SCARLATTI

Workforce modelling

Scarlatti's approach to workforce modelling

August 2015

Introduction

About Scarlatti

Scarlatti is a management consultancy firm based in Auckland and Hamilton but working for clients throughout New Zealand. We have a strong strategic and analytical focus which we apply to our core capabilities of project management, business planning, and modelling. Our clients include industry organisations, private businesses and education providers.

Our workforce capability experience

Scarlatti has undertaken a range of workforce modelling projects and is also actively involved in projects where insights from modelling work are being used to develop interventions to attract, retain and / or train workers. Historically, most of our work in this area has been undertaken for the primary sector workforce but recently we have begun working with a range of other clients. A related area of capability is analysing the returns on investment in vocational training.

About this document

This document provides an overview of the approach that Scarlatti takes to workforce modelling. This includes our approach to characterising demand, not only for workers, but also for skills. It sets out Scarlatti's approach to modelling the *supply* response needed to meet workforce demand. Finally, this document provides an overview of Scarlatti's 'Inchworm' tool, which is used to undertake quantitative analysis for workforce modelling.

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Advantages of our approach

Scarlatti's approach to workforce modelling treats the workforce as a complex system. This system features a range of processes, such as recruitment, training, turnover and migration, which need to be characterised in order to arrive at the insights most useful for policy makers, investors and service providers.

Our approach provides some points of difference to most other workforce modelling methodologies. These include:

- **Models for the three principle drivers of demand –** Demand for workers and skills is driven by:
  1. Growth and other industry changes
  2. The need to replace departing workers
  3. The requirement to upskill the workforce

  Although all three drivers are important, they are not always given appropriate consideration. Upskilling, in particular, is often overlooked, despite the potential for it to be the most important of the three drivers.

- **Models of the supply response required –** While important, characterising demand does not lead directly to insights that can be actioned. By modelling processes like recruitment and training and relating these to demand, it is possible to quantify the responses needed from training providers, policy makers and investors. A range of scenarios can be modelled, allowing users to explore the implications of different interventions.

- **Characterising response times –** It is difficult to change a workforce quickly. Even when interventions like recruitment and training go well, it takes many years, often decades, for the impacts to be fully felt. A systems modelling approach provides a way of forecasting and characterising future changes in the workforce over long periods of time, as a result of interventions.

Applications of workforce modelling

Scarlatti's workforce modelling has been used by a variety of organisations in different ways, including:

Policy setters

- To put in place appropriate interventions. For example, to set immigration policy suitable for the needs of a given industry.

Industry and government investors in workforce outcomes

- To prioritise different interventions. For example, to answer questions like *"is it better to invest in a project to reduce staff churn or to increase on-job training for newly employed workers?"*
- To set targets. For example, to answer questions like *"how much do training volumes need to ramp up to meet a goal of having 60% of managers trained by 2025?"*

Tertiary providers

- To develop investment plans. For example, to decide whether they need to invest more in management training, as opposed to hands-on practical skills.
- To provide thought leadership with which to engage with industry leaders. For example, to make a convincing case for the importance of certain types of training to the industry.

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Drivers of demand

Workforce modelling is based on three drivers of demand:

1. **Growth** – Industry growth (or shrinkage) creates demand for new workers and may also change the mixture of roles required.

2. **Replacement** – Any workforce, whether growing or not, needs replacements for workers that leave for reasons like changing occupations & retirement. Replacement demand is not uniform for all workers – younger, newer (and often recently trained) workers are generally more likely to leave than older, established workers.

3. **Upskilling** – The need to upskill a workforce creates demand for training either through on-job training and / or by replacing departing workers with higher skilled successors.

The relative importance of these three drivers varies from industry to industry.

These three drivers create demand for:

1. Workers
2. Skills

These should be modelled separately as the 'stocks and flows'* since workers and skills are not the same. For example:

- A model of workers may define the stock as the total number of workers and the flow as new recruits to the workforce.
- A model of skills, on the other hand, may define the stock as the number of skilled workers and the flow as training. Training does not introduce new people into the workforce, but it does introduce new skills.

* Stocks and flows is a model, where inputs (and outputs) to the system are seen as flows and the accumulation of these flows over time defines the stock. For example, a system can be a water container, where the input (flows) is the rate of water added into it and the stock is the volume of water in it.

Growth demand

Usually, industry growth directly affects the number of workers required within a workforce.

Growth, or other changes, can also affect the *mixture* of roles and skills needed in the industry. For example, in a consolidating industry, the total number of workers may stay constant but the ratio of junior workers to managers may increase.

Our modelling approach

- Gather data about the current workforce, including, where available, a breakdown by industry, regions and role / skill level.
- Use relevant industry and public data to develop projections about the growth of an industry. Alternatively, simply utilise existing work for this step.
- Develop a projection of the number of workers required:
  - By role
  - By industry
  - By region
  - By year
- Use this 'demand matrix' as input to a workforce simulation.

In some cases the conclusions from the workforce analysis are relatively *insensitive* to the assumptions that underpin these projections. In these cases, replacement demand and upskilling demand are more important considerations than growth demand.

Replacement demand

Workers regularly leave the workforce for a variety of reasons. Older workers will retire, younger workers will go travelling, both will leave to go to other industries and / or other regions.

The probability of any individual leaving the workforce varies depending on factors like their experience, age, skills and role. For example, younger (often newly trained) workers are more likely to leave the workforce than established workers. Characterising these factors allows us to move beyond the assumption of a uniform replacement rate. This is important because, for example, the young workers that are most likely to leave are also the most likely to have been trained. This disproportionately increases demand for training due to workforce attrition.

Our modelling approach

- Use administrative data on industry tenure to develop models for the probability of a worker leaving the workforce based on their age and experience.
- Apply these models statistically, at an individual level, to characterise workforce turnover.

In our experience, replacement demand is usually more significant than growth demand, even in fast growing industries.

Upskilling demand

The skills profile of the workforce today may not be enough to meet the future needs of employers.

To upskill a workforce requires training current workers and / or replacing departing workers with higher skilled replacements.

Our modelling approach

- Establish target levels for skills, by role, at particular points in time.
- Vary the amount of on-job training and new graduates provided to a virtual workforce via simulations in order to determine the amount of training required to hit targets.
- Iterate between target setting and modelling training volumes required.

Where targets are set to upskill a workforce quickly, upskilling demand is likely to be the dominant demand driver.

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Approach to modelling supply

We consider three broad types of supply:

1. The supply of skilled workers, for example, the number of tertiary graduates available to the workforce each year
2. The supply of unskilled workers, for example, the number of school leavers available to the workforce each year
3. The supply of skills to workers already in the workforce, for example, the number of apprenticeships and on job training completed

Each type of supply composes a different type of flow to the proposed 'stocks and flows' model, respectively:

- Simultaneous supply of skills and people
- Supply of people only
- Supply of skills only

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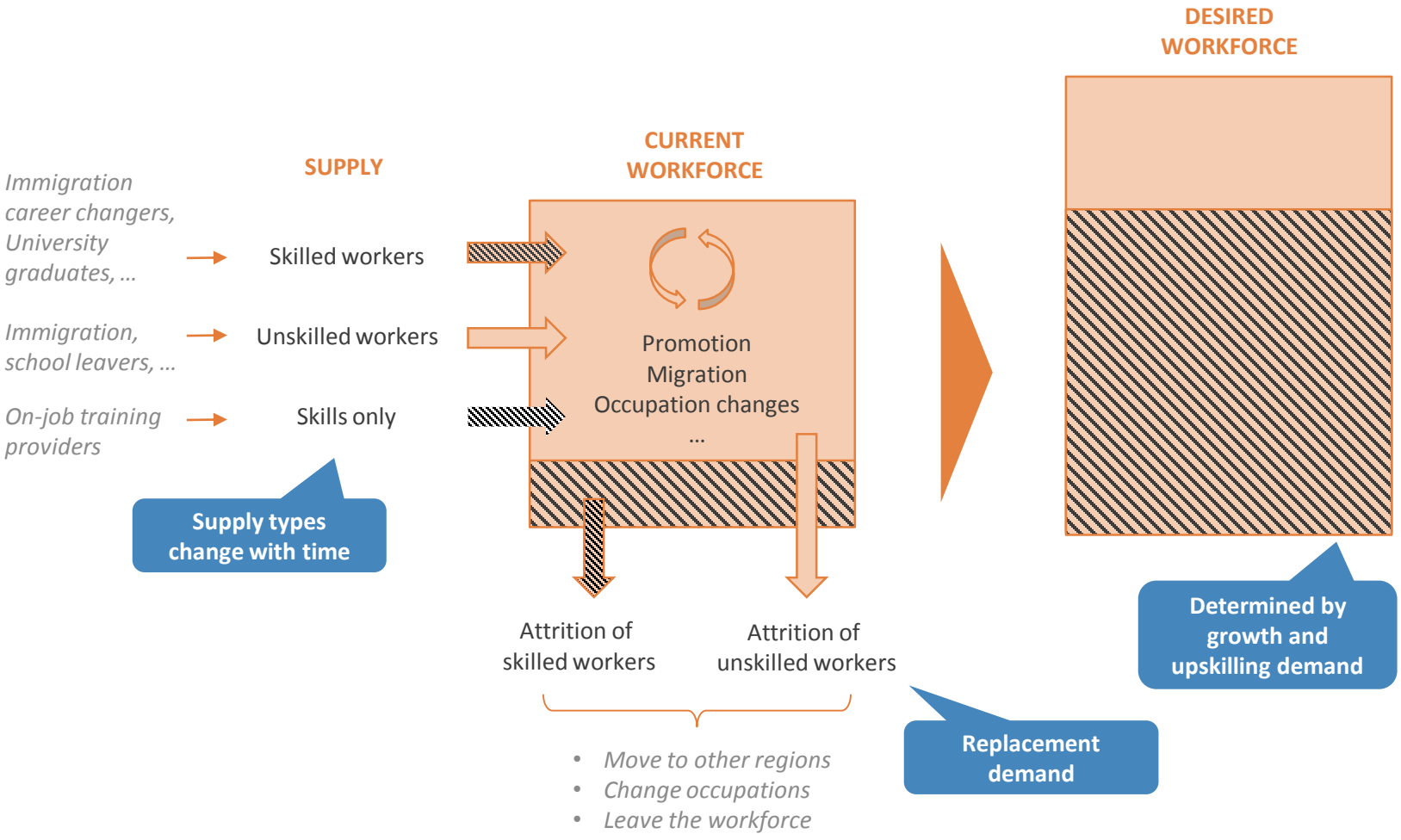
‘Stock and flow’ of the workforce system



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Inchworm (Industry **Ch**aracterisation of **Wo**rkforce **M**odel**)** is a dynamic, agent-based model that characterises important features of an industry workforce.

Each agent in the model represents an individual (a virtual worker) characterised by intrinsic career properties. Their virtual careers are shaped by processes such as recruitment, promotion, migration and training, each of which is modelled.

Each Inchworm simulation runs over a multi-decade period. Typically, this will include calibrating 10+ past years to current (or recent) known values and then running 20-30 years into the future.

The profile of the overall industry and / or regional workforce is determined by aggregating the population of these agents. In effect, Inchworm generates a database about the life history of a population of virtual workers. By querying this database, it is possible to investigate the impact of different input scenarios.

Example: A ‘virtual worker’ in dairy cattle farming

What Inchworm simulates about Dairy Farmer A…

Key dates	Born in 1985, first full year in industry was 2005																												
Recruited from	Non-primary sector New Zealand workforce																												
End of year (year 00 = 2000)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Industry tenure					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Age					19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Region					Canterbury			Waikato																						
Role					Farm assistant							Herd manager			Farm manager															
Qualification					Level 2, 3 other										Level 4 vocational															

Which might mean…

Person A grew up the Canterbury region. He left school with NCEA Level 2 at the end of Year 12, and went to work in the hospitality industry. At the age of 19, he decides to give the dairy industry a go, and gets a job as a farm assistant in 2004. After working at the farm for 3 years, he decides to see more of the country and moves to the Waikato region. In 2011, he gets promoted to herd manager and after a couple of years decides to upskill, successfully completing a Level 4 Dairy course in 2013. With his new skills, he becomes a variable order sharemilker at the at the age of 29 years old.

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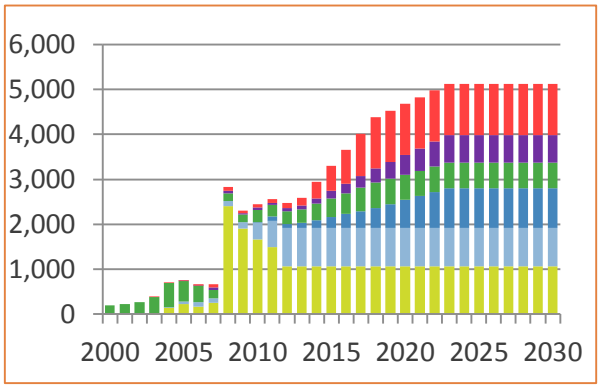
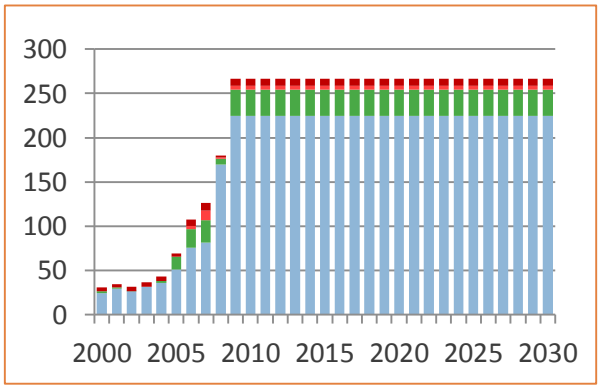
Examples of Inchworm outputs

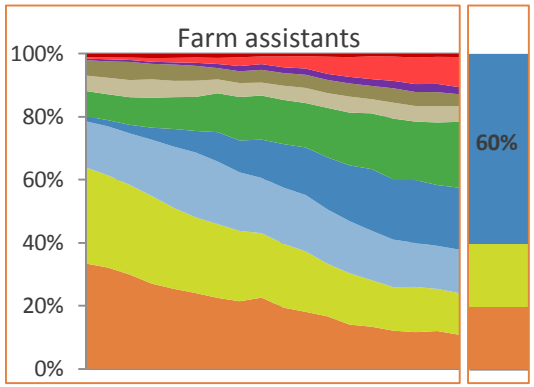
The figures below show the type of output that can be generated with Inchworm, using the dairy industry as an example. The left-hand graphs describe the volume of training over 30 years, while the right-hand graphs show the changing skills in the industry, as compared with set targets.

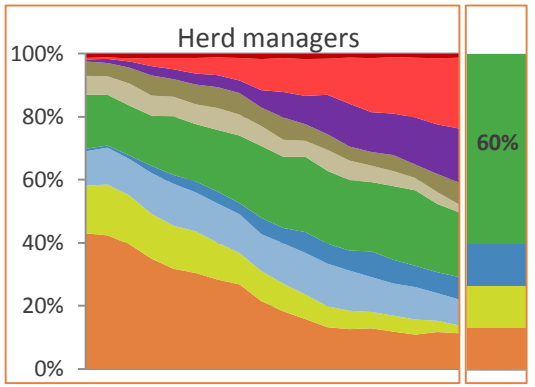
Volume of training added to (top) and entering (bottom) the dairy farming industry

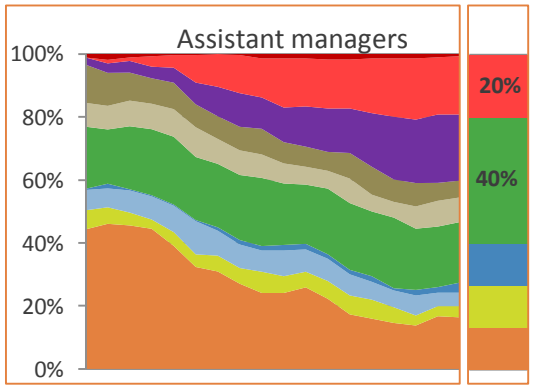


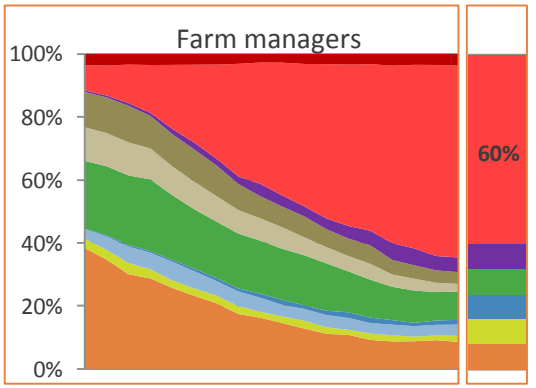


Skill changes in different dairy farming occupation roles*









* Different colours in the above charts represent different level of skills

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Inchworm – a typical modelling process

Workforce specification

Working with the client, the workforce to be modelled is characterised by defining properties such as job roles, regions and skill levels.

There is a high degree of flexibility in how these variables are set to allow these to be defined in a meaningful way for the client.

Target modelling

Two typical targets to be used for this model are workforce size and skills.

The target workforce size is sliced and diced annually by industries, roles, and regions in most cases. It is determined from available statistics and projected into the future using industry knowledge.

The target workforce skills are subsequently defined by size and ‘workforce specification’.

Supply modelling

Working with government agencies and tertiary providers, the supply of fresh graduates and trainees each year is obtained.

The supply can be projected into the future using industry knowledge and / or made into a decision variable (see ‘Target analysis’ on the next slide).

Inchworm – a typical modelling process (continued)

Agent modelling

Agent-based modelling involves probability models that determine each agent's action in the simulation. Here, the probabilities of turnover, migration, recruitment, promotion and training are modelled as functions of agents' properties such as age, tenure, skills.

Calibration

The model is calibrated with real data to make it realistic and relevant. We do this by simulation - running the model from a few decades back to the current year and checking the output of the current year with available real data.

Model parameters are adjusted until a robust agreement between the model's outputs and the real data is reached.

Simulation

Using the calibrated parameters, the model is simulated into the future. Events such as turnover, migration, recruitment, promotion and training will occur according to the set parameters. Note that, collectively, these events would dynamically generate / shrink the workforce demand.

A workforce database is generated and updated for each year simulated.

Target analysis

The workforce database from the simulation is queried to obtain the forecast workforce size and skills. These are compared to the target (see 'Target modelling' on the previous slide).

Projected supply figures from different sources can be tuned and the simulation re-run to determine how much supply is required to match this target.