Worth												
222		Other financial assets/liabilities					676,816	18,277	5,832	700,925	796,546	23,484	-345
223	Financial assets minus liabilities										780,364	6,854	86,895
224	Net worth										2,412,476	14,254	58,423

NTA framework, balance sheets = Extended HH sector balance sheets Incl. NPI's, plus balance sheets of a HH sector breakdown by age

Comprehensive NTA framework, balance sheets incl. non-HH sector balance sheets

Reliabilities of data in NTA framework

Basic Data

GDP	F1
NFC sector data	M
FC sector data	S
GOV sector data	F1
NPI sector data	L
ROW sector data	S
HH sector NR data	
Indvidual final consumption, total	S
Labour income	M
Taxes less subsidies on products and production	S
Taxes on income and wealth	S
Net social contributions	M
Social benefits other than social transfers in kind	H
Other current transfers	L
Operating surplus	M
Property income	M
Capital transfers	P
Depreciation	L
Balance sheet data, non-financial produced assets	M
Balance sheet data, non-financial non-produced assets	M
Balance sheet data, financial assets and liabilities	M
HH sector Micro data	
Indvidual final consumption, total	S
Labour income	M
Taxes less subsidies on products and production	S
Taxes on income and wealth	M
Net social contributions	L
Social benefits other than social transfers in kind	M
Other current transfers	L
Operating surplus	H
Property income	L
Capital transfers	M
Depreciation	L
Balance sheet data, non-financial produced assets	L
Balance sheet data, non-financial non-produced assets	L
Balance sheet data, financial assets and liabilities	L
Demographics	F1

Reliability symbol	Quality of data/ratio value	Reliability coefficient, prior
F1	Near-fixed	+/- 0.001
S	Superior	+/- 0.010
H	High	+/- 0.030
M	Medium	+/- 0.060
L	Low	+/- 0.120
P	Poor	+/- 0.240

Micro data are included as data and in ratios if their total is between 80% and 120% of the macro data. If less than 80% or higher than 120%, micro data are only included in ratios (next page)

Ratios define analysis in NTA framework

Ratios	
Value added components	L
Compensation of employees per employee	H
Mixed income per own account worker	M
Pension and non-pension contributions/wages and salaries	H
Social benefits per individual	H
Distribution of workers by age groups	F1
Distribution of population by age groups	F1
Employment as percent of population	F1
Distribution of individual final consumption between HH's, GOV and NPI's	L
GOV individual consumption as percent of total GOV consumption	M
Individual final Consumption / disposable income	H
Individual final consumption per individual	H
% Composition of individual final consumption	H
Components of disposable income (%'s)	L
Sector distribution coefficients, selected flows	L
Balance sheet structures	H
Profile Distribution Ratios, IEA	S
Profile Distribution Ratios, Balance sheets	M

Identities define consistency between values of variables in NTA framework

- Identities define consistency between HH sector variables and age breakdowns using micro data

- Identities define consistency between sector variables and variables of the total economy and rest of the world

- Identities define SNA and NTA aggregates (e.g., labour income) and balancing items (e.g., NTA life cycle surplus/deficit, transfer surplus/deficit) and SNA aggregates and balancing items (e.g., GDP, saving, changes in net worth) in terms of individual transactions

- Identities in balance sheets between opening and closing balance sheets and changes in asset accounts

- Identities define consistency between flow-account variables and balance-sheet variables (e.g., changes in net worth)

Objectives of study

- Define NTA framework in which Bayesian estimates are made. This work is done

Work-in-progress

- Comparison of posterior and prior reliabilities of comprehensive NTA framework, showing how much a framework orientation contributes to improvement of reliability of estimates

- Comparison of posterior reliabilities between NTA framework with only monetary data and a framework in which population and micro data are included. This is to asses improvement of the reliability of NTA and SNA estimates, using additionally micro and population data that are not used by national accountants

- Estimation of comprehensive framework when only a limited data set is available. The results could be used when national accounts are mainly limited to GDP data

- Projection of a limited data set to the future and estimation of the remaining variables using the Bayesian estimation method

Obstacles to NTA implementation

- lack of information on the link between economic and demographic data and limited cooperation between national accountants and demographers

- Difficulty of finding age-related micro data that are reliable alternatives to estimation of the macro variables

- Focus in national accounting on GDP and not on sector accounts or balance sheets. Sector accounts are the main source for NTA data

- Lack of consistency between flow accounts and balance sheet data