### Innovation, SDGs and evaluation Anthony Arundel & Micheline Goedhuys

## DEVELOPMENT UMALD



Goal	Business innovation	Government innovation	Policy
1. End Poverty			
2. End hunger and provide food security			
3. Healthy lives			
4. Inclusive and equitable education			
5. Gender equality			
6. Sustainable water and sanitation			
7. Affordable and sustainable energy			
8. Sustainable economic growth			
9. Resilient infrastructure			
10. Reduce inequality			
11. Sustainable cities			
12. Sustainable consumption & production			
13. Combat climate change			
14. Sustainable use of oceans			
15. Sustainable use of land			
16. Peaceful and inclusive societies			



### **Role of business sector innovation in SDGs**

Level of role	Areas	Number of SDGs
High	Sustainable zero CO2 emission energy, Sustainable production	3
Moderate	Utilities: water, sanitation & infrastructure	2
Low	Sustainable agriculture, fishing, forestry; health, cities and growth	5

Much of this is covered under 'environmental innovation'



# Relevant data that can be collected in innovation surveys

- Environmental and social objectives for innovation
- Outcomes within the firm (decline in energy and material use per unit of output, internal recycling, etc)
- Types of innovation by industry

#### **Questions focused on environmental innovation:**

- Drivers (regulations, consumer demand, etc)
- Obstacles (regulations, lack of demand, lack of skills, etc.)
- Expenditures
- Methods used (end-of-pipe, process innovation, product innovation, etc.



#### **Emerging innovation concepts of relevance to SDGs**

- Inclusive innovation (Heeks et al, Chattaway et al. etc.)
- **Grassroots innovation** (Gupta, Smith et al, etc.)
- Frugal innovation (Prahalad and Mashelker, Tewari, etc.)
- Social innovation (Mulgan, Kemp et al and many others)
   Relevant to both the business and government sectors

#### **Emerging components of innovation:**

- Shared economy (e.g. uber, airbnb etc) or solidarity economy (faire trade, local exchange trading systems)
- Creative commons/open source; crowdfunding
- Design-thinking, co-creation
- All of these topics can be covered in innovation surveys



### **Innovation outcomes of relevance to SDGs**

- Difficult to ask survey respondents about effects outside the boundaries of their organisation (but can be done cautiously).
- Best to link data on innovation with independent data sources, such as on CO2 emissions or food production, etc.



### Linking different types of data

- R&D investments by field of research (FOR)
  Are investments correlated with innovation survey data on objectives?
- International Energy Agency (IEA) data on investments on CO2 emissions by sector and shares of different energy types (renewables, fossil fuels etc.) –Can track emissions per GDP by sector (transport, commercial,
  - etc.) to see if energy intensity is improving
  - Link changes in energy intensity to innovation survey data on innovation expenditures, objectives / outcomes



### **Performance evaluation (micro- analysis)**

- Link innovation survey data to outcome data after a suitable time lag.
- Use regression to evaluate the effect of different firm-level characteristics and innovation activities on:
  - firm performance (innovation outputs, economic outcomes such as sales increase, productivity, etc.)
  - firm reported environmental outputs such as
     CO2 emissions

# Effect of innovation on national, regional or sector outcomes (macro level analysis)

- Link innovation survey data to outcomes of interest: agricultural production, air pollution, CO2 emissions, etc.
- Regression to carefully control for other factors that could cause the same outcomes:
  - -**CO2 emissions:** decline in economic activity, shift in production overseas, non-innovation shifts in energy types (coal to gas), etc.
- **Requirement:** method requires a sufficiently large number of nations, regions or sectors.



### **Evaluation of innovation policies** (or other policies to support SDG goals)

- Policy evaluation involves monitoring, evaluation and impact evaluation
- Monitoring: tracking what happens over time. Results can inform program implementation and dayto-day management
- **Evaluation**: Objective assessments of policy carried out at discrete points in time
- Impact evaluation: changes in outcomes that are caused by the policy



### **Impact evaluation**

- Impact is the difference in outcomes (innovation, CO2 emissions) with and without a specific policy
- Impacts are difficult to identify because of:

   Confounding factors: other causes of the same outcome that are also associated with the use of a policy (firm size, age, if the firm exports, etc)
  - -Self-selection effects: individuals (firms) self-select to apply for an innovation support program
     »Can also be double selection: by the firm and by the agency responsible for a program



### **Evaluation problem**

- Ideally, evaluation requires information on the counterfactual: what would have happened if the policy had not been in place (if the user of the policy had not done benefited from it)?
- But, the counterfactual is never observed we can only observe and compare the performance of firms that did and did not make use of a policy.
- Evaluation techniques provide different solutions to the counterfactual problem, confounding, and self-selection.



### **Relevant innovation policies for evaluation**

- R&D subsidies or tax incentives
- Research grants
- Grants / subsidies to hire university graduates (engineers)
- Grants / subsidies for equipment purchases (IT, etc)
- Subsidies or other support to venture capital
- IPR policies
- Public procurement that requires innovative solutions
- Policies to support collaboration on innovation



# Example: grant to cover 50% of salary costs to hire a new doctorate in engineering to reduce CO2 emissions

- Best evaluation method: SMEs are randomly assigned to one of two groups – receive the grant or do not receive the grant (randomized trial).
- All firms need to be interested in the grant and have a baseline level of competence (reduces costs as the sample can be smaller).
- With randomization, any differences in the average outcomes (successful environmental innovations) after two years are likely to be due to the grant.



### **Alternative methods without randomization**

Matching methods: Construct a control group for observable differences in firms that apply and do not apply for a grant.

**Propensity score matching** identifies a set of characteristics that is related to application for a grant and finds for each participant a matched control (or controls) that are very similar on the set of characteristics (measures of proximity).

Statistical techniques are available to account for variations in the proximity of matches.



- Propensity score matching can use innovation survey data if the survey collects data on the application for and use of grants among innovative firms (and preferably among non-innovative firms too – permits two control groups).
- The mean program 'gain' can be calculated between firms that received the grant and firms in the control group that did not receive the grant:
- Average CO2 emissions in firms with the grant: 2 t per (x)
- Average CO2 emissions in firms with no grant: 3 t per (x)
- Difference (program gain) -1 t per (x)



# When panel data are available (firms tracked over time) <u>Difference in differences</u> method.

- Useful when firms that receive and do not receive the grant differ in non-observable characteristics (management skills, corporate culture etc.) than can affect the outcome.
- Data are available from before the grant obtained and for after the grant obtained for firms that did and did not receive the grant.
- Uses internal controls based on outcomes from before receipt of the grant.

Assumes: 1) unobservables do not change over time2) in the absence of the grant, the two groups would have followed parallel trends.



### Conclusions

- Business sector innovation surveys are mostly relevant to SDGs with an environmental component; followed by SDGS for health, growth and cities.
- Government sector innovation surveys can also be of use.
- Innovation surveys are relevant to evaluations of firm performance for outcomes linked to SDGs.
- Innovation surveys can be used to evaluate macro outcomes such as regional trends in air pollutants, but requires a large number of 'regions'.



### **Conclusions – policy evaluation**

- Avoid 'cheap and easy' evaluation methods that do not control for self-selection and confounding because they can provide very misleading results:
  - –Using innovation survey data to produce descriptive outcome data for firms that receive a grant and those that do not.»Asking firms in a survey if they benefited from a grant or not.
- Randomized trials are the most reliable, but are costly innovations surveys not relevant here.
- Innovation surveys are of value to *ex-post* matching or difference in differences methods, but these are not as reliable as randomization and are difficult to conduct – requires experts to conduct the analyses.