



European
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Sixth IRIMA Workshop on: 'R&D Investment and Firm Dynamics'

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*Causal relations between sales
growth, employment growth,
profits growth, assets growth
and R&D growth: SVAR
evidence from SB companies*

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Motivation and scope of the study (1)

- Europe needs growing firms that invest in R&D. How should this be done?
- To answer to this question we should be able to determine "what causes what" – i.e. to identify causal relationships among R&D and other variables of interest (sales, profits, employment).
- So far research into R&D investment and industrial dynamics has generally produced estimates of associations rather than causal effects.

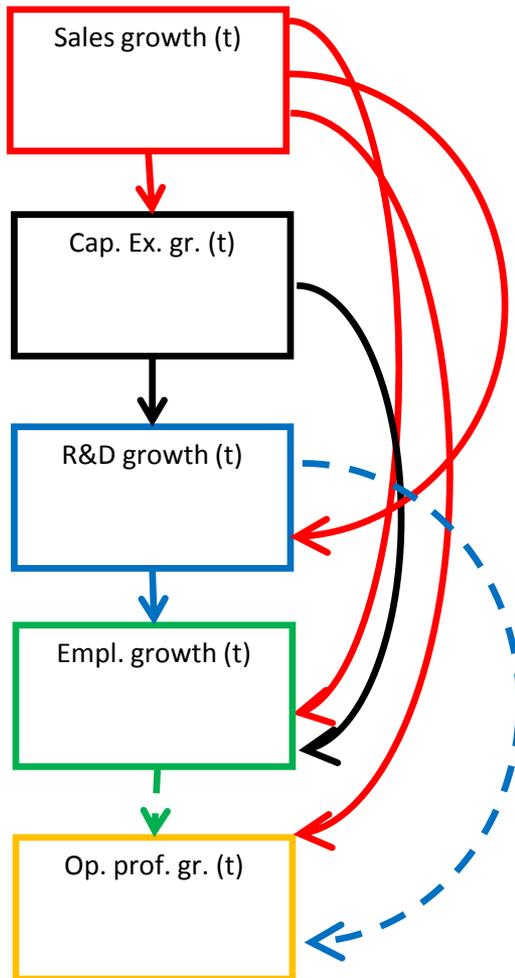
Motivation and scope of the study (2)

- We try to better understand how R&D investment takes place in growing firms by applying a new technique (developed by Machine Learning scholars) to a specific set of data on big R&D investors
- We do it using a data-driven Structural Vector Autoregression (SVAR)
- We apply this technique to a panel dataset built using several vintages of the EU industrial R&D Scoreboard (SB04-SB14)

On data and methodology

- EU industrial R&D Scoreboard (SB04-SB14) 14 years unbalanced panel dataset.
- Causal relations are inferred using a data-driven Structural Vector Autoregression (SVAR)
- We apply the ICA-LiNGAM model (Shimizu et al., 2006) applied to the dynamic panel data context (Hyvarinen et al., 2010), first introduced into economics by Moneta et al (2013)
- Identification crucially relies on non-Gaussianity of the SVAR variables.
- Independent Components Analysis (ICA) is used to identify the latent independent components, that are then arranged in a causal ordering.

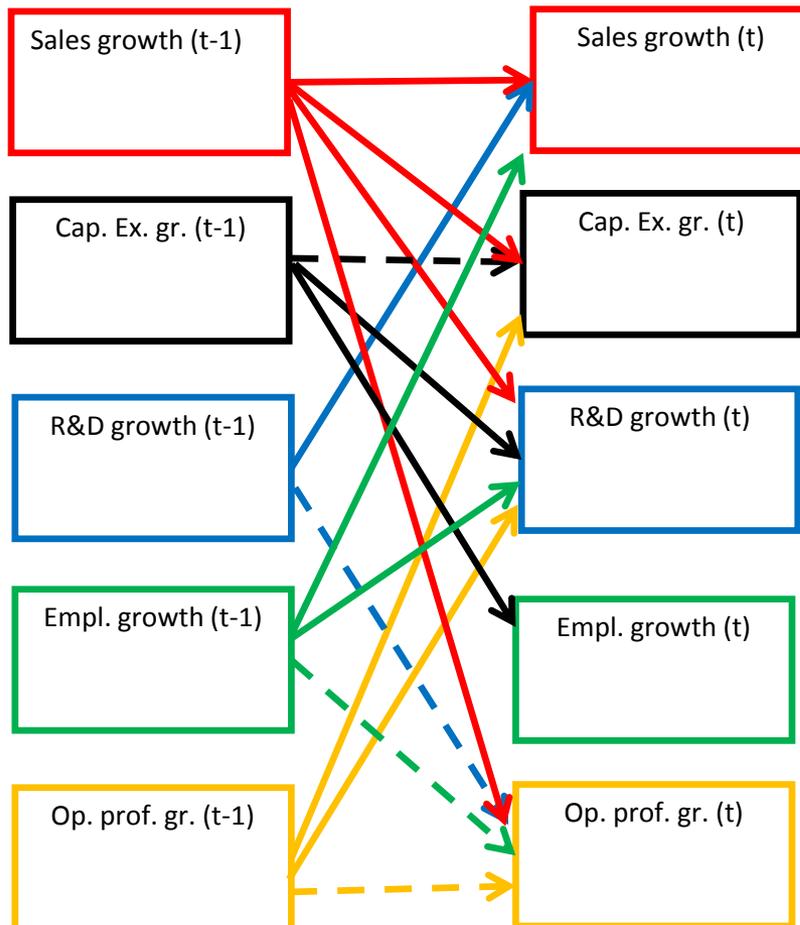
Results (1)



- Sales growth comes first in the causal ordering, having large positive causal effects on the other variables within-the-period
- Sales growth appears to kick-start the growth process, with other growth in other dimensions co-evolving as a consequence of the initial sales growth stimulus.
- Growth of capital expenditures follows suit, having a positive influence on growth of R&D and employment.
- R&D growth comes third, having a positive effect on employment growth as well as a negative causal effect on growth of profits (presumably because expenditures on R&D appear in the firms accounts as a cost, thereby diminishing profits).
- Employment growth comes next, also having a negative effect on growth of profits (because the direct effect of the wage bill on profits is negative; although there are many indirect effects via e.g. subsequent increases in sales).
- Growth of operating profits comes at the end of the causal ordering

Notes: Solid arrows indicate positive effects, dashed arrows negative ones.
Coefficients not significant at the 95% level are not shown.

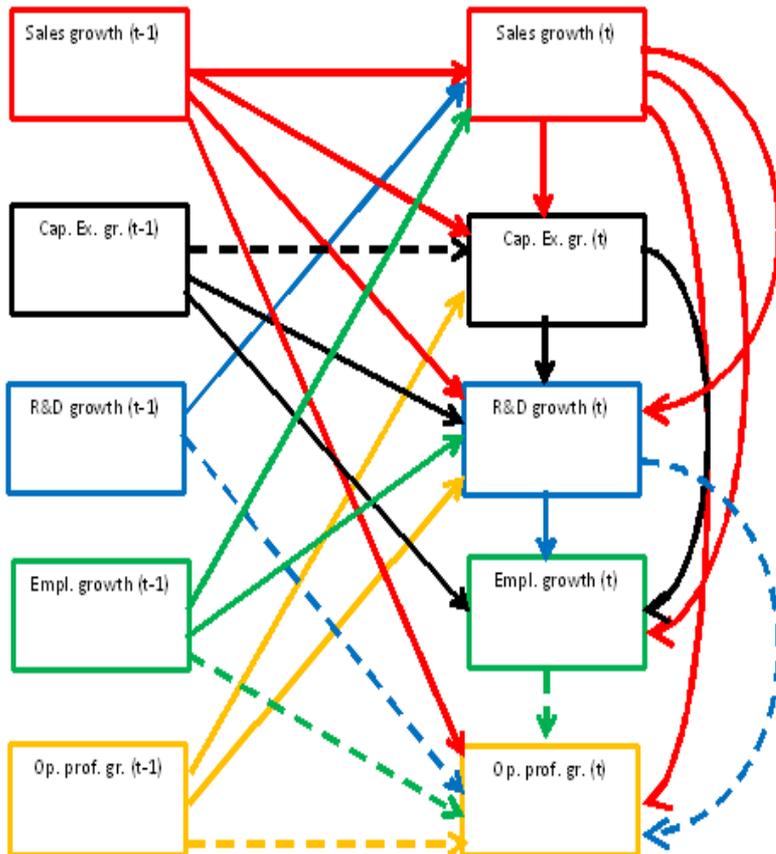
Results (2)



Notes: Solid arrows indicate positive effects, dashed arrows negative ones.
Coefficients not significant at the 95% level are not shown.

- Sales growth comes first in the causal ordering, having large positive causal effects on the other variables also when we consider the lag
- The lagged effects are similar to those observed for the instantaneous case
- Sales growth has significant positive effects on subsequent growth of R&D, capital expenditures, and profits.
- Growth of capital expenditures, in turn, has positive significant effects on R&D growth and employment growth, but a negative effect on growth of capital expenditure in the next period.
- R&D growth has a significant positive effect on subsequent sales growth (even after one year, which is perhaps surprisingly fast) and a negative effect on profits.
- Employment growth boosts subsequent growth of R&D and sales, but has a negative direct effect on growth of operating profits.
- Growth of operating profits has a significant positive effect on growth of R&D and capital expenditures, , but has a negative direct effect on growth of operating profits.

Policy messages



Notes: Solid arrows indicate positive effects, dashed arrows negative ones.
Coefficients not significant at the 95% level are not shown.

- **Policy message 1**
Sales growth is the primis motor of the growth process. As sales increase, R&D budgets increase more or less proportionally.
- **Policy message 2**
Capital expenditures growth boosts R&D and employment growth
- **Policy message 3**
R&D growth has an instantaneous stimulus on employment growth
- **Policy message 4:**
Growth of operating profits has a minor role on R&D
- **Policy message 5:**
If Europe is to have 'smart growth' whereby firm growth occurs alongside investments in R&D and innovation, there is a key role of demand

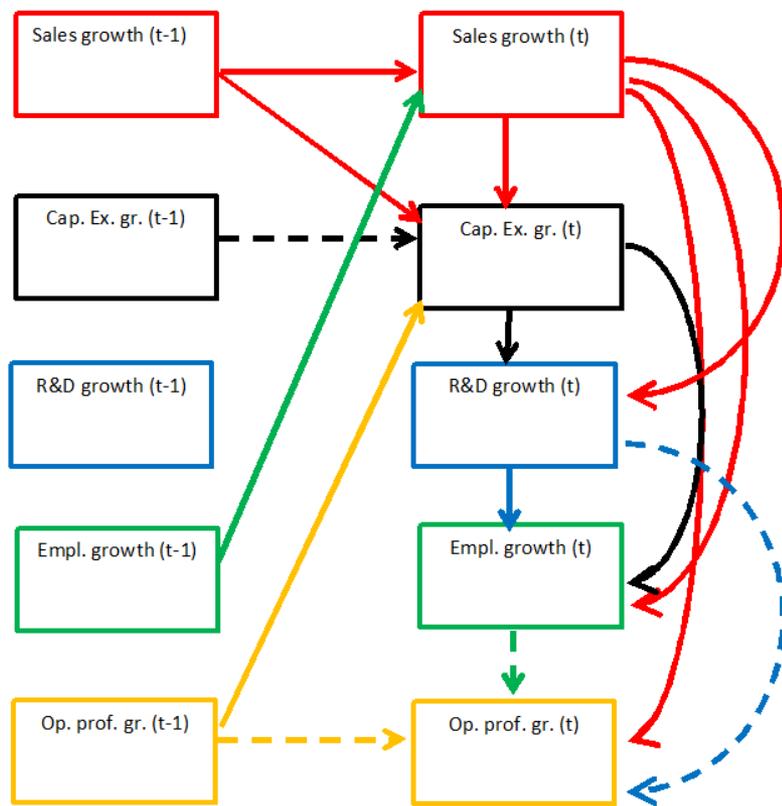
Limitations – possible extensions

- We perform our analysis on a very specific set of firms
- We observe the overall links, we can't disaggregate by sector/geographical area because we need lots of observations
- SVAR is a linear regression model and assumes acyclicity (i.e. focuses on the major direction of causality and ignores minor feedback effects) and non-Gaussian residuals (which seems reasonable here)

Thank you!

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Appendix – Main causal effects



Solid arrows indicate positive effects, dashed arrows negative ones
 Coefficients not significant at the 95% level are not shown.
 Coefficients between -0.05 and 0.05 are not shown



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References - extra

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