Assessing the potential impact of EU Cohesion Policy based on a structural macroeconomic model with semi-endogenous growth

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ESPON Workshop
Scenarios and modelling in the framework of exploring Territorial Cohesion
Disclaimer

The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the European Commission.
Structural general equilibrium model to assess the impact of Cohesion policy

- Account for cross economy spillovers of policies - general equilibrium effects
- Provide coherent and internally consistent framework to analyse channels through which policies have effect
- Account for international spillovers (global model)
- Provide dynamic profile – adjustment costs

But:
- Dependent on “efficient use” of funds: assuming no waste, no sub-optimal use (reality may be different)
- Model cannot give point estimates of impact
- Simulations can only indicate the channels through which cohesion spending may have an impact and indicate its potential effects
Motivation - Background

Chatterjee-Turnovksy (2005): "Financing Public Investment through Foreign Aid: Consequences for Economic Growth and Welfare" RIE

- Restricted to the effects on a small recipient country, no feedback on the donor countries, public investment only. → Calls for an important extension of this analysis is to consider the impact of the transfer in a multi-country growth equilibrium setting.

- Accounting for budgetary implications at the country level and its spillovers (full costing of the policies)

Analysis only at the macroeconomic/country level, no focus on regional levels
Structure of the presentation

- QUEST III model with endogenous growth
- Calibration of the baseline
- Cohesion policy implementation in the model
- Simulation scenarios
**QUEST III R&D model**

DSGE model family: microfounded, forward-looking dynamic stochastic GE models (IMF: GIMF, ECB: NAWM, FED:SIGMA)
Global model (28 MS plus RoW)

Economy populated by:

- Households
- Final goods producing firms
- Intermediate goods producing firms
- R&D sector
- Monetary and fiscal authorities
- Disaggregation of labour force: low-, medium, high skilled (employment rate, skill efficiencies)
- Technological change: increasing product variety (Jones, Dixit&Stiglitz)
Households

Non-constrained households ("Ricardian")
Liquidity-constrained households
Habit persistence

Non-liquidity constrained households
- buy new patents of designs produced by the R&D sector
- rent their total stock of design to intermediate goods producers
- pay income tax on the period return of intangibles
- receive subsidies after their investment in R&D products

Liquidity constrained households
- "Hand to mouth" consumers, no access to financial/asset markets
Firms: final goods sector

Final output is produced using a labour aggregate, $L_t$ and $A_t$ varieties of intermediate inputs ($x_{it}$) with an elasticity of substitution $\theta$.

Monopolistically competitive market:

$$Y_t = L_t^\alpha \left( \sum_{i=1}^{A_t} x_{it} \theta \right)^{1-\alpha} K_G^{\alpha_G}$$

Dixit-Stiglitz product variety
Productivity enhancing effect of public capital $K_G$
Firms: intermediate goods sector

The intermediate sector consists of monopolistically competitive firms

- enter the market by licencing a design from domestic households
- make an initial payment to overcome administrative entry barriers
- (tangible) capital inputs are also rented from the household sector
- firms which have acquired a design can transform each unit of capital into a single unit of an intermediate input
- entry occurs until the PDV of profits (where the discount factor contains the risk premium for intangible capital) is equal to the price of the patent (intangible) and a fixed entry cost
Innovation corresponds to the discovery of new designs.

The R&D sector hires high-skilled labour $L_{A,t}$ and generates new designs $\Delta A_t$ according to a following knowledge production function:

$$\Delta A_{t,d} = \nu A_{t,f}^\omega A_{t,d}^\theta L^\lambda_{A,t}$$

$\omega$ and $\theta$ measure the foreign and domestic spillover effects from the aggregate international $A_f$ and domestic $A_d$ stock of knowledge
Human capital accumulation (Jones, 2002)

Labour-aggregate composed of three skill-types (low, medium, high):

\[ L_{Y,t} = \left( s_s^{\frac{1}{\sigma_L}} \left( h_s^L L_t^L \right)^{\frac{\sigma_L-1}{\sigma_L}} + s_M^{\frac{1}{\sigma_L}} \left( h_M^M L_t^M \right)^{\frac{\sigma_L-1}{\sigma_L}} + s_{H,Y}^{\frac{1}{\sigma_L}} \left( h_H^H L_t^H \right)^{\frac{\sigma_L-1}{\sigma_L}} \right)^{\frac{\sigma_L}{\sigma_L-1}}. \]

- \( s_s \) population share of group \( s \)
- \( L_s \) employment rate of group \( s \)
- \( h_s \) accumulated human capital group \( s \)

Accumulated human capital \( h_s \) is produced by participating in education:

\[ h_t^s = h_s e^{\psi \Lambda_t^s}, \quad \psi > 0 \]

where \( \Lambda_t^s \) is amount of time spent accumulating human capital
(years of schooling- \( \psi \) Mincerian return to schooling)

Additional training:

\[ \Lambda_t^s = \Lambda_t^s + l_{t,TR}^s, \quad \text{where} \quad l_{t,TR}^s = (1 - \chi_s) l_{t-1,TR}^s + \epsilon_{t,TR}^s, \]
The trade-off between skills

Final production needs all types of skills

R&D production can employ only high-skilled

→ Allocating more high-skilled to R&D decreases the share of high-skilled available for final goods production!
Fiscal and monetary authority

Government: tax-rule
\[ \Delta \text{tax} = \gamma_1 (\text{DEBT} - \text{DEBTTARG}) + \gamma_2 (\Delta \text{DEBT}) \]
(response to debt-changes)

Central bank: Taylor-rule
\[ \Delta \text{inom} = \gamma_{inf} (\text{INF} - \text{INFTARG}) + \gamma_2 (\text{OGAP}) \]
(response to changes in expected inflation and output gap)
Overview

Final Goods

Intermediate Goods

Entrants

Mark up

Credit frictions
Tangibles

Credit frictions
Intangibles

Subsidies

Household

Research

Government

Patents

Admin. Entry Barriers
Overview

Monetary authority
Interest rate (Taylor)-rule

Interest rates

Firms:
Monopolistic competition
Maximise profits

Consumption, investment
Labour and capital income

Interest rates

Representative Household:
Maximise life-time utility

Transfers, benefits

Taxes

Fiscal authority:
Budgetary rules

Taxes

Subsidies
Overview

Euro area

ECB

Trade

Institute
Calibration

Components of GDP, labour (employment, activity rates etc.), capital, R&D inputs
→ AMECO/EUROSTAT

Tax/Wage data
→ TAXUD/EUROSTAT (EUROMOD)

Trade matrix
→ COMEXT
Calibration

Mark-ups
→ estimated based on WIOD/EUKLEMS

Benefits
→ OECD (EUROMOD)

• Structural parameters are taken from the estimated QUEST3 version
• R&D: Botazzi-Perri (2007)
• Reference date: 2013 or latest available → yearly update
• Shocks calibrated using GDP projections from DG ECFIN projection method
Simulations of Cohesion Policy

Detailed fiscal block:

\[ B_t = (1 + r_t) B_{t-1} + G_t + IG_t + TR_t + BEN_t + S_t - T^C_t - T^L_t - T^P_t - COH_t \]

Interventions linked to model variables (judgmental !)

<table>
<thead>
<tr>
<th>Field</th>
<th>Variable to implement the shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>Temporary increase in ( I^G_t ), government investment (via ( \epsilon^G_t ))</td>
</tr>
<tr>
<td>Agriculture, Industry &amp; Services</td>
<td>Temporary increase in other government expenditures (( G_t ))</td>
</tr>
<tr>
<td></td>
<td>Reducing fixed costs of tangible capital costs faced by final goods firms (( FC_Y ) and ( rp^K ), permanent or temporary reductions)</td>
</tr>
<tr>
<td>RTD</td>
<td>Reducing the fixed costs or risk-premia faced by the users of R&amp;D products, (( FC_A ) and ( rp^A ), permanent or temporary reductions)</td>
</tr>
<tr>
<td>Human resources</td>
<td>Raising human capital and government transfers expenditures</td>
</tr>
<tr>
<td></td>
<td>- investment in high-skilled human capital (( h^u_t ) via ( \Lambda^u_t ))</td>
</tr>
<tr>
<td></td>
<td>- educational investments in all skills (( h^s_t ) via ( \Lambda^s_t ))</td>
</tr>
<tr>
<td>Technical assistance</td>
<td>Temporary increase in government consumption (( G_t ))</td>
</tr>
</tbody>
</table>

\( COH = \) Net Cohesion Receipts (i.e. adjusted for contribution to EU budget)

Contributions to EU budget assumed proportional to MS’s GDP and financed by increase in labour taxes
## Matching fields of interventions and model variables

<table>
<thead>
<tr>
<th>Category Cd</th>
<th>Category</th>
<th>Type</th>
<th>Model</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>R&amp;TD activities in research centres</td>
<td>RTD</td>
<td>RPREMA</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>R&amp;TD infrastructure and centres of competence in a specific technology</td>
<td>RTD</td>
<td>FCA</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Technology transfer and improvement of cooperation networks ...</td>
<td>RTD</td>
<td>FCA</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Assistance to R&amp;TD, particularly in SMEs (including access to R&amp;TD services in research centres)</td>
<td>RTD</td>
<td>FCA</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Advanced support services for firms and groups of firms</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Assistance to SMEs for the promotion of environmentally-friendly products and production processes (...)</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Investment in firms directly linked to research and innovation (...)</td>
<td>RTD</td>
<td>RPREMA</td>
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</tr>
<tr>
<td>08</td>
<td>Other investment in firms</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Other measures to stimulate research and innovation and entrepreneurship in SMEs</td>
<td>RTD</td>
<td>RPREMA</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Telephone infrastructures (including broadband networks)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Information and communication technologies (…)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Information and communication technologies (TEN-ICT)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Services and applications for citizens (e-health, e-government, e-learning, e-inclusion, etc.)</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Services and applications for SMEs (e-commerce, education and training, networking, etc.)</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Other measures for improving access to and efficient use of ICT by SMEs</td>
<td>AIS</td>
<td>FCY</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Railways</td>
<td>INFR</td>
<td>IG</td>
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<tr>
<td>17</td>
<td>Railways (TEN-T)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Mobile rail assets</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Mobile rail assets (TEN-T)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Motorways</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Motorways (TEN-T)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>National roads</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Regional/local roads</td>
<td>INFR</td>
<td>IG</td>
<td></td>
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<tr>
<td>24</td>
<td>Cycle tracks</td>
<td>INFR</td>
<td>IG</td>
<td></td>
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<tr>
<td>25</td>
<td>Urban transport</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Multimodal transport</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Multimodal transport (TEN-T)</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Intelligent transport systems</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Airports</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Ports</td>
<td>INFR</td>
<td>IG</td>
<td></td>
</tr>
</tbody>
</table>
Economic Impact Cohesion Spending: summary

• Consumption increases:
• Ricardian consumers: anticipate higher permanent income
• Liquidity-constrained: higher employment and wages
• Wages grow in long run in line with productivity
• Donor countries: higher contributions to the EU budget - increase in labour taxes - negative impact on employment growth.
• Recipient countries: higher growth boosts tax revenues.
Economic Impact Cohesion Spending: summary

- Corporate investment is generally crowded out in the short run,
- in the medium run productivity enhancing effects come to dominate and investment spending increases.
- Upward pressure on inflation as demand effects dominate in short run,
- but in medium run, as potential output increases, inflationary pressures subside.
- Imports are boosted by the increase in demand
- (Real) appreciation reduces exports growth.
Figure 1. New Member States, 2014-20

Cohesion spending (% of GDP) and GDP impact (% difference from baseline)
Figure 2. Old Member States, 2014-20

Cohesion spending (% of GDP) and GDP impact (% difference from baseline)
Effects Cohesion Spending

Support Agriculture, Industry & Services plus Technical assistance:
• Reductions in fixed costs (lowering start-up costs and increasing entry of new firms)
• Lower capital costs for tangible capital (increasing investment and capital accumulation).
• Government consumption (unproductive government spending), (only growth boosting effect in the short run)

Infrastructure spending:
• i.e. Transport, telecommunication, energy, environmental, social infrastructure
• Government investment (productive)
• Government consumption (unproductive) (“social infrastructure”)

• Both lead to higher aggregate demand but are partly crowded out by lowering private consumption and private investment and some of the demand impulse leaks abroad through higher imports.
• However, in the medium term government investment raises productivity
Effects Cohesion Spending

Support to R&D
• Reductions in fixed costs
• Reductions in intangible capital costs for the intermediate sector
• By reducing costs, new start-ups enter the market (new products). By supporting innovation, high skilled workers are reallocated in the model from the production sector to the R&D sector.
• Initially, this reallocation reduces final goods production and has a negative impact on growth, but over time the positive output effects dominate as productivity increases, and this also stimulates physical investment (endogenous growth)

Investment Human Capital
• Government spending
• Improvement skill efficiencies
• The effects on average skill efficiencies take time to build up (cohort effects)
• Longer time spent in education/training – delayed entry into labour force
• Negative impact initially – large positive impact in medium run
### Short and long run effects by fields of intervention

<table>
<thead>
<tr>
<th>Field of intervention</th>
<th>Short run</th>
<th>Long run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure investment</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Human capital investment</td>
<td>- / 0</td>
<td>+++</td>
</tr>
<tr>
<td>R&amp;D promoting policies</td>
<td>- / 0 / +</td>
<td>++</td>
</tr>
<tr>
<td>Assistance ind. &amp; services</td>
<td>+</td>
<td>(+)</td>
</tr>
<tr>
<td>Technical assist.</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Conclusions

We used a microfounded DSGE model with semi-endogenous growth

In the short run:
• spending could lead to crowding out of productive private investment and could give rise to real appreciations which lower export growth
• R&D promoting policies could drive up wages of researchers and crowd out high skilled employment in other sectors.
• little benefit one can expect in the short run from training and other human capital investments.

In the medium term:
• the productivity enhancing effects of infrastructure investment, R&D promoting policies, and human capital investments become gradually stronger
• endogenous growth effects : positive benefits become stronger in the medium and long run
Selected papers


See also QUEST model page on ECFIN website: http://ec.europa.eu/economy_finance/research/macroeconomic_models_en.htm
Thank you!
Sensitivity analysis 1: GDP effects for alternative output elasticities of public investment, NMS aggregate, 2007-13
Long delays in spending due to implementation lags.

- Delays in submitting programmes and decision lags mean funding is spread over many more years.
- Spending in the first three years (2007-9) has been extremely low.
- These delays may be inevitable due to the strict conditions which projects are subject to, but it means potential benefits of this funding are not reaped to the full.

➢ Speeding-up absorption / frontloading spending would yield larger GDP gains.
GDP impact slow vs. fast absorption, NMS aggregate, 2007-13

Front-loaded payment (blue):

- If such implementation delays could be avoided and a faster "absorption" of the funds could be achieved, this would not only raise GDP in the short run but also raise potential output by more in the medium term.

- The long delays in payments are partly due to the strict conditions which these projects are subject to, designed to avoid funding being lost on unproductive projects.

- Wasteful spending should obviously be avoided, but this simulation indicates there are also significant costs in delaying available funding for productive investments.