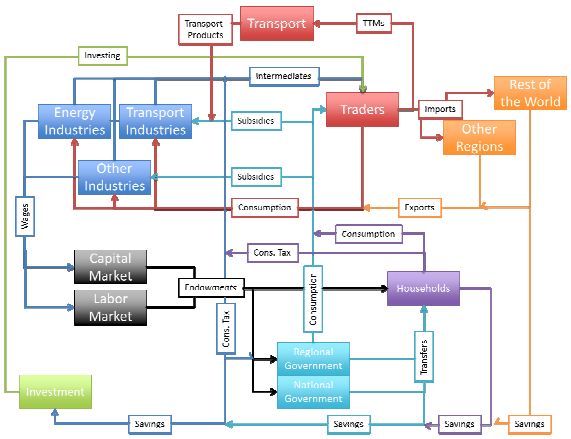
REMES

RCGE Model, 24.11.2016

Introduction

- REMES is a Computable Generalized Equilibrium (CGE) model
- It has been tailored to a Norwegian Social Accounting Matrix and aims to represent the dynamics of the country
- It is coded in GAMS-MPSGE a language/system designed to speed up and simplify the development of CGE models
- It represents one or more regions of the country, along with industry sectors, production goods, households, government, tax collection, investment, and international trade
- Many of its features are modular; they can be activated or deactivated depending on the case and type of analysis
- REMES has a base model, along with several which have branched from it to cover even more specific case studies and modelling needs

Base Model Diagram



REMES'S Components

- **Zero-profit Conditions**: The value (cost) of the inputs must be greater or equal to the value (earnings) of the outputs
  - Depends on production technologies
- **Market-Clearing Conditions**: The totality of the output of each commodity must be input to something
  - Different for consumer goods, production factors, and welfare goods
  - Depends on production technologies and activity levels
- **Income Balance**: The income of each consumer must be equal to the consumer's purchases of welfare
- Ad-hoc Conditions: Used to scale up/down endowment, endogenous taxes

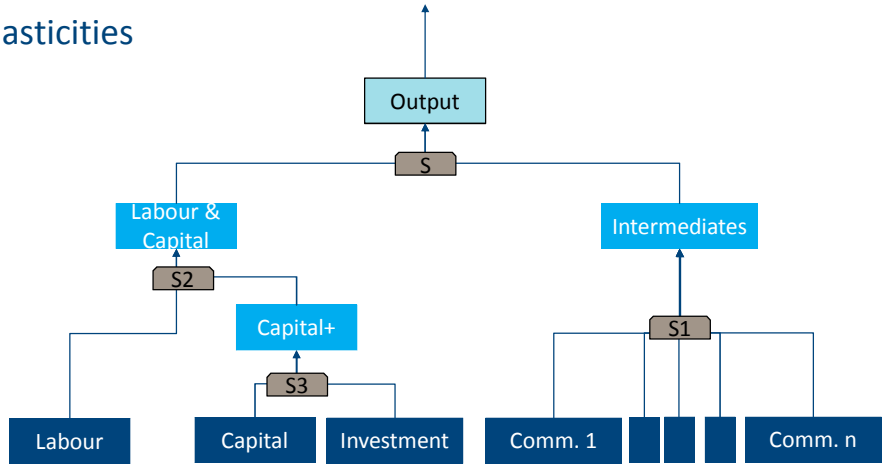
Assumptions and Data Input

- REMES is a **neo-classical Arrow-Debreu** CGE model
  - Amount of endowments (labour, capital) determine the closure of the model
- Each run of the model represents one-period money flows.
- Sectors, commodities and regions is **defined by the data input**; specific regions and sectors can later be further differentiated in the model
- Two basic data inputs: a **Social Accounting Matrix**, and a set of **Elasticities of substitution** for industries

Social Accounting Matrix

		Ind_1	Ind_2	Prod_1	Prod_2	Labour	tdirect	Capital	tax_sec	tax_com	HOUS	GOVT	INV	STOCKS	tmarg	trade	tot
R1	Ind_1			409900													409900
R1	Ind_2				1683845												1683845
R1	Prod_1	155833	276079								286404	8453	46848	6702		324927	1105246
R1	Prod_2	41605	485316								307449	305492	190735	53827	213781	796390	2394596
R1	Labour	59611	585769														645381
R1	tdirect										146994						146994
R1	Capital	51438	202992														254429
R1	tax_sec	-919	-14828														-15747
R1	tax_com			85246	53653												138900
R1	HOUS					645381		254429				159782					1059592
R1	GOVT						146994		-15747	138900						249440	519587
R1	INV	102333	148517								34599	45859					331308
R1	STOCKS												60529				60529
R1	tmarg			161456	13300												174756
R1	trade			448642	643798						284146		33196				1409782
R1	tot	409900	1683845	1105246	2394596	645381	146994	254429	-15747	138900	1059592	519587	331308	60529	213781	1370757	

Elasticities



REMES Modelling Elements

- Commodities: **everything with a price**.
- Three types of commodities are distinguished by the model:
  - **Intermediate products**: Products produced and consumed/purchased by industry actors
  - **Production factors**: Purchased by the industry, but "produced" in a fixed amount by consumers
  - **Welfare products**: The only type of commodity directly purchased by consumers
- **Market clearing** for all commodities depend directly on how those commodities are produced, and the activity levels (availability) of their producers and consumers.
- Prices are unitary: REMES always sees **relative changes in prices**.

REMES Modelling Elements

- Sectors: identified by their **activity level**
- Producers have commodities as **inputs and outputs**
- A **Production Cost Function** determines how much worth of each input is needed to produce the worth of output.
- Substitution determines the level in which inputs (outputs) **can substitute** each other (e.g. Capital and Energy may substitute Labour to a certain extent)
- Changing substitution levels and reference volumes implies a **change in technology** (same output is produced with different input)
- Activity levels define the amount of input/output the sector consumes/produces, and are relative, just like prices.

REMES Modelling Elements

- Consumers are characterized by a **budget**
- A budget if financed by a series of endowments and tax income, which are either
  - Income from endowed **labour, capital, land**…
  - Income from **transfers** from other consumers
  - Income from **taxed sectors, paid** to the consumer
  - Expenses **paid directly** to other consumers
- The budget is spend in welfare commodities
- Welfare commodities are then **transformed into consumption of goods**
- Budgets are **absolute** in value

REMES Modelling Elements

- Taxes are applied to a sector's **inputs or outputs**
  - Their value is **relative** to the prices of the commodities taxed
  - Can be **endogenously or exogenously** defined
  - Taxes between consumers are rather **transfers between consumers**
- Multipliers can be applied to **endowments**
  - To **endogenously define** the size/worth of an endowment
  - E. g. To reduce the amount of provided Labour if wages go too high
  - E. g. To increase government grants if consumer goods become to expensive
- Endogenous taxes and multipliers are both defined with **custom auxiliary equations**

A Production Block

```
*Domestic Production
$PROD:XD(cnt,sec)$(XDZ(cnt,sec) and (SW_GTRANS eq 0) and R_S(cnt)) t:0 s:0
s1:1 s2:0 s3(s1):0
O:PD(cnt,sec,com)        Q:XDDZ(cnt,sec,com)   P:(1+taxpz(cnt,sec))
+        A:GOVTN$(SW_GOVT ge 2)       T:taxp(cnt,sec)$(SW_GOVT ge 2)
+        A:GOVTL(cnt)$(SW_GOVT eq 1)  T:taxp(cnt,sec)$(SW_GOVT eq 1)

I:P(cnt,com)     Q:(IOZ_adj(cnt,com,sec)+IOZ_adj(cnt,com,sec)*trmz(cnt,com))
+        P:(1+taxcz(cnt,com))
+        A:GOVTN$(SW_GOVT ge 2)          T:taxc(cnt,com)$(SW_GOVT ge 2)
+        A:GOVTL(cnt)$(SW_GOVT eq 1)     T:taxc(cnt,com)$(SW_GOVT eq 1)
+        s2:

I:PL(cnt)$(SW_LMKT eq 1)                 Q:LZ(cnt,sec)    s1:
I:PLN$(SW_LMKT eq 2)                     Q:LZ(cnt,sec)    s1:
I:RKC(cnt, sec)$(SW_KMKT eq 1)           Q:KZ(cnt,sec)    s3:
I:RKCN$(SW_KMKT eq 2)                    Q:KZ(cnt,sec)    s3:
I:PS(cnt)$(SW_INVS eq 1)                 Q:INVZ(cnt,sec)  s3:
I:PSN$(SW_INVS eq 2)                     Q:INVZ(cnt,sec)  s3:
```

A Consumer Block

```
*Household Demand
$DEMAND:HOUS(cnt)$(R_S(cnt))
E:PL(cnt)$(SW_LMKT eq 1)          Q:(LS.L(cnt)*(1-ty(cnt)))
E:PLN$(SW_LMKT eq 2)              Q:(LS.L(cnt)*(1-ty(cnt)))
E:RKC(cnt, sec)$(SW_KMKT eq 1)    Q:(KZ(cnt,sec)*(1-ty(cnt)))
+       R:OIL(sec)
E:RKCN$(SW_KMKT eq 2)             Q:(KS.L(cnt)*(1-ty(cnt)))
E:PTR(cnt)                        Q:(TRANSF.L(cnt))
+       R:PCINDEX(cnt)
E:PS(cnt)$(SW_INVS eq 1)          Q:(-SH.L(cnt))
+       R:R_SH(cnt)$(SW_ELCERT ne 1)
E:PSN$(SW_INVS eq 2)              Q:(-SH.L(cnt))
+       R:R_SHN$(SW_ELCERT ne 1)
E:ER                              Q:(TRHROW.L(cnt))
D:PU(cnt)                         Q:CBUDZ(cnt)
```


Current Options/Features of REMES

- **Local/National Government**, or both. Consumption figures can be assigned or calculated, but income specifications could be updated.
- **National/Local Capital markets**. Formerly, both national and local markets could be active at the same time, but this was removed due to problem with local price consistency.
- **National/local labour market**. Implemented similarly than capital, with further improvements in specialized models
- **National/local investment system**.
- **Supplementary Regions**, of which only their interactions with other regions are modelled, but no internal dynamics to simplify calculations or include regions without precise data

Submodels of REMES

- The **Recursive-Dynamic submodel**, we run the model twice; the investment results from the first run are used to modify/increase capital endowments for the second run
- The **ELCERT submodel** adapts the model above to make sure there is enough investment in green energy sources to cover a given capital increase
  - Green energy producers can sell green certificates along with energy from new sources, which are bought by an specialized agent
  - This agent in turn finances itself taxing certain producers and households a green certificate tax

Submodels of REMES, cont.

- The **TIMES-REMES submodel** is specially prepared to take input from the TIMES model in the form of technology changes and investment requirements. REMES, in turn, will calculate energy demand in each regions and by each sector, and pass it onto times
- The **Exchange Rate/Oil Price** submodel models oil commodities and the Norwegian continental shelf in a different way to other commodities/regions, and also incorporates a different relationship with the Rest-of-the-World region
  - Able to match GDP prognosis by the KMD for vie exchange rate and oil price adjustments

Applications and uses

- Given a snapshot of an economic system, and the relationships defining it, REMES can calculate the activity levels of each actor, consumption levels, taxes, prices of goods, GDP by region, and so on
- Endogenous constraints and exogenous data can be used to guide certain REMES parameters along paths or states, seeing how the rest of the economy reacts
- This provides a complementary analysis for other models
- Uses include assessment of
  - the impacts of oil/exchange rate changes in a country's GDP over the years
  - interaction between energy sources and transport
  - green certificate's effects on the electricity producers
  - effects industry changes have on immigration, unemployment and wages

Strengths and Weaknesses

- +Quick development and change
- +Flexible structures if within MPSGE-framework
- +Useful custom expression for additional control

- -Requires GAMS, MPSGE, PATH
- -Precise mathematical description is labourious
- -Black-box: some issues might take significant time to solve