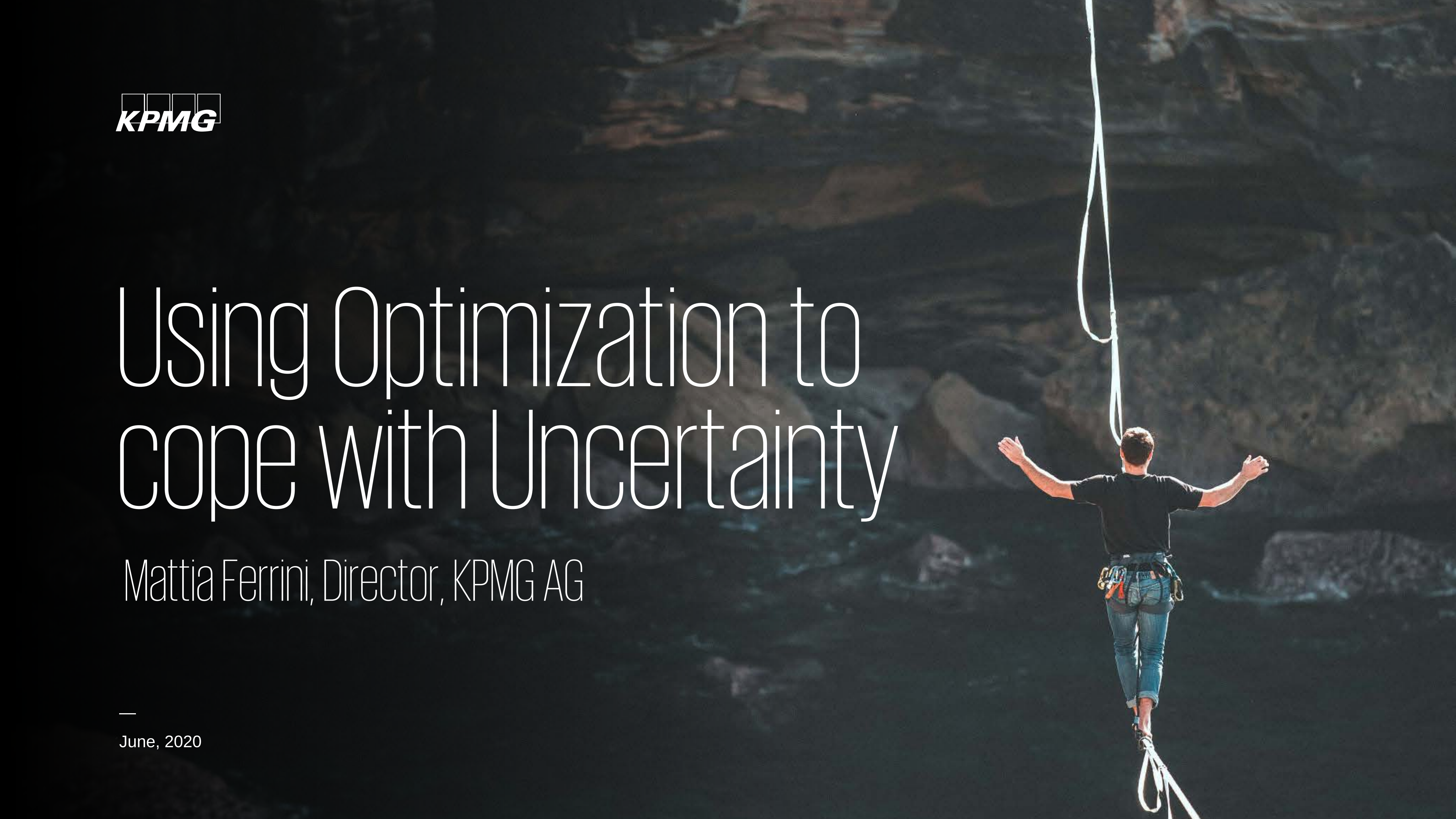

KPMG

Using Optimization to cope with Uncertainty

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June, 2020

The background

COVID19

Understand uncertainty

- Identify the sources of uncertainty
- Identify risks

Rethinking Modelling

- Rare-events and catastrophe modelling in the day to day decision making process
- More resilient business models
- Disruption as an opportunity to gain competitive advantage

How to leverage disruption?

1) Understand

- Identify what **micro and macro economic factors** drive your business

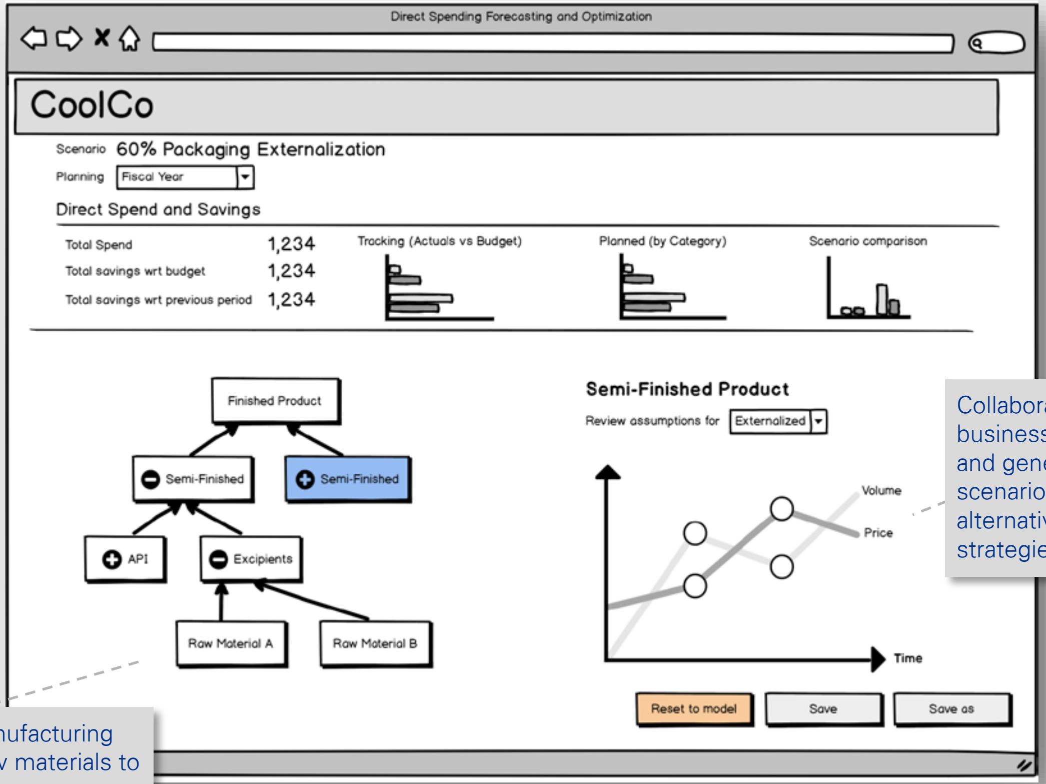
2) Anticipate

- Prepare ahead of **worst case scenarios**
- **Stress test your business**
- **Identify criticalities**

3) Spot opportunities

- **Reason strategically**
- Models as **useful representation** of a business
- **Reason collaboratively**

Example: sourcing strategies in the pharmaceutical industry



Collaboratively review business assumption and generate different scenarios based on alternative sourcing strategies.

Visualize the manufacturing process from raw materials to finished products

The background

High uncertainty is everywhere

Sport tournaments

- Risk of cancellations (weather, COVID19)
- Forecasting viewers, attendants, ..
- Model travel related stress

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Stores and Route optimization

- Model uncertainty in
  - lead times
  - availability and cost of shipping routes

Marketing optimization

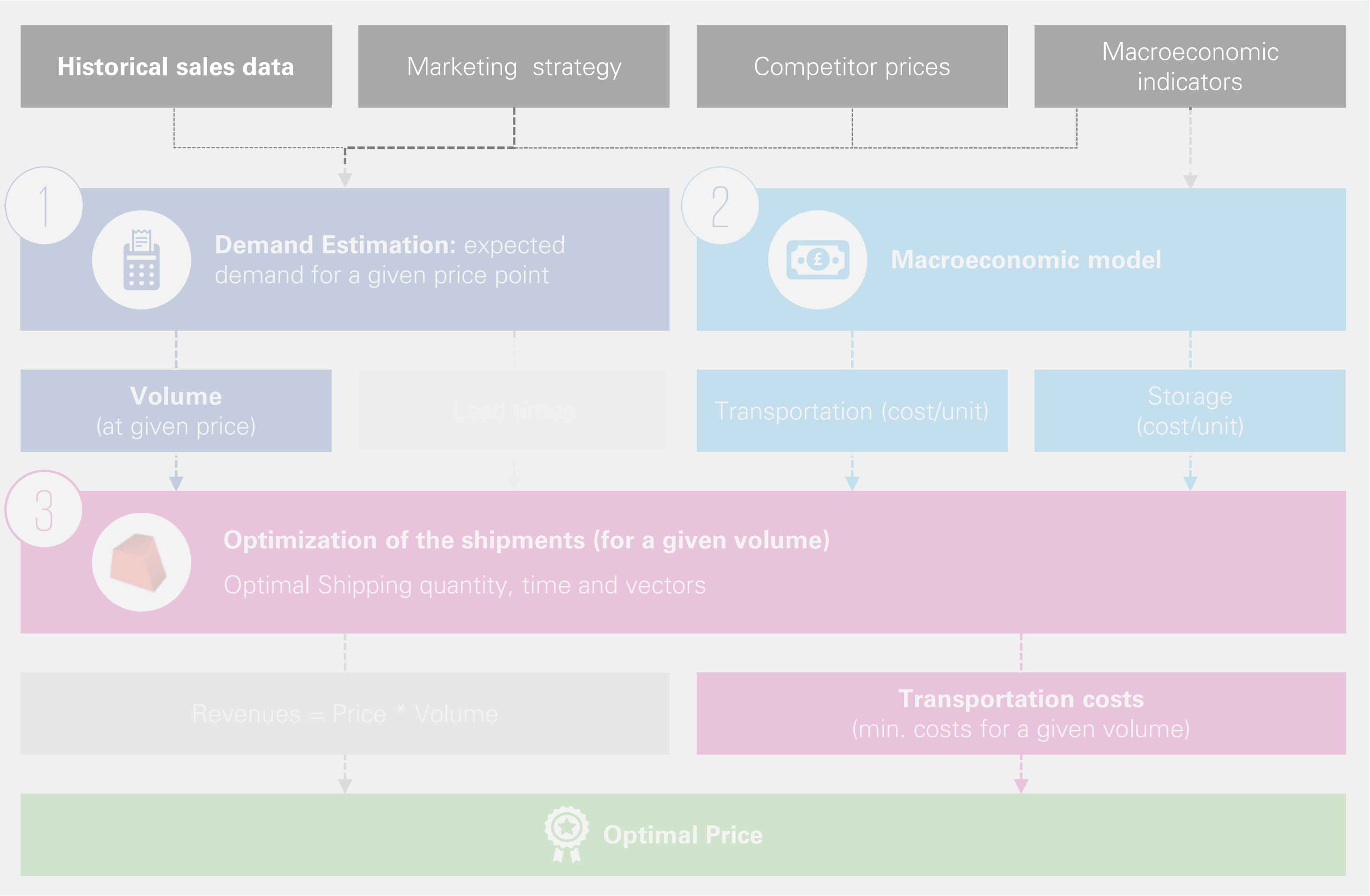
- Changes in customer habits, e.g.
  - Homework: less time on smart phones?

Price Optimization

- Willingness to spend
- Consumer preferences
- Demand by channel

Credential: European distributor of industrial goods primarily manufactured in Asia

Price Optimization



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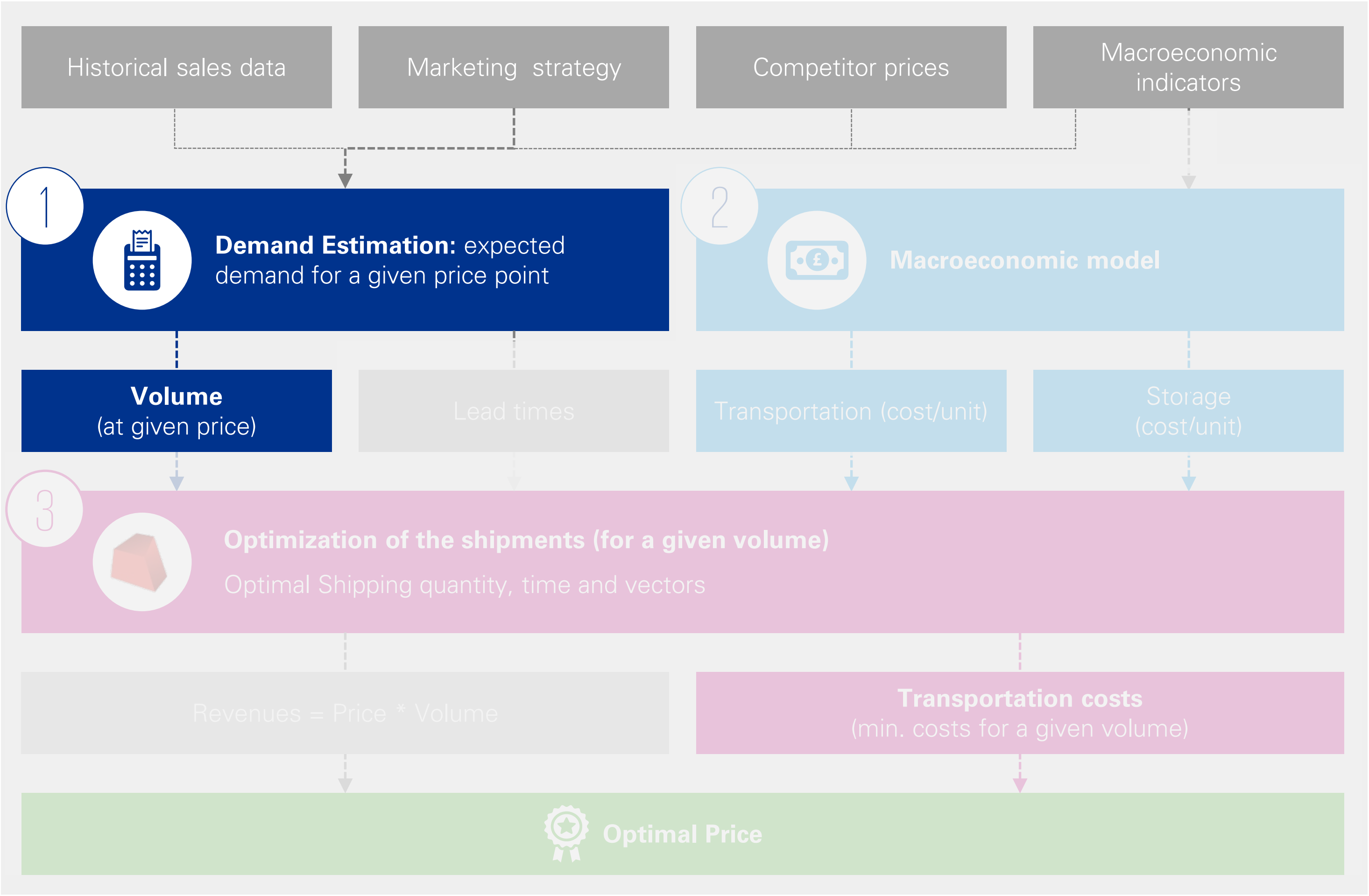
Price Optimization



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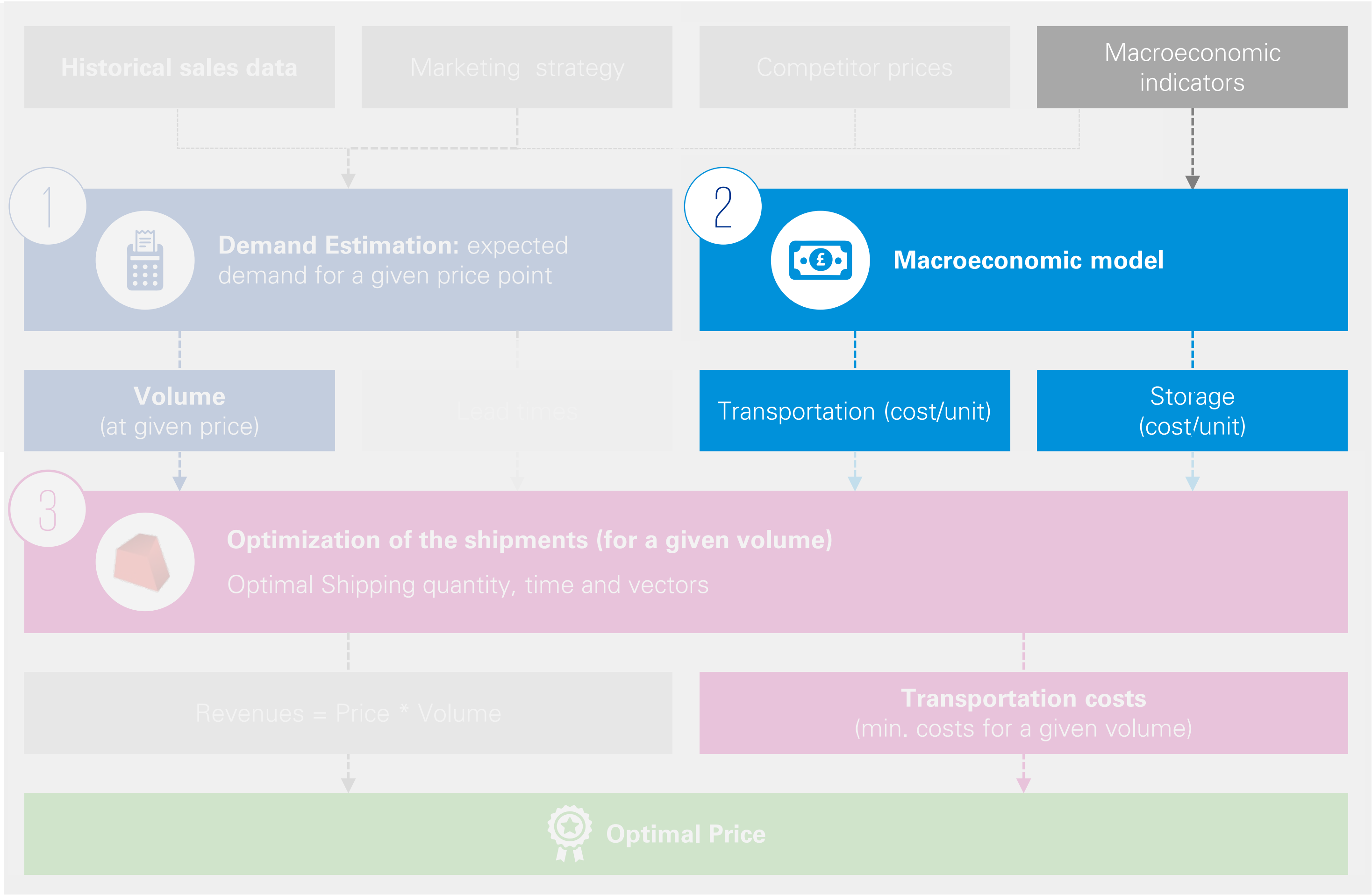

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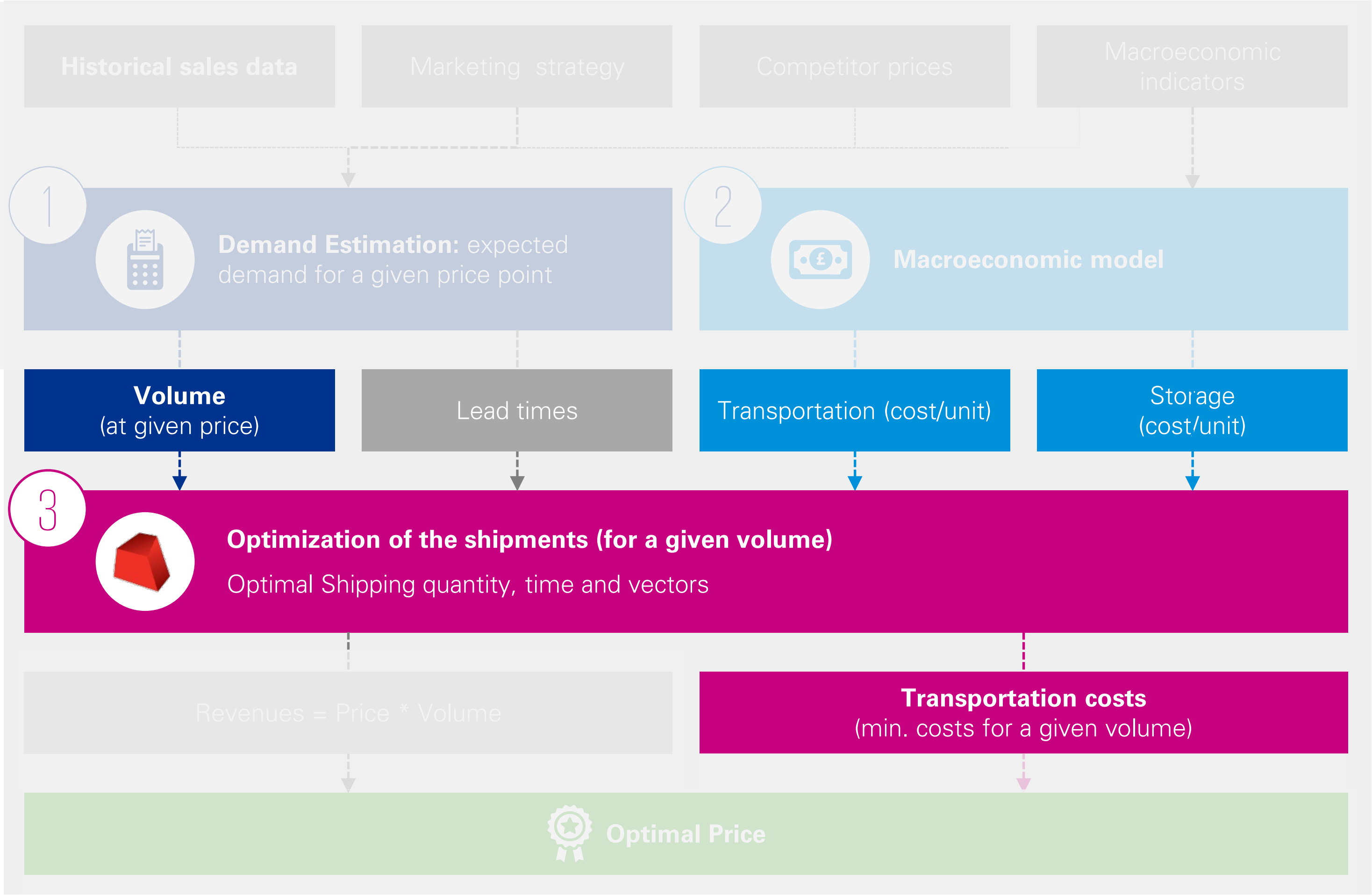

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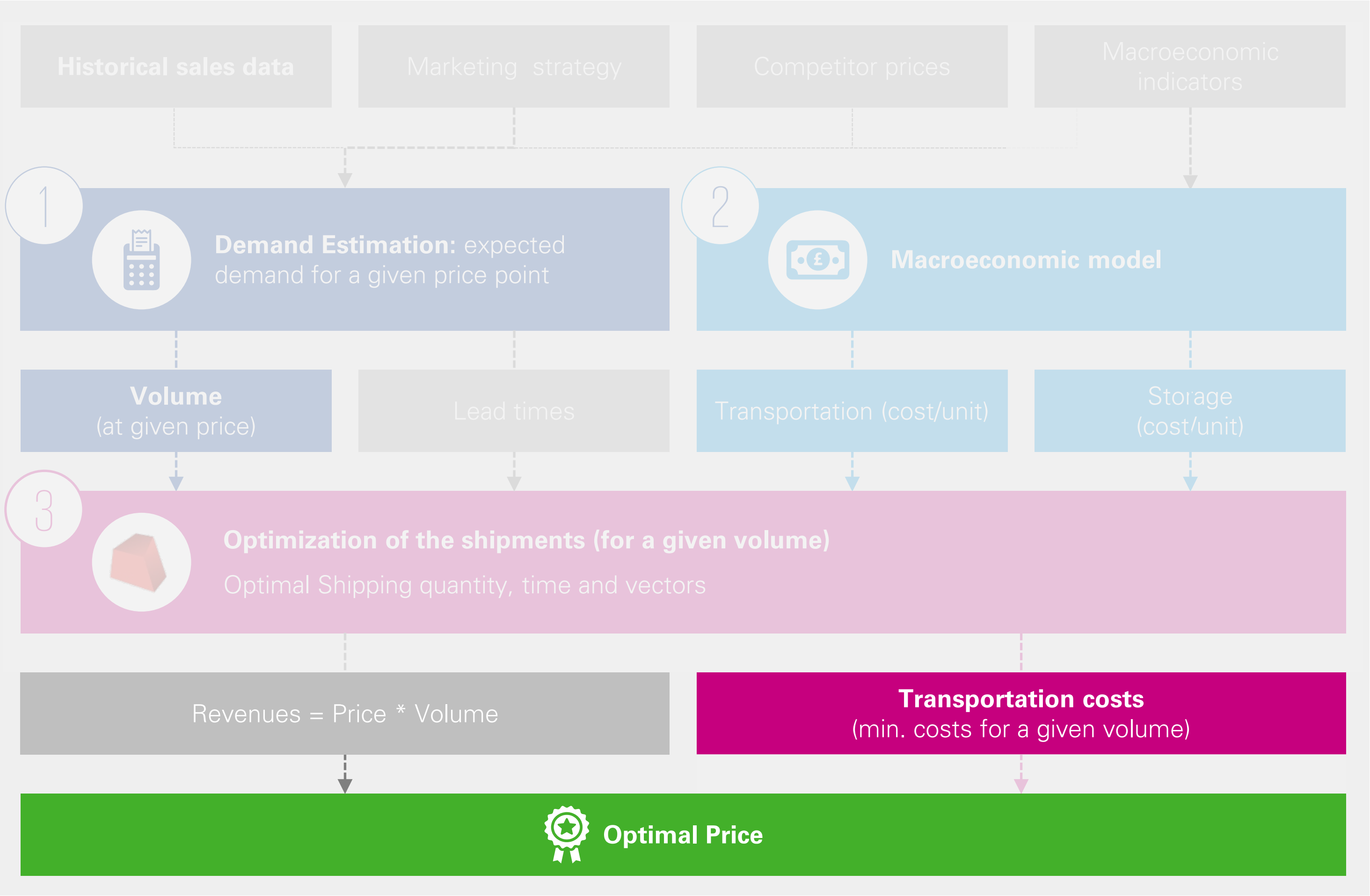

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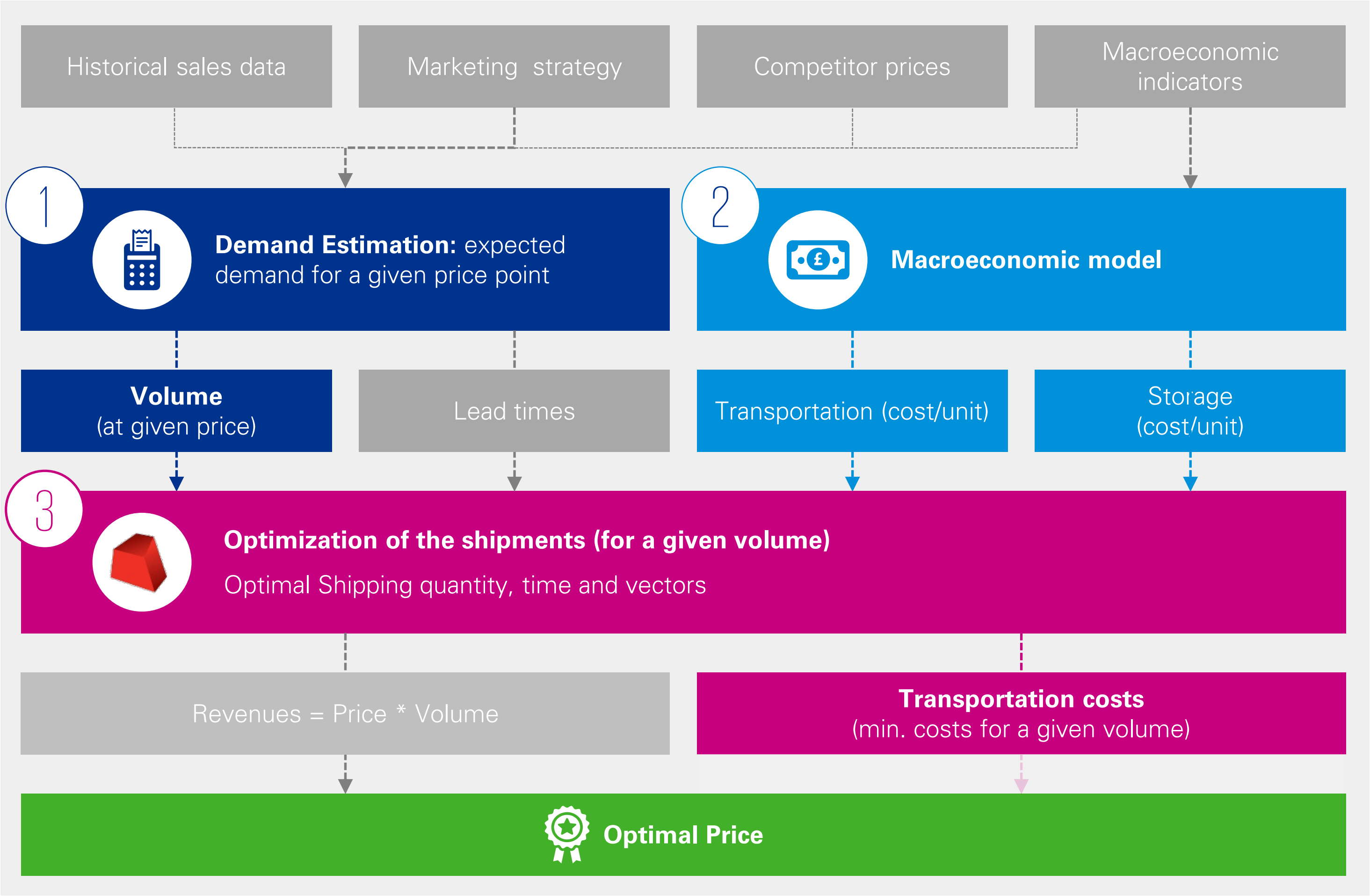
Price Optimization



Advantages:

- Structure the mathematical model as company's value drivers tree
- Aggregate bottom-up forecasts with proper accounting rules while taking into account the risk of cannibalization
- Enables the preparation of fine-grained **scenario analyses**

Optimization under uncertainty

Probabilistic Programming

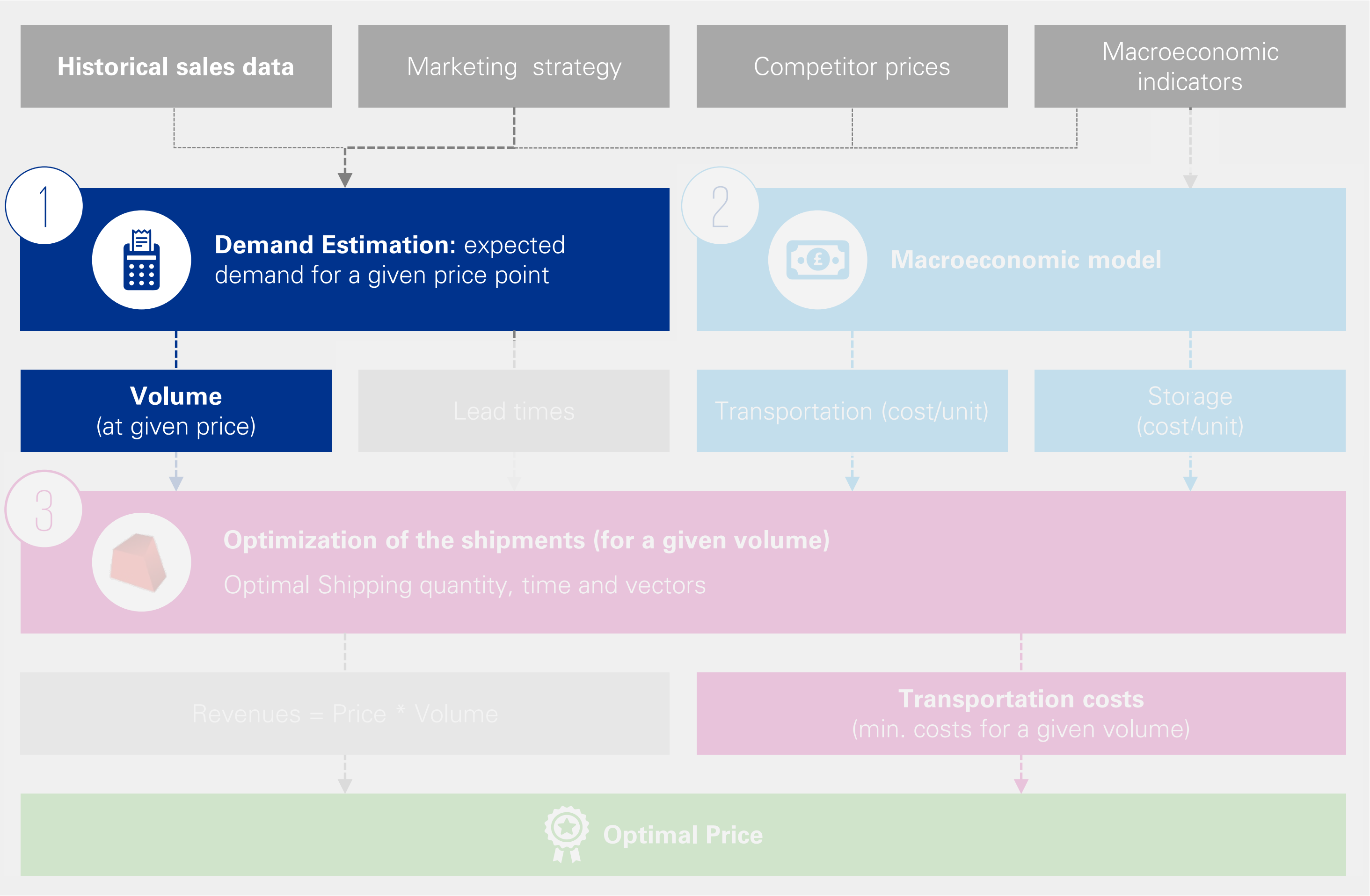
Stochastic Optimization

Optimization under uncertainty

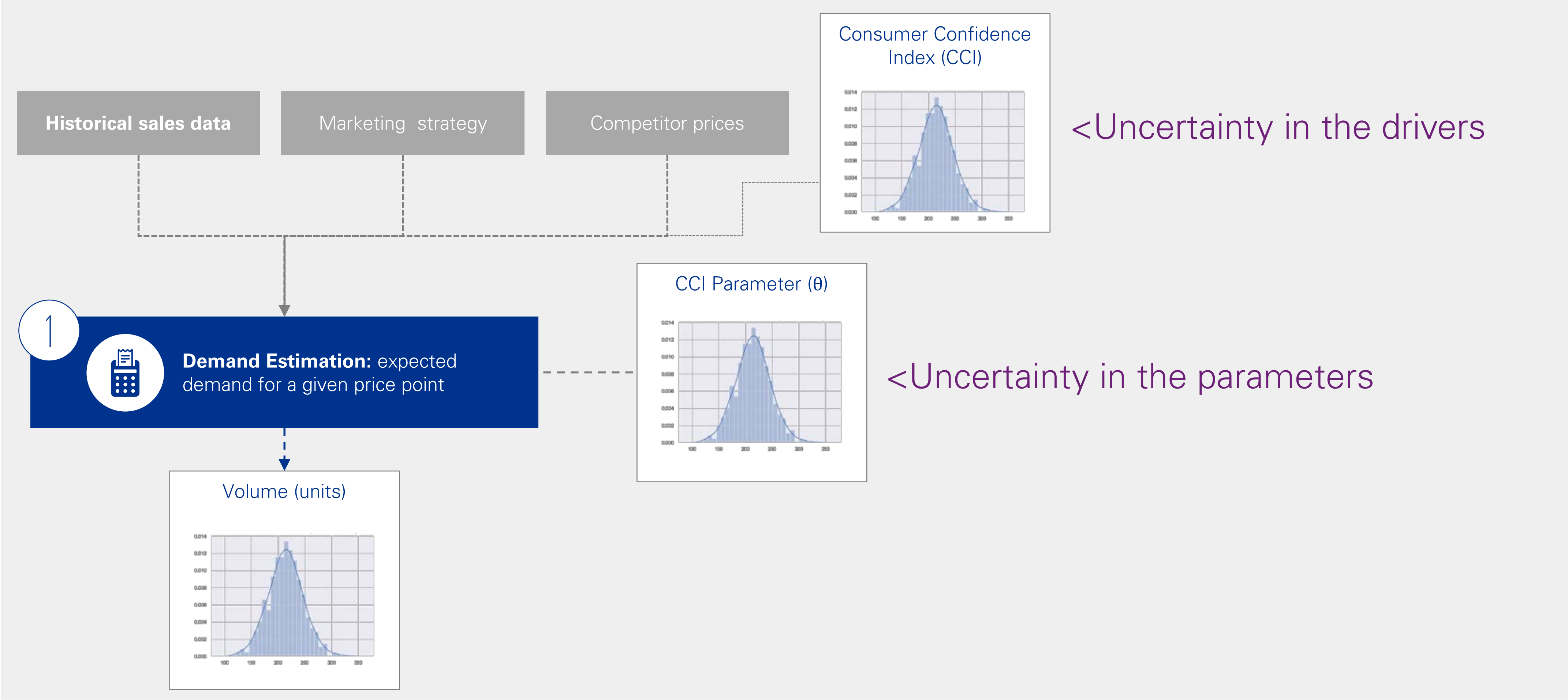
Probabilistic Programming

Stochastic Optimization

Price Optimization



Uncertainty is everywhere



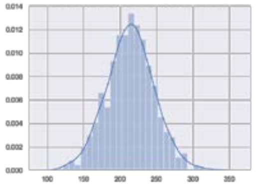
Quantified Uncertainty

Historical sales data

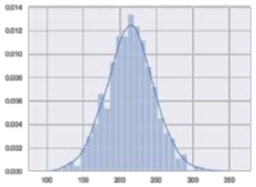
Marketing strategy

Competitor prices

Consumer Confidence Index (CCI)



CCI Parameter (θ)



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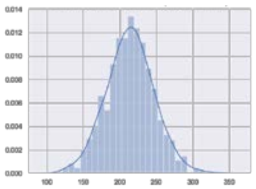
Demand Estimation: expected demand for a given price point

Volume (units)



Advantages:

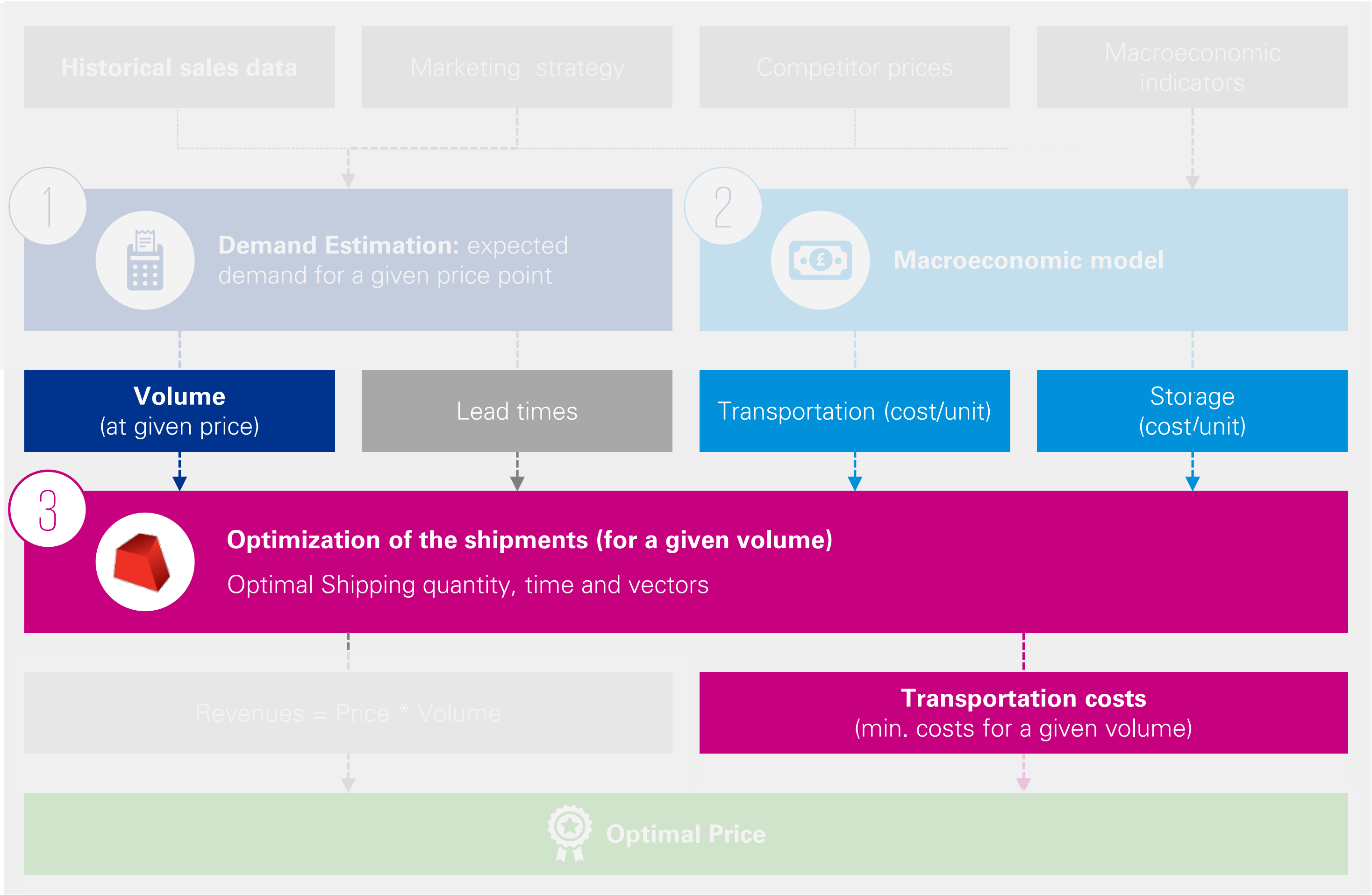
- Inject domain expertise and experts' opinions
- **Confidence intervals** and **sensitivity analysis**
- Probabilistic models that support **rare event** and **catastrophe modelling** (e.g. fat tails).

Optimization under uncertainty

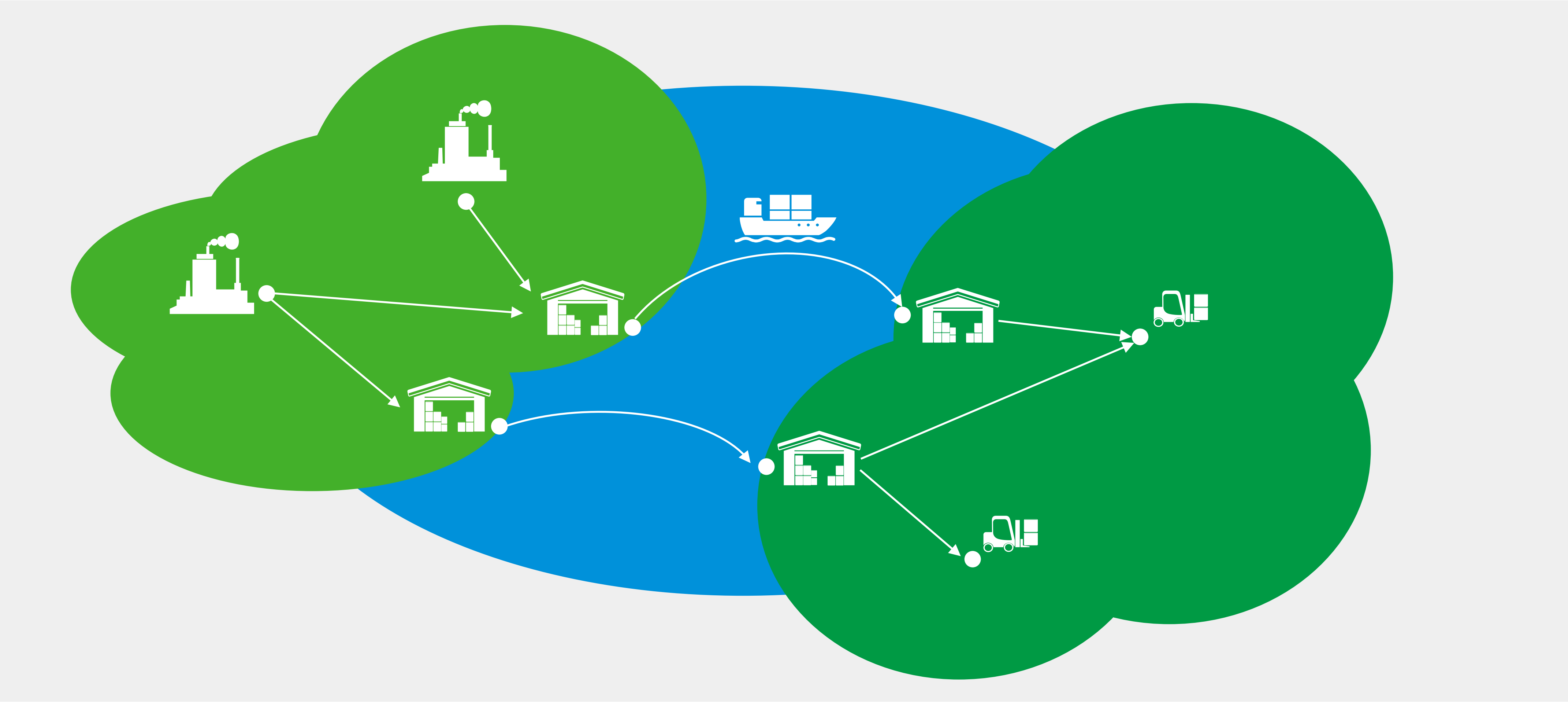
Probabilistic Programming

Stochastic Optimization

MILP optimization of shipments



Shipments optimization as a MILP problem



What is Stochastic Optimization?

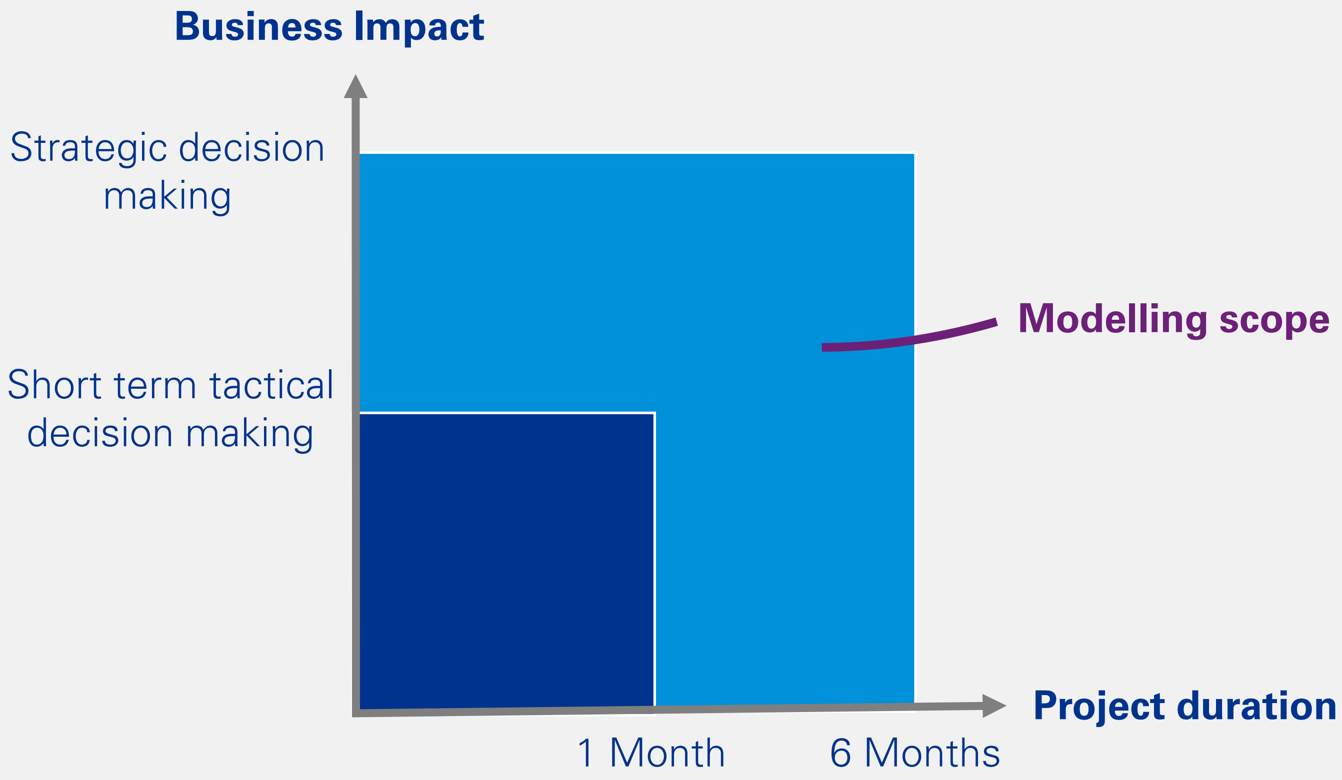
Robust Optimization (Implicit)

- You don't need to know how parameters are distributed
- assume **parameter uncertainty sets**,
  - e.g. **robust counterpart**: stochastic quantity is replaced by its expectation and a margin of safety
- Hard constraints in the uncertainty sets
- «worst case oriented»

Explicit Stochastic Optimization

- You make explicit use of information about the distribution of parameters
- You can define your **own utility function** and **risk measures**
- It's possible to have **soft constraints** (satisfy in probability)
- Can be computationally nasty
- Most of the time it is necessary to approximate solutions (e.g. Monte Carlo)

Project Plan



Conclusions

COVID19

- Priority: Robustness and Resiliency
- Disruption is an opportunity

Probabilistic Programming

- Build models that reflect the value drivers tree of a company
- Leverage risk management, rare events and catastrophe modelling in day to day decision making processes
- Quantify uncertainty

Robust and Stochastic Optimization

- Additional complexity ..
- .. Better decisions
- Can be tackled by Gurobi

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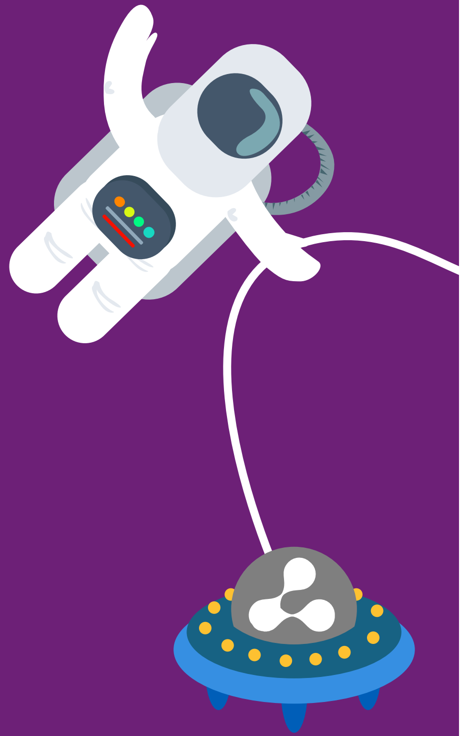

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