Quantitative Impact Analysis

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Ice Breaker

Show of hands / vote online:

- Who feels good this morning about coming into a workshop on Quantitative Impact Analysis?

Why did the logic model go to therapy?

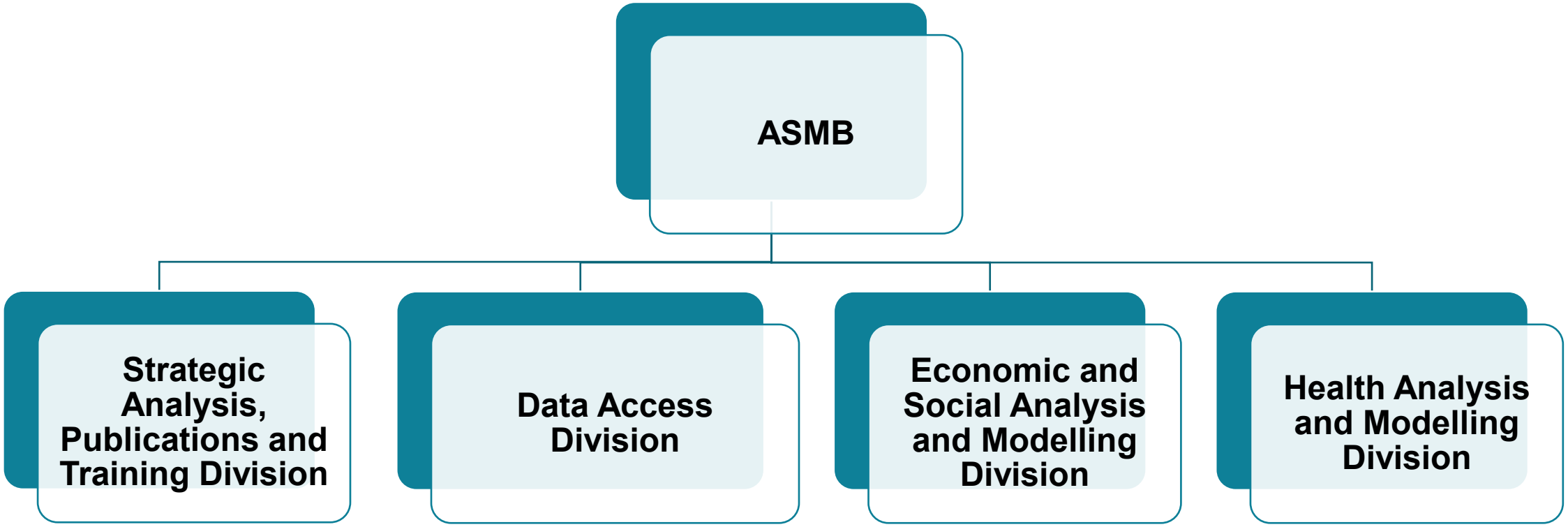
- It had too many *unresolved outcomes*

Introductions

Who are we?

INNOVATION AND EXPERTISE IN RESEARCH

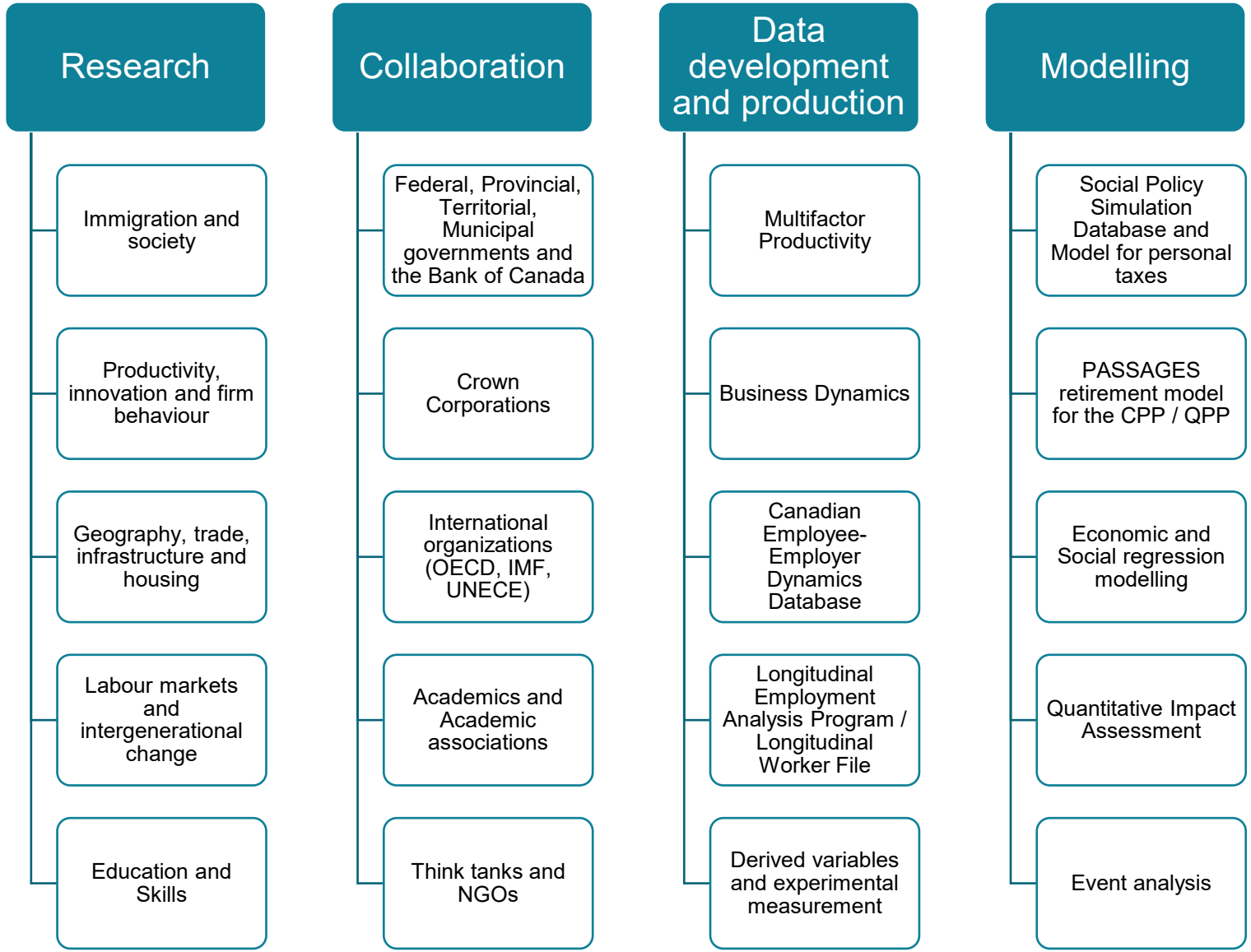
The Economic and Social Analysis and Modelling Division (ESAMD) is part of the Analytical Studies and Modelling Branch (ASMB). ASMB is the research and modelling incubator at Statistics Canada with a mandate to provide high quality, relevant, and timely information on economic, health, and social issues that are important to Canadians.



What ESAMD Does

ESAMD is a research and development group at Statistics Canada that focuses on combining subject matter experts, models and data to produce the information decision makers need for evidence-based decision making

Its activities and partnerships cover many aspects of society, the economy and the environment



Quantitative Impact Assessment - Background

1. What is QIA?
2. Understanding outcomes vs quantitative impacts

What is Quantitative Impact Assessment?

QIA is an assessment approach that uses a galaxy of statistical techniques to *create counterfactual scenarios* for what would have happened in the absence of the program

- Summary of Aneta Bonikowska (Fundamental Concepts of Quantitative Impact Assessment)

Quantitative Impact Assessment works in concert with policy work

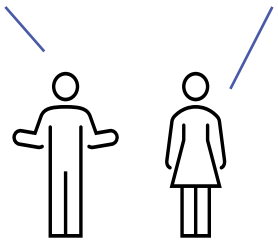
As a policy analyst, how do you know if a program is successful?

A program is successful only if it changes the lives or the behaviour of participants

The fundamental QIA challenge:

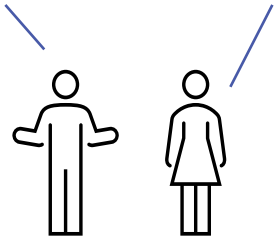
To know if this has happened, we must be able to observe an outcome (e.g. fire fatalities) in two different states (with and without the program), for the same people, at the same time

Why do we need to observe outcome with and without the program?



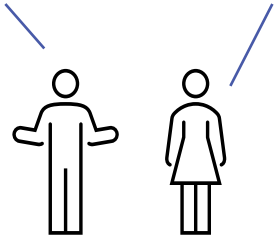
If the outcome is the same with or without the program, then it did not work

Why do we need the same people?



If participants already did what the program aimed to do, it will look like the program worked

Why at the same time?



It may take time to observe outcomes and circumstances change

Program development focuses on outcomes; Evaluation focuses on impacts

	Outcome (What the program delivers)	**Impact** (The change in the outcome)
Qualitative – Information on qualities or opinions	• Interview summaries • Narratives • Comments / satisfaction	• Case studies • Stories showing behavioural change
Quantitative – Information that can be measured or counted	• Program metrics (e.g. number of participants) • Indicators (e.g. income, number of post secondary students)	• Changes in measured indicators (e.g. increased incomes, more students)

How do we measure a quantitative impact from a program / policy?

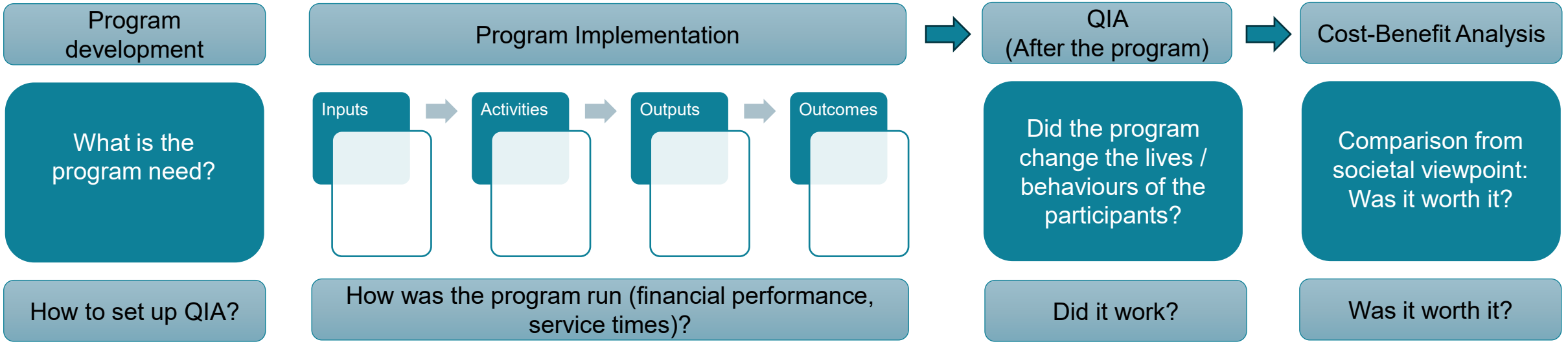
- The **actual outcome** is what is observed (e.g. income)
- The **true impact** is the change the program makes to the actual outcome
  - e.g. how much income goes up because of the program - this cannot be measured
- The **estimated impact** is the outcome with the program compared to an estimate for what would have happened without the program
  - e.g an estimate for the change in income without the program - called the counterfactual

How does QIA fit into program evaluation?

- QIA is one tool for evaluating a program
- Other types of evaluation tools include information like:
  - Financial reviews—did the program meet its expected outputs while achieving its expected cost?
  - Client surveys—were clients satisfied with access to and delivery of the program?
  - Program metrics—how many stakeholders visited the program website or used the online tools related to the program? How many participants were enrolled? How long are wait times?
- QIA is not necessarily more advanced or more difficult than other types of evaluation—but it does provide different information

When does QIA fit into program evaluation?

- Programs / policies are implemented to influence outcomes
  - Can use simulation models, Supply and Use Tables or other models to help inform anticipated results
- QIA seeks to estimate the causal impact of a program/policy on outcomes of interest *after the program* but, should be planned for *before the program*



Quantitative Impact Assessment - Methods

Step 1: Find a control group

Step 2: Measure the difference in outcomes (impacts) between participants and the control group

Finding control groups

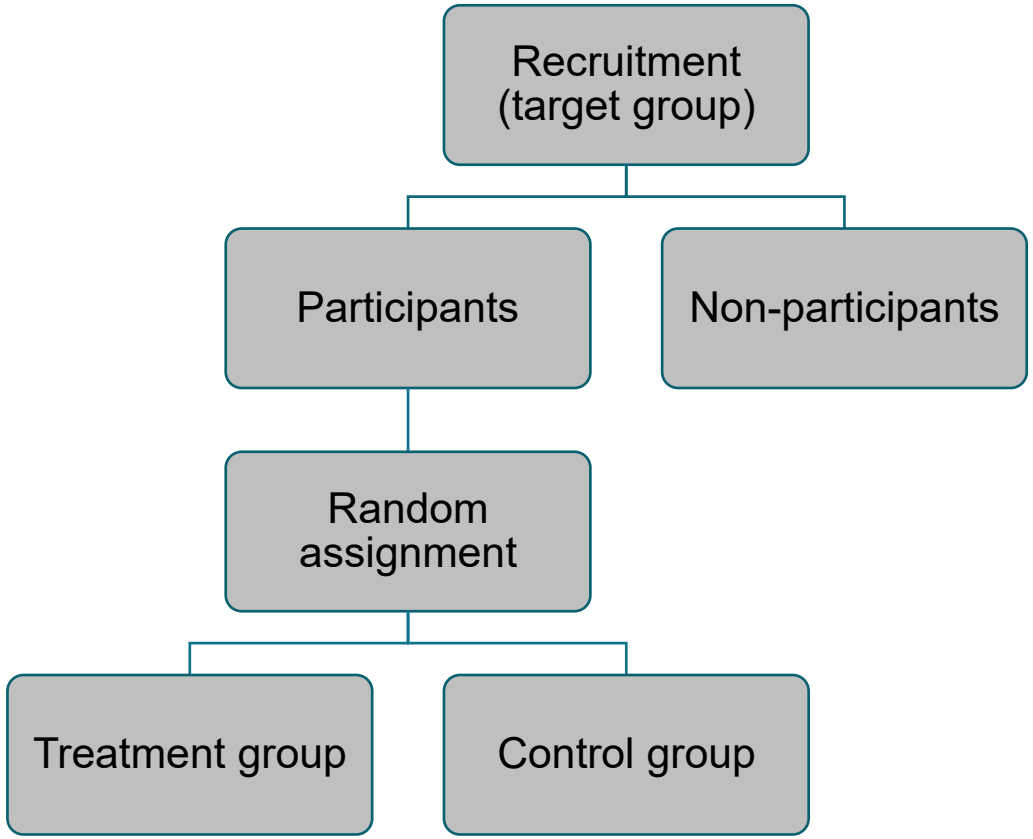
To conduct QIA it is critical to find ‘similar people’, ‘similar firms’, ‘similar places’, etc to make the counterfactual scenario

The most common ways to find control groups are:

- Randomized control trials
  - Use program design to randomly assign participants to treatment and control groups
- Matching estimators
  - Use statistical models to recreate control groups based on observable characteristics
- Natural breaks / natural experiments
  - Use a cut-off, single jurisdiction program, etc to create a control group
  - Can be used with matching estimators

Randomized Control Trials (RCTs)

- RCTs are the gold standard for causal analysis
- Random assignment is expected to create treatment and control groups that are similar to each other in relevant characteristics
  - Sometimes a balance in characteristics is needed to help make sure that after random assignment the groups are similar in a set of characteristics (e.g. age, gender, etc)
- RCTs are uncommon in economics and rarely applicable for program evaluation



Matching models

- Statistical models find people / firms / places that are similar to program participants, but who are *not in the program*
- Matching models need a set of relevant characteristics that allows for the creation of a control group
  - Or the improvement of characteristic balance between a treatment group and a control group in an RCT
- There needs to be common data participants and in the control group
  - Technically known as a “Common support”
  - When there is little overlap, we either have to accept poor matches or discard a lot of data

Common matching models
- Nearest neighbor (match to the closest observation)
- Propensity score matching (match based on a score)
- Exact matching (match only if (all) the characteristics are the same)

If we are using matching estimators, we need to make sure the same characteristics (age, size, etc) and the same outcome variable (revenue, profits, investment, etc) are available

Methods for measuring impacts (the difference the program made)

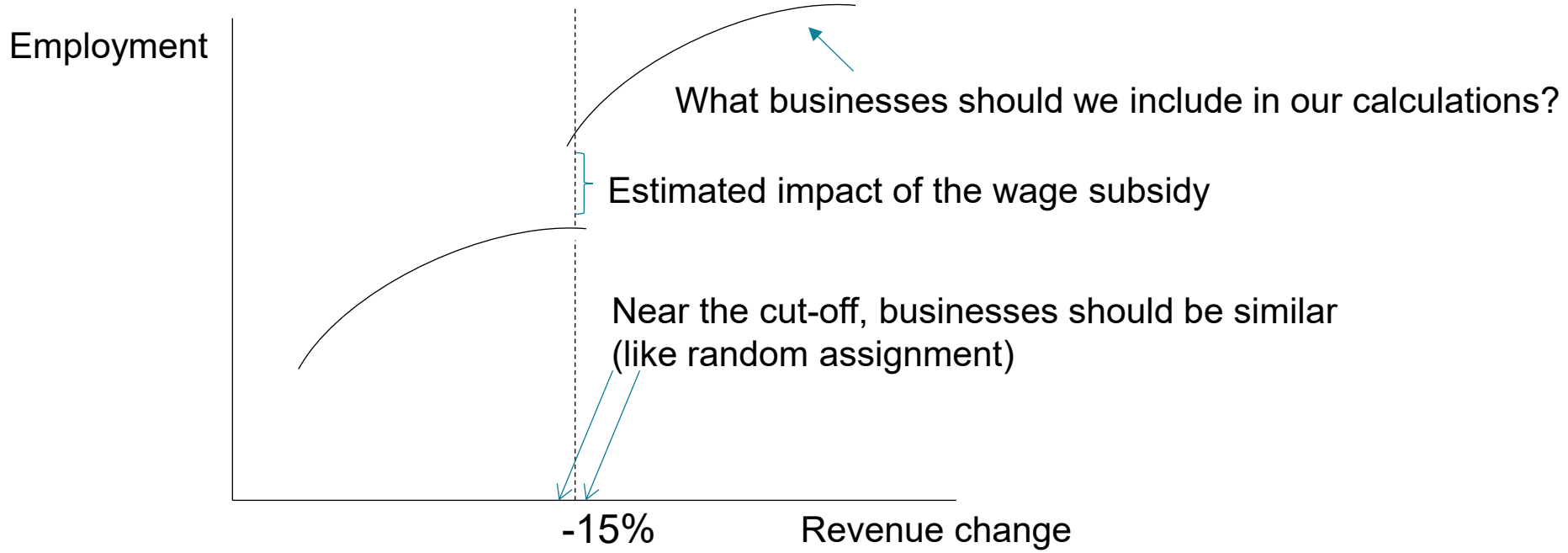
Once the treated and control groups are established, QIA uses statistical models to test whether a program has a statistically significant impact on an outcome variable. In some cases, methods like T-tests or analysis of variance (ANOVA) can be used.

More sophisticated approaches are:

- Discontinuity estimators
- Difference in Differences
  - Can also use Survival analysis and hazard functions
- Event study
- Marginal Structural Models

Discontinuity estimators

- Discontinuity estimators can be used for programs where there is some cut-off that defines participation
  - e.g., a wage subsidy is offered to businesses that experienced a revenue decrease of 15% during a recession (a decrease of 14.99% isn't low enough)

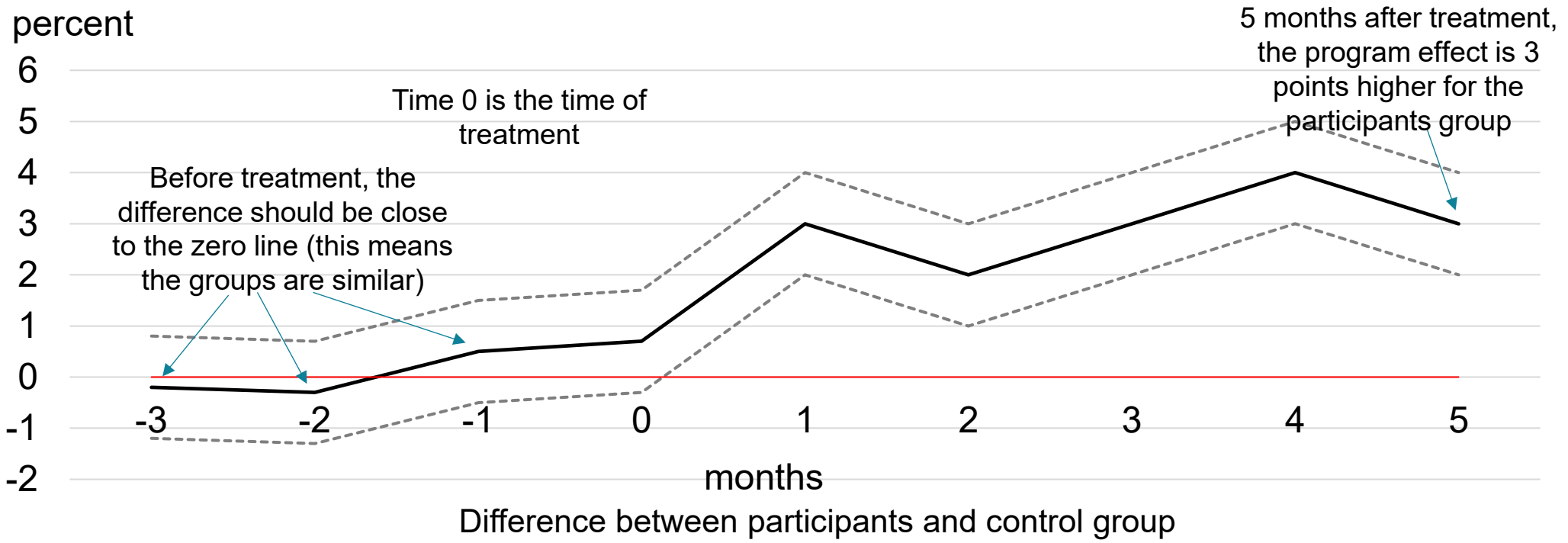


Difference-in-differences (DID)

- DID compares the change in the outcome (before and after the program) of program participants and the control group
- For this to be appropriate, the parallel trends assumption must be met—the assumption that the groups *would have followed* similar trajectories in the absence of the treatment
  - We do not observe alternate realities, so we have to:
    1. Check that the groups had similar trends before the treatment
    2. Argue that this relationship would have continued without treatment

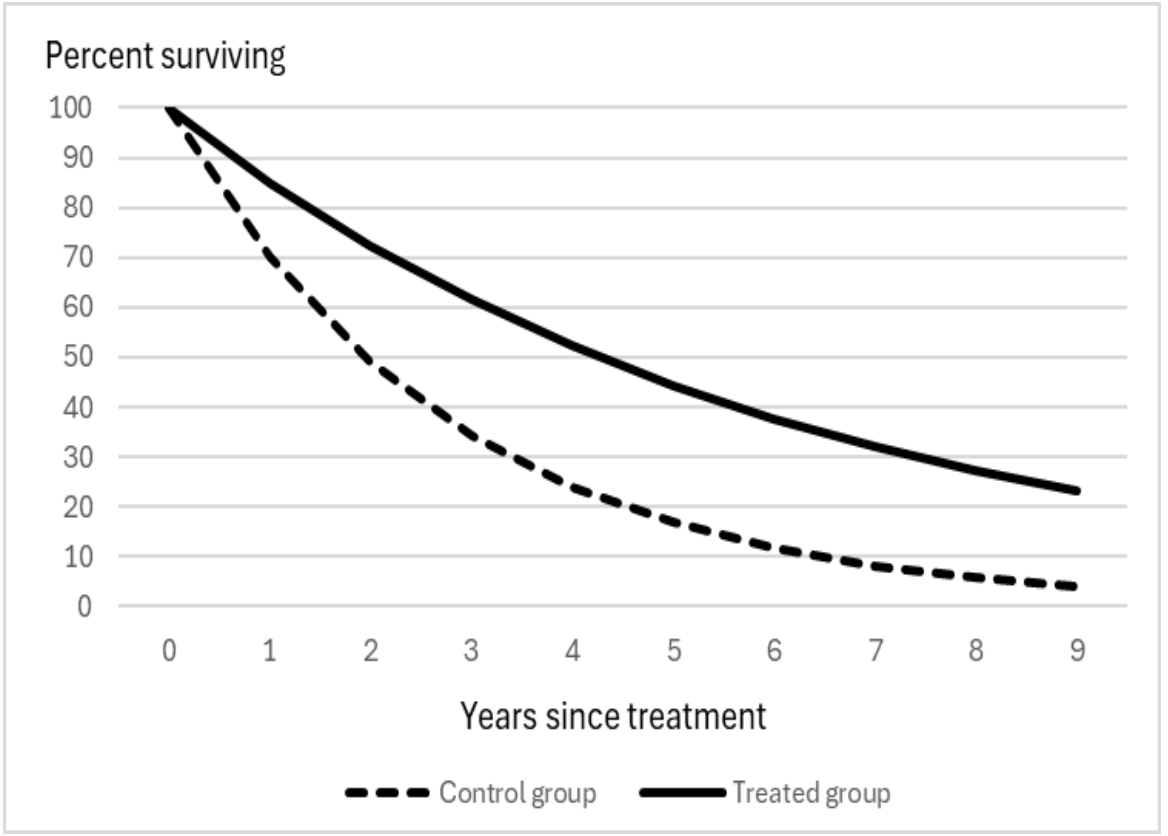
Event study

- Event study offers a way to understand how a treatment affects participants over a longer time horizon
  - With DID, we estimate a single treatment effect—essentially lumping all the post-treatment data together
  - With Event studies, we calculate multiple treatment effects—one year post treatment, two years post treatment, etc



Survival analysis (with DID)

- Survival analysis measures time until an event
  - Comes from medicine / biology where survival from an event is examined for a population / cohort
  - Two main estimation approaches:
    - Kaplan-Meier Survival curves show what percentage of a population / cohort are expected to survive at time t.
    - Cox Proportional Hazard analysis statistically tests a treatment
  - Can use participant and control groups to inform DID by using survival curves



Marginal Structural Models (MSMs)

- MSMs are sophisticated statistical models that estimate causal effects when time-varying events that make it hard to understand a program's impact are present
  - For example, a firm may participate in more than one program during the evaluation period

- MSMs need more data and more robust design to be implemented, but they can model programs over many periods or where program support varies in intensity
  - For example, if support tapers off over time

- MSMs are ideal for longitudinal studies with a focused "research question" that tests a theory of behaviour beyond associating programs with outcomes

Quantitative Impact Assessment – Data foundations

High quality data is necessary for QIA

QIA requires data on:

- The outcome for program participants and the control group
- The program / support that was provided
- Participant characteristics

Data requirements

Method	Eligibility cut-off	Treatment status	Participant characteristics	Time period
Discontinuity estimators	Yes	No	Yes	Post-treatment
Matching estimators	No	Yes	Yes	Post-treatment
Difference-in-differences / Event studies / Marginal Structural Models	No	Yes	Yes	Pre-treatment + post-treatment (3+ periods for event studies)
Survival analysis / Hazard function	No	Yes	Yes	Post treatment (more periods are better)

QIA using only program data

- Mostly limited to specific circumstances because it is not ethical to provide the program (or treatment) to only some eligible participants and to collect the necessary data on control groups
- Exceptions:
  - RCTs for areas like medical research or animal research
  - Census approach where data is collected or available on a complete universe such as testing vehicles for reliability

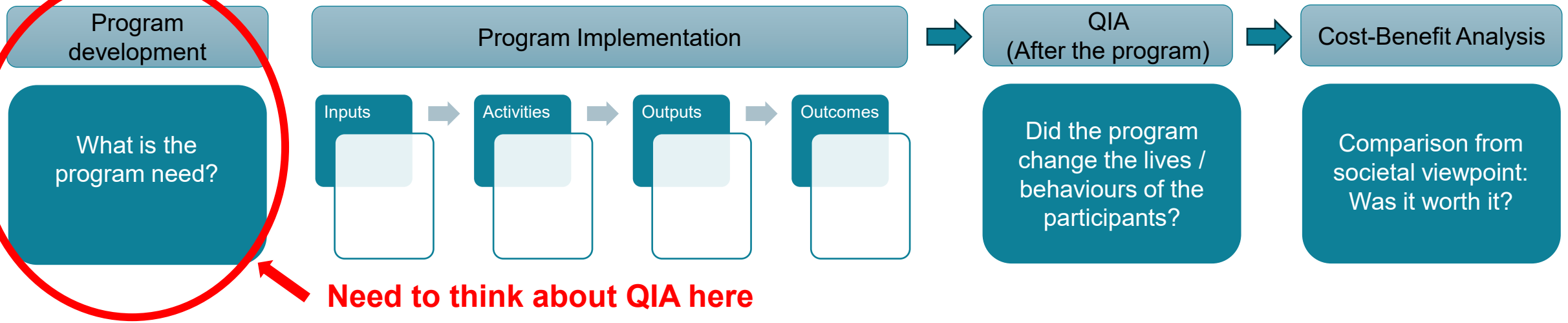
Data collection to enable data linkage

- BUT, richer data, *created through linkage to external data,* provides more appropriate control groups, better counterfactual scenarios and a more robust QIA, in a more timely and cost efficient way!
- What is data linkage ?
  - Combines data on the same individual or entity (i.e. business) from different data sources (e.g. tax data, education data, health data) to create a more comprehensive data source;
  - Data linkage is a more cost and time efficient way to gather needed information when a single data set does not include all required information
  - Learn more - Unlock the Power of Data Linkage

Data collection to enable data linkage

What do you need to link program data to external data to support QIA?

- Need to plan for this from the ***BEGINNING*** of the program development and implementation process;
- Need to identify relevant external data sources and assess the feasibility of linking program data (i.e. technical, legal);
- If feasible, need to collect unique identifiers (i.e. SIN, BN) or identifying information (i.e. name, address, date of birth) to facilitate data linkage (see Data Linking for Program Monitoring, Evaluation and Reporting) Canada.ca)



To link program data with Statistics Canada data, you need to collect the right information

- Statistics Canada has *many, many* data holdings for individuals and business (i.e. sociodemographic, tax, education, health data) to support QIA – to identify control groups, measure impacts AND enable disaggregated results
- To link with the Statistics Canada data holdings, it is recommended to collect unique identifiers (if possible) to facilitate more timely and efficient data linkage

Businesses	Individuals	Geography
Unique Identifiers: • Business number • Other? Other identifying information: • Addresses, including postal codes • Legal and operating names and addresses • URLs • Phone numbers • Latitude / Longitude	Unique Identifiers • Social insurance number • Other? Other identifying information: • Name • Date of birth • Addresses, incl postal codes • Phone numbers • Latitude / Longitude	Unique identifier • Latitude / longitude • Full Address Other identifying information • Geo spatial files

There are multiple services and data platfoms to enable linkage at Statistics Canada

Linkage source	Description
Canadian Employer Employee Dynamics Database (CEEDD)	Database that allows longitudinal and geospatial (1sq km) analysis of employer-employee linked data, productivity and investment, analytical tax variables and environmental events
Business Linkable File Environment	Enables linkage at the enterprise level across multiple data sets in the business domain to facilitate pan-Canadian and economic statistical research
Social Data Linkable Environment	Enables linkage at individual level across multiple data sets in the social domain to facilitate pan-Canadian and economic statistical research
Education and Labour Market Longitudinal Platform	Allows longitudinal integration of administrative data related to education with other data sources to create anonymized, customized datasets for analytical purposes

QIA using StatCan data – some real examples

- Immigration - *What are the early economic outcomes of immigrants screened in using Express Entry (EE)?*
  - Linked IRCCs Comprehensive Ranking System data to StatCans Longitudinal Immigration data base (includes tax data)
  - Results - EE principal applicants generally outperform their non-EE counterparts with higher incomes, but not among women
- Support programs - *Who benefited from the Canada Emergency Response Benefit (CERB)?*
  - ESDC CERB program, disability and labour market data were linked to tax, immigration and census data.
  - Results - younger workers, visible minorities, refugees and Indigenous workers were more likely to have received the CERB than workers without these characteristics (see Workers receiving payments from the Canada Emergency Response Benefit program in 2020)

Statistics Canada provides many types of support for QIA

- *Consultation* - Advice on data collection and linkage, outcome variables, control groups, QIA methods to support QIA (free !)
- *Analysis* – Statistics Canada subject matter experts can be contracted to conduct the QIA - create the data files, develop and run QIA models, interpret results and provide a report
- *Training* - QIA training is offered on an on-demand basis
- *Data Access* - Secure access to confidential micro data through the Virtual Data Lab or Secure Data Access Centres so you can do it yourself! (statcan.dad-apu-dad-uta.statcan@statcan.gc.ca)

Take aways

- QIA provides a robust, quantitative approach to program evaluation;
- Planning matters! Need to plan at the BEGINNING of the program or policy development process (NOT AT THE END!)
- Data linkage is timely and cost-efficient way to get the data you need to do QIA
- You are not alone... call us!

Contact information

Canadian Employee-Employer Dynamics Database

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Business Linkable File Environment:

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Social Data Linkable Environment:

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