

Workshop on assessing the impacts of environmental regulations,
MODEDR project

Prague, 23-24.11.2009

CGE model of the Czech Economy

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Agenda

- Model overview
- Taxes
- Specification of the economy
- Unemployment curve
- Abatement curve
- Model closure

Overview of the Czech Model

- Multi-sector static Applied General Equilibrium model of Arrow-Debreu type
- Environmental module: pollution and abatement
- Environmental policy instruments:
 - quotas (emission limits)
 - tradable permits
 - taxes
- Ecological tax reform module: equal yield constraint
- Taxes in the benchmark equilibrium: 10 types of taxes
- No impact from environment to economy (except welfare)
 - no value of environmental quality
 - no damages from environment on economy
 - no efficiency analysis, just cost-effectiveness

Taxes

■ Production

- Process-related air-pollution emission tax
- Energy combustion-related air-pollution emission tax
- Payroll tax (contribution of employers)
- CIT
- Other net taxes on production

■ Products

- Excise tax
- VAT
- Other net taxes on products

■ Other

- Payroll tax (contribution of employees)
- PIT

Specification of the economy

- Multi-sector Applied General Equilibrium model
 - description of the national economy for 2005
 - producers: profit maximisation under perfect competition
 - consumers: utility maximisation under budget balance & LES structure
 - “equilibrium” on all markets (Walras’ Law)
- International trade
 - small open economy
 - domestic and foreign goods are imperfect substitutes (Armington)
 - no international co-ordination of environmental policy
- Prices:
 - described as relative prices (no inflation)
 - individual agents are price takers; no money illusion
 - all benchmark prices are 1

Wage Curve

- A negative relationship between the unemployment rate and real wage *levels*
 - i.e. it goes against the Phillips Curve that ties wage *growth* to the unemployment rate
- $\ln(w^{\text{real}}) = \beta \ln(ur) + z$, where $\beta < 0$
 - i.e. an increase of unemployment by 1% is associated with a decrease of wages by $\beta\%$
 - *show graph here*
- It has been originally formulated by Blanchflower & Oswald (1995) and empirically tested for Czech economy (2005)

Production Part

- 7 production factors:
 - 2 exogenous supply (capital and labor)
 - 5 endogenous supply (coal, natural gas, biomass, oils, electricity)
- 19 sectors with constant returns to scale
- Production function is a combination of
 - Leontief's function
 - nested CES functions $Z = \pi \left[\delta^{\frac{1}{\sigma}} K_1^{\frac{\sigma-1}{\sigma}} + (1-\delta)^{\frac{1}{\sigma}} K_2^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$
- *show graph here*

Consumption Part

- Representative household
 - Utility function: Stone-Geary type
 - Demand function: LES
 - Welfare is measured by EV

$$U(\mathbf{x}) = \sum_i \beta_i \ln(x_i - \gamma_i)$$

$$x_i(p_i, m) = \gamma_i + \left(\frac{\beta_i}{p_i} \right) \left(m - \sum_j p_j \gamma_j \right)$$

- Government
 - No utility function
 - Demand function: Leontief
- Exogenous demand
 - “Gross fixed capital formation” from i/o table is aggregated with “changes in inventories”

Foreign Trade

- Export:
 - endogenous export supply
 - exogenous world price, i.e. horizontal export demand curve (a characteristics of a small-open economy)
 - CET function

- Import:
 - endogenous import demand
 - exogenous world price i.e. horizontal import supply curve
 - Armington-CES function
 - special treatment for Gas sector

- *show graph here*

- Exchange rate:
 - Numéraire
 - Trade surplus or deficit is possible

Environment

■ Emission:

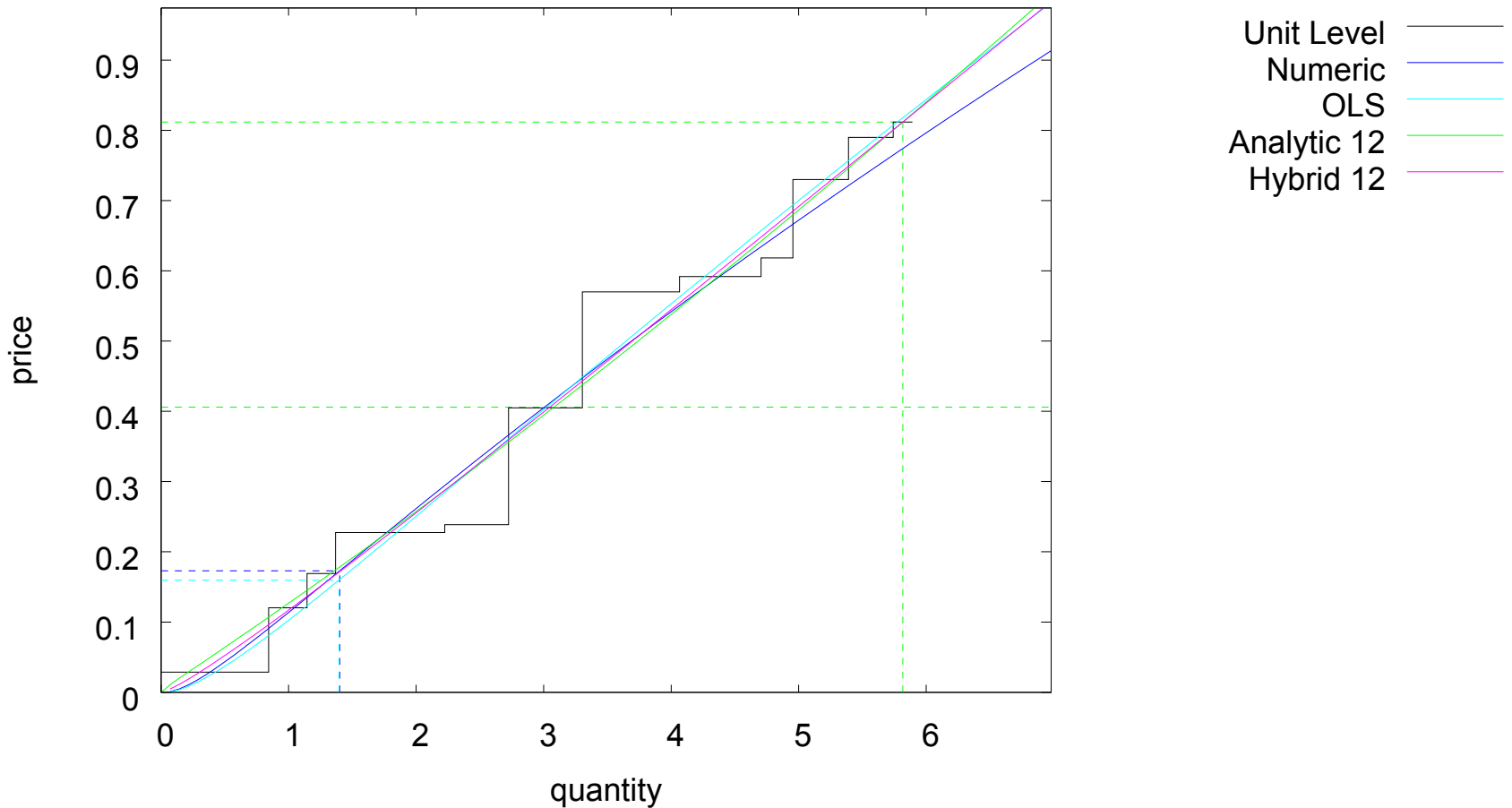
- air pollutions: SO_2 , CO_2 , CO, NO_x , PM, VOC
- emission sources: fuels combustion, industrial process, households consumption, mobile sources
- endogenous choice between (i) paying for pollution permits or emission charges; (ii) investing in abatement; (iii) reducing activity level; (iv) substituting with less polluted factors
- special treatment for emission by households

■ Abatement:

- modelled like 'normal' production sector (Leontief production function)
- abatement service is demanded by all polluters (on a perfect market)
- decisions on ratio between pollution and abatement are reversible (endogenous)
- capital and some produced goods are inputs in abatement sector (spending effect)
- changes in input costs leads to changes in marginal abatement costs (eg: changes in productivity)

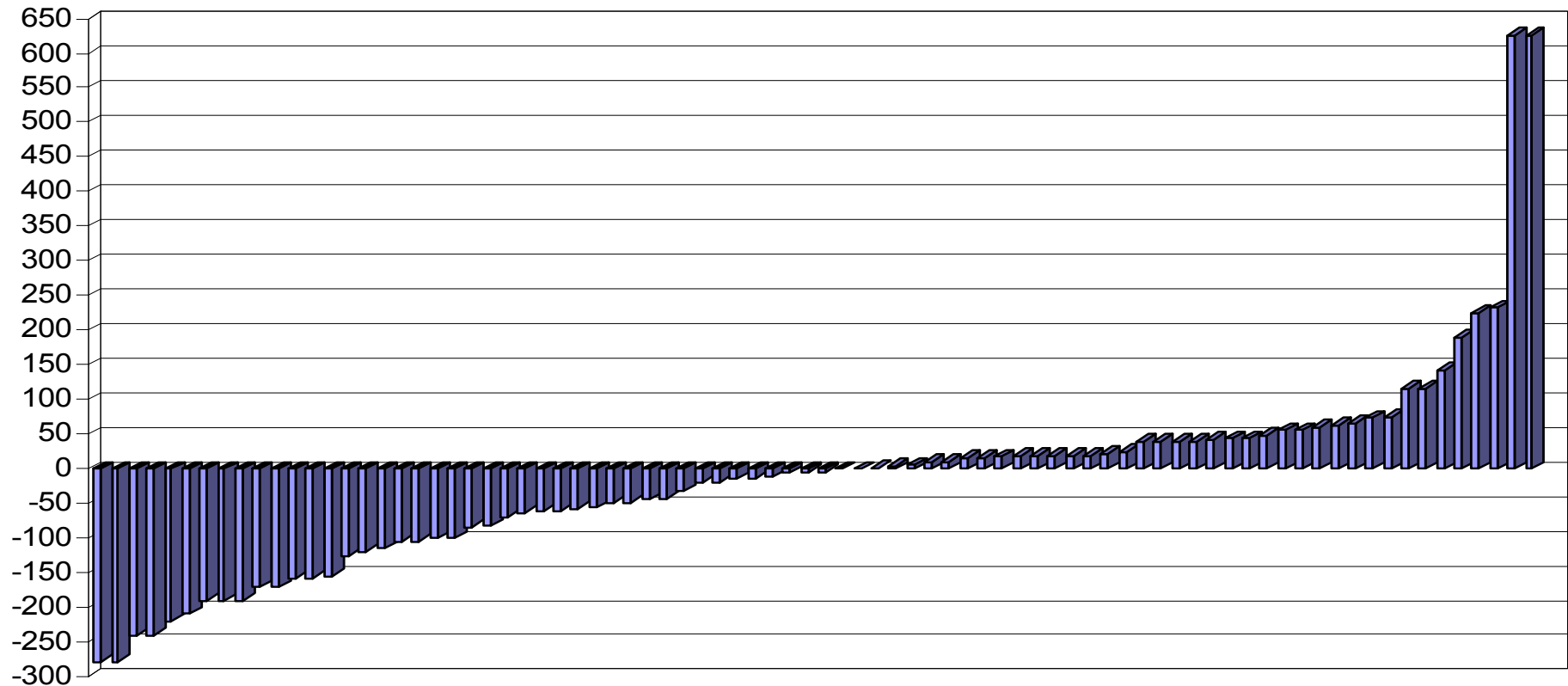
Approximation of MAC curve

Compare Approximations



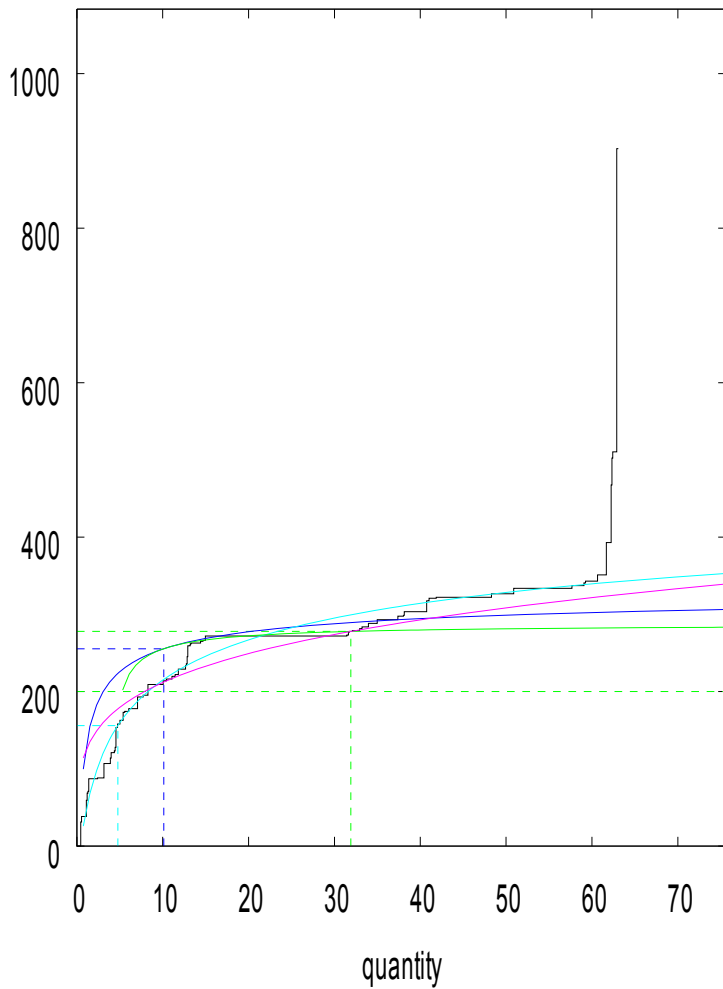
MAC curve of GHGs by McKinsey (scenario with gradual fuel shift)

Max of mc

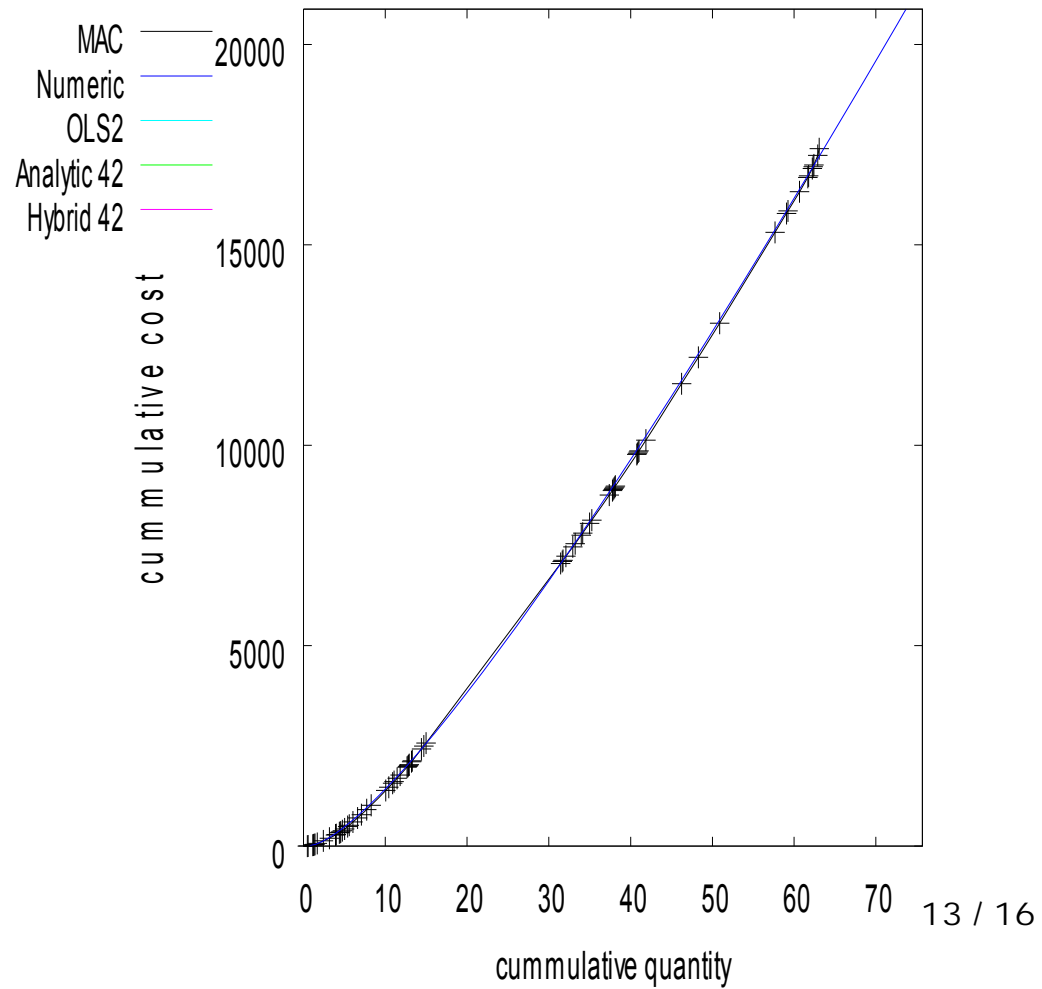


MAC vs TAC curves

Compare Approximations

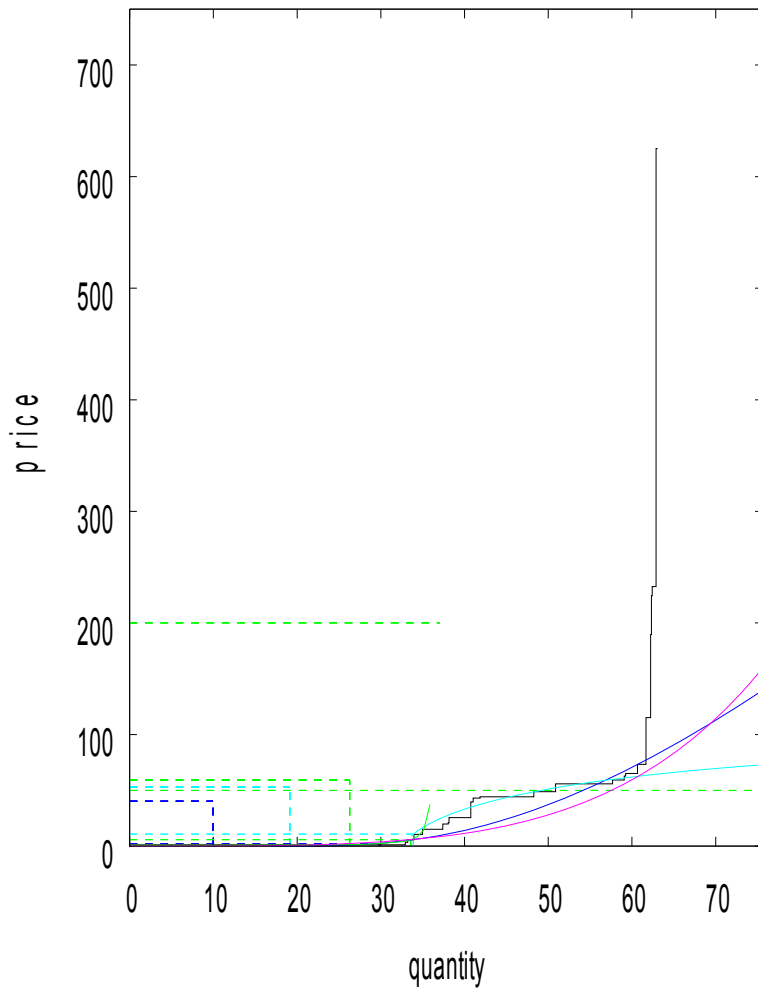


GHG abatement cost for Czech



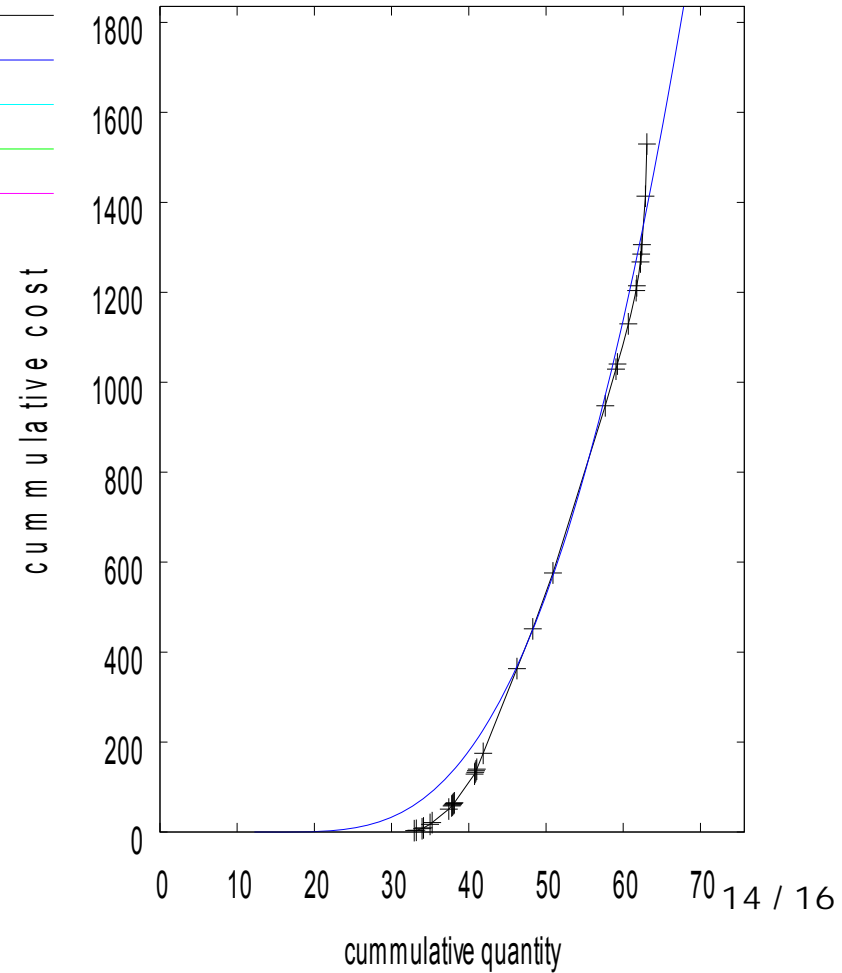
MAC vs TAC curves

Compare Approximations



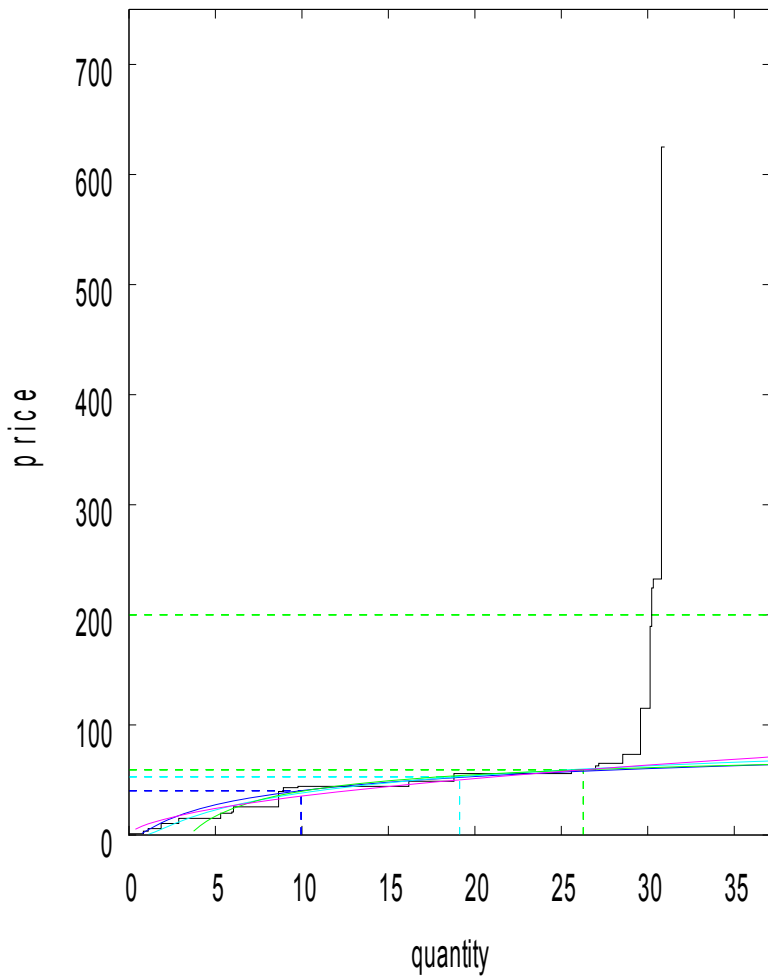
MAC
Numeric
OLS2
Analytic 45
Hybrid 45

GHG abatement cost for Czech

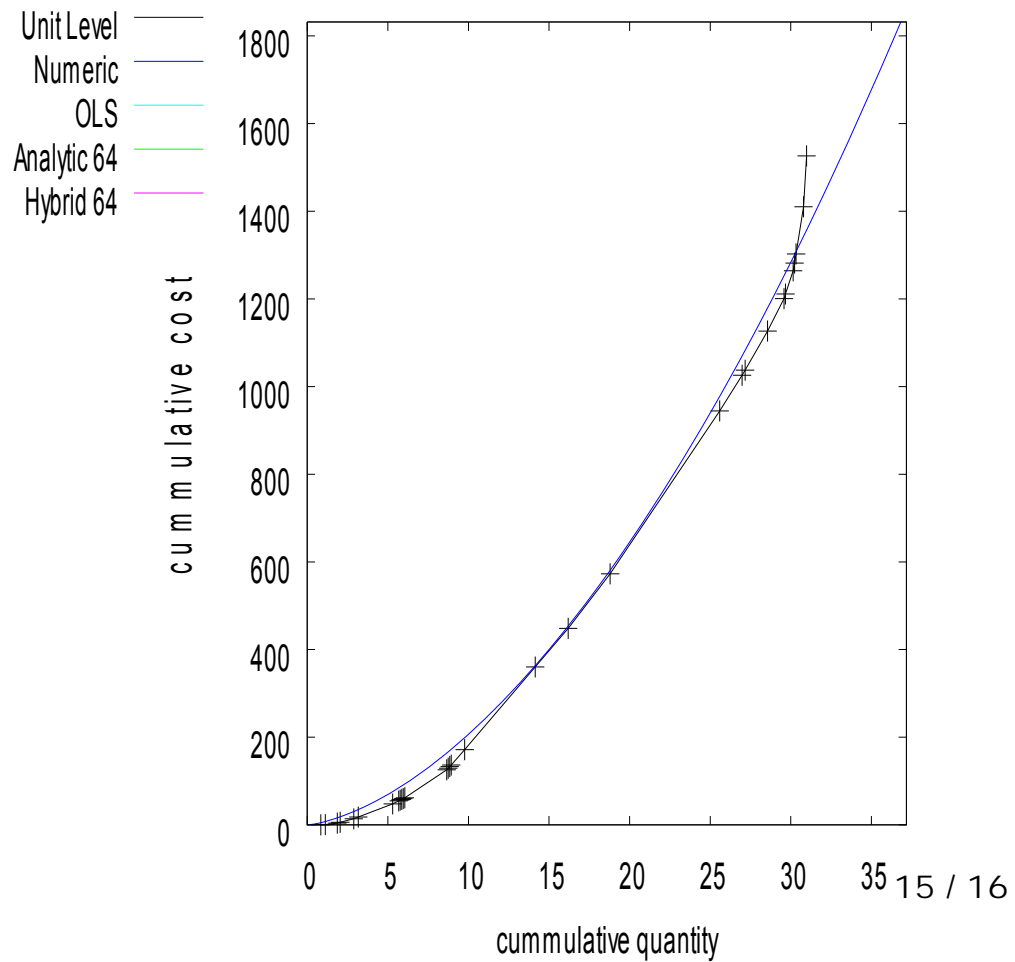


MAC vs TAC curves

Compare Approximations



GHG abatement cost for Czech



Model Closure

- One excess demand equation is dropped (Walras' Law): current account balance
- Government income balance is adjusted by transfers
- Households income balance is adjusted by exogenous demand