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CENTRE FOR THE STUDY OF LIVING STANDARDS

A COMPANION GUIDE TO ANALYZING AND PROJECTING OCCUPATIONAL TRENDS

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A Companion Guide to Analyzing and Projecting Occupational Trends

Abstract

This report is intended to complement *Future Labour Supply and Demand 101: A Guide to Analysing and Predicting Occupational Trends*, a technical document commissioned by the Forum of Labour Market Ministers (FLMM) Labour Market Information Working Group (LMIWG) with the aim of achieving greater consistency and coordination in labour supply and demand modeling in Canada. In conjunction with the technical document, this companion guide will assist stakeholders in making informed decisions regarding the occupational modeling needs of their organizations.

A Companion Guide to Analyzing and Projecting Occupational Trends

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A Companion Guide to Analyzing and Projecting Occupational Trends

Executive Summary

The Labour Market Information Working Group (LMIWG) of the Forum of Labour Market Ministers (FLMM) commissioned the development of a guide to projecting future occupational supply and demand trends and imbalances. This was done with the aim of achieving greater consistency and coordination in labour supply and demand modeling in Canada. The guide, a technical document entitled *Future Labour Supply and Demand 101: A Guide to Analysing and Predicting Occupational Trends*, was prepared by the Centre for Spatial Economics.

This companion guide, prepared by the Centre for the Study of Living Standards, is intended to complement the technical document and assist stakeholders in making informed decisions regarding the occupational modeling needs of their organizations.

Many factors influence labour market trends. These factors may be associated with short-term business cycle fluctuations, or with longer-term structural developments in the economy including technological progress, demographic change, and globalization. In the face of such uncertainty, labour market stakeholders, such as workers, employers, and governments, must make decisions about education and training, hiring, and investment – decisions that will affect the future supply of and demand for jobs and workers across a variety of sectors and occupations. Occupational forecasting modes can be useful tools to assist stakeholders in their decision-making and to help prevent costly labour supply and demand imbalances in the future.

Any economic modeling exercise requires decisions about what variables to include, how to model the relationships between the variables, and what underlying assumptions to make. There is no single best approach. The choice of model should depend on the ultimate need that the forecasting model will fulfill, the resources available for the development of the model, and the availability and quality of data. This report provides guidelines for the development of occupational forecasting models to suit the needs of various stakeholders, including firms, government departments, labour unions, and educational institutions.

There are several limitations to occupational modeling and forecasting. The accuracy of a model's forecasts depends on the soundness of the macroeconomic scenario on which the model is based. Measurement error in the variables and inappropriate assumptions about them may result in inaccurate forecasts. To some extent, there is a trade-off between accuracy and cost; more accurate forecasts will require more complex and costly models that account for a wider variety of relevant factors. Different stakeholders may make different choices with respect to this trade-off, depending on their particular forecasting needs.

A Companion Guide to Analyzing and Projecting Occupational Trends

I. Introduction[1]

Purpose of the Report

In the absence of a pan-Canadian labour supply projection model that would enable analysis at the provincial and sub-provincial levels, the Labour Market Information Working Group (LMIWG) of the Forum of Labour Market Ministers (FLMM) identified the need for a practical approach to achieve greater consistency and coordination in labour supply and demand modeling in Canada. To achieve this objective, the LMIWG commissioned the development of a guide to projecting future occupational supply and demand trends and imbalances, which would serve as a useful tool for stakeholders. The guide, a technical document entitled *Future Labour Supply and Demand 101: A Guide to Analysing and Predicting Occupational Trends*, was prepared by the Centre for Spatial Economics.

This companion guide is intended to complement the technical document, and assist stakeholders in making informed decisions regarding the occupational modeling needs of their organizations.

Structure of the Report

The guide will be divided into four major sections after the introduction. Section II will describe the rapidly changing economy and labour market, the factors determining labour demand and supply (e.g. business cycle, demographic structure, etc.), the relationships between these factors, and the linkages between these factors and projected labour market outcomes. The section will provide an overview of relevant concepts (e.g. skill gaps, labour market imbalances, workforce shortages, skills demands, skills mismatches) and highlight the role of modeling and forecasting in identifying potential imbalances.

The third section will review the key considerations when developing an occupational projection model, and provide the basic structure of the model. It will outline the model and describe the steps involved in its development, the role of occupational and industry categories, the required components and inputs, and the forecasting techniques. This section will underline the key elements of a baseline model in non-technical terms, and will briefly explain how it can be expanded or modified to resemble a number of existing occupational forecast models.

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[1] This report was written in March 2009 while the author was an economist at the Centre for the Study of Living Standards (CSLS). It was written under the supervision of CSLS Executive Director Andrew Sharpe. The author would like to thank members of the Forum of Labour Market Ministers Labour Market Information Working Group for comments, and Jean-François Arsenault and Alexander Murray of the CSLS for editorial assistance.

The fourth section will briefly discuss the limitations of occupational modeling, including forecasting accuracy issues and data and resource availability issues.

Section V will provide stakeholders who wish to undertake labour supply and demand modeling and forecasting with a road map, that is, a tool to identify and develop a model that is suitable for them. Depending on their needs, resources and capacity constraints, organizations may benefit from forecast models that differ in their complexity and focus (*e.g.* occupations, education or skills).

Finally, a glossary of basic terminology and a list of additional resources related to modeling and forecasting, including publications, websites and agencies, will be provided in an appendix. Additional resources will include a detailed list of available labour market data sources for Canada.

II. Occupational Forecasting and the Labour Market

A. A Changing Economy and Labour Market

There are a number of factors affecting the supply and demand of labour. These factors may be ***cyclical***, related to short-term fluctuations in aggregate demand, or ***structural***, reflecting long-term trends or developments in the economy or society, independent of short-term fluctuations. Structural factors include technological advances, the globalization of competition, and changes in the demographic composition of the population.

Technological change has had a major impact on the occupational structure of many countries by shifting their industrial structure (*e.g.* from primary and manufacturing industries to services, in Canada) and by increasing the demand for highly skilled work relative to that for less skilled work – a phenomenon referred to as 'skill-biased' technological change.

Globalization also affects occupational structure, by shifting the industrial structure of countries.[2] In addition, a number of researchers have suggested that globalization increases the need for high-skilled labour in advanced economies, and reduces the demand for low-skilled labour. There is also evidence that globalization has contributed to a reduction in wage differentials across countries for labour of similar skill level, but has (along with technological change) led to an increase in wage inequality between lower and higher skill levels within high-wage countries.

Demographic factors in the context of Canada and most industrialized economies generally refer to the increasing average age of the workforce, with fewer entrants and a large number of retirees as the baby boomers cohort reaches retirement age. Other factors that are having an impact on skill requirements and occupational demand include competition and changing patterns of consumer demand, changing work practices and regulatory changes and increasing concern about environmental issues.

Given the rapidly changing economy and labour market conditions, occupational projection models and forecasts need to be constantly updated to reflect new developments.

B. Labour Market Concepts: Demand, Supply, Equilibrium and Imbalances

Occupational demand refers to the number of workers required by employers for an occupation, given a certain wage level. By definition, therefore, it includes the number of workers employed as well as the number of vacant positions that employers would like to fill for this occupation. Occupational supply refers to the number of workers employed

[2] Economic theory predicts that globalization will shift the industrial structure of countries towards their export sectors, which are the sectors that use their relatively abundant factors of production more intensively.

or seeking employment in an occupation, given the existing ***labour market conditions*** (primarily, at a certain wage level). Occupational supply may be referred to as the occupation's labour force.

When the occupational demand and supply are equal, the labour market for the occupation is said to be in ***equilibrium***. A divergence between labour demand and supply is a labour market ***imbalance***. There are two types of labour market imbalances: ***excess supply*** (unemployment) and ***excess demand*** (labour shortages).

Labour market imbalances attributable to the business cycle are by definition temporary. However, imbalances can also arise from structural factors such as technological change (e.g. new technologies resulting in a shortage of new skills that workers have not had opportunity to acquire, or reducing the need for workers to perform specific tasks) or demographic factors (e.g. a high number of retirements). Inefficient education investment decisions can also result in imbalances (e.g. shortage of doctors or civil engineers).

A labour market ***adjustment*** occurs when labour demand or labour supply shift so as to eliminate or reduce an imbalance. For instance, when confronted with a labour shortage, adjustments by firms include raising wages, providing additional training to the existing workforce, substituting the scarce labour for capital or for some other type of labour, and in some cases, attempting to move production to a different location. Labour market adjustments by workers include acquiring new skills that are in demand, or moving to a geographic area where there are vacancies due to labour shortages.

Labour market adjustments generally do not take place instantaneously, however. A lack of information, the time required for training or re-training (particularly for high skilled occupations), and various institutional barriers to labour market adjustment mean that in a given place at a given time there will be gaps between the quantities supplied and demanded for particular skills. For instance, employers may be unable to raise wages due to inflexible compensation structures or because doing so reduces their international competitiveness. Obstacles to regional labour mobility can also contribute to shortages. Moreover, firms and individuals simply may not recognise the signals of changes in the labour market in order to react to them (e.g. raise wages or invest in training); slow response time may delay market adjustment.

It is important to note that even if all imbalances were temporary (due to labour market adjustment), a shift in labour demand and/or labour supply resulting in a different equilibrium may be preferable for various reasons.[3]

[3] Although many would consider labour market imbalances temporary, the literature on multiple equilibria emphasises that economies may get stuck at various states depending on their histories. Some of these perhaps rather stable equilibria can be more desirable for a society than others.

C. The Role of Occupational Modeling and Forecasting

By providing information for employers, employees and policymakers, occupational forecasting facilitates a labour market balance and reduces adjustment costs; increases productivity and efficiency; and reduces social and economic problem arising from labour market imbalances (*e.g.* a shortage of doctors, social problems associated with high unemployment). It also helps ensure that workers are employed in occupations that correspond to their skill level, resulting in significant productivity and efficiency gains.

Occupational forecasting also improves personal and public investment decisions, and in particular decisions pertaining to education. Individuals often lack the information and the incentives necessary to invest in acquiring the knowledge and skills that will be required in the future. This leaves government with a dual role: identifying the skills that will be in high demand in the future and the areas where shortages may occur (through occupational forecasting) and subsidizing education.

In addition to providing information, occupational models can illustrate potential implications of a change in assumptions, including a change in government policy, on future labour market developments (Centre for Spatial Economics, 2005).

Today, the use of occupational modeling and forecasting is widespread. Most models used are national in scope, although sub-national components are also available, such as provincial models for Quebec and Alberta.

III. Developing a Basic Occupational Forecasting Model

A. Initial Considerations in Developing a Labour Supply and Demand Model

There is no *one* ideal occupational forecasting approach or model for all stakeholders. The choice of model and approach for each organization or stakeholder depends on a number of factors:

- The ultimate need that the forecasting model fulfills:
  - who are the end users of the forecast and/or whose perspective does the model need to convey?
  - what is the desired output format?

- The amount of resources committed to the task: a more complex and comprehensive model requires more resources

- Data availability, quality and coverage, which depend on:
  - the source of the data (Canadian labour market data sources are listed in Annex 2)
  - the level of detail or disaggregation required (whether the forecast is for an occupation vs. occupational group, industry vs. sector)

These issues, as well as the steps described below are combined in a flow chart in Section V, providing the user with a road map to occupational forecasting.

B. Assumptions, Variables and Coefficients

An economic model involves a set of variables (factors or events that can take on a number of values), assumptions regarding these variables and the relationships between them, and coefficients and parameters that represent these assumptions. For example, an assumption often made in the context of occupational forecasting in the past was that different kinds of labour or different occupations were not substitutable. This assumption means that the supply (availability) of more workers from one occupation has no impact on the supply of workers for another occupation. The relationship between the supply of workers across occupation can be represented by a coefficient, called the elasticity of substitution, which is assumed to equal zero in this case. Based on this assumption, the potential supply of workers in other occupations (even occupations requiring similar skill sets) was not accounted for in determining future imbalances in a specific occupation.

This assumption was made to enable the representation of a complex set of relationships by a simple economic model (which is why such assumptions are often referred to as ‘simplifying assumptions’). In practice, however, this assumption is unlikely to hold. Although workers from different occupations cannot substitute entirely for one another, they can do so to a certain extent, as there is generally some overlap in

skills across occupations (particularly within the same occupational group). Thus, a more realistic assumption is that the elasticity of substitution varies between zero and one, and takes on higher values for occupations that are either low-skilled or require similar skill sets. In fact, the assumption of zero substitution has been highlighted as an important weakness of occupational forecasting in the past. New models generally account for inter-occupational mobility in some way, although there is not yet a standard way of doing so.

Stock and Flow variables

Occupational demand and supply as defined in the previous section, refer to the level (or ***stock***) of workers required or willing to work at a certain wage. In the context of occupational forecasting, however, or at least for the purpose of this report, occupational demand and supply are ***flow*** variables, in that they refer to changes in the level or stock of required or available workers. Thus, for the remainder of this report, 'occupational demand' refers to the demand for *new* workers in an occupation. It generally consists of two elements: expansion demand (employment requirement attributable to growth) and replacement demand (employment requirement to replace the workers leaving the occupation for various reasons). Similarly, 'occupational supply' refers to the supply of *new* available and qualified workers for an occupation. It consists of 'school leavers' (people who have left the formal training system), immigrants, and 're-entrants' (people who re-enter the occupation's labour market after a period of non-employment). Re-entrants can be people who were previously unemployed (in the labour force and actively seeking work) or not in the occupation's labour force (including people previously employed in another occupation).

C. Forecasting Techniques

The forecasting techniques used at different stages of the occupational forecasting process vary in complexity, from simple extrapolative techniques (projecting a historical trend into the future without accounting for the influence of economic or other factors), to simple regressions linking changes in a dependent variable to changes in another (*e.g.* outflow of workers from employment to non-employment as a function of the GDP gap), to more complex econometric models and techniques that allow for the interaction of different variables. There often is a trade-off between the simplicity of the model and techniques used and the accuracy of forecasts. The choice of model ultimately depends on its purpose and on the resources available for its development.

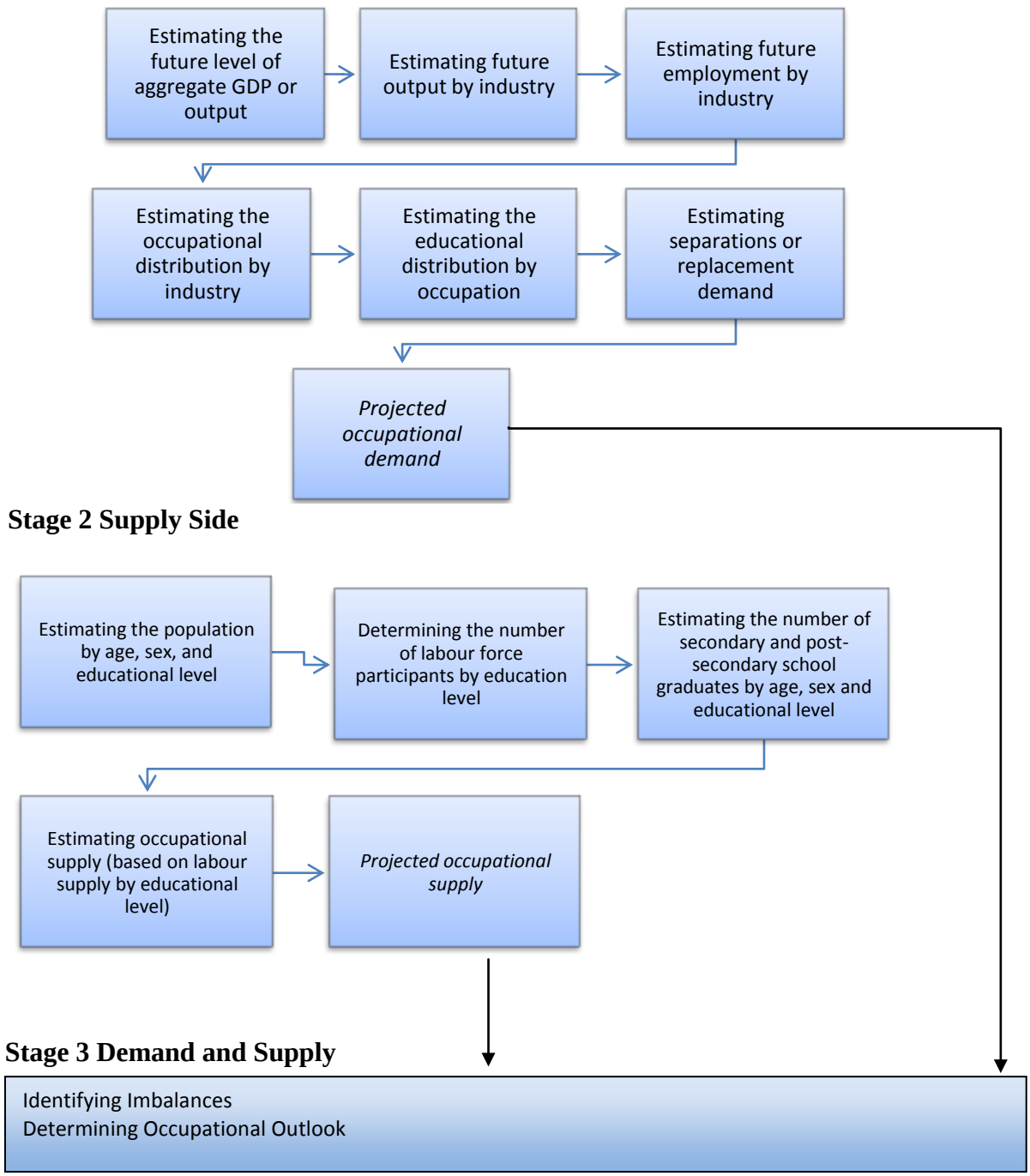
D. Basic Structure of a Labour Supply and Demand Model

Occupational modeling and forecasting has a long history. The dominant approach is the *Manpower Requirements Approach (MRA)*, which consists of three stages or components: projecting occupational demand, projecting occupational supply and balancing demand and supply. Each of these stages involves several steps. Because of the large size and complexity of the models, occupational demand and supply are generally determined independently of one another. There are models that determine both supply

and demand simultaneously (*e.g.* a Dutch model, using an iterative modeling approach) but such models are beyond the scope of this document.

The MRA approach is - at least partially - used in all existing models. This approach is therefore used here to develop a basic occupational forecasting model, which can then be expanded or modified as needed. The approach is summarized in Figure 1.

Figure 1. Developing a Basic Occupational Forecasting Model



E. Detailed Steps Involved in the Development of a Baseline Model

A stepwise approach to occupational modeling is recommended because of its relative simplicity, and because it provides useful information at various steps.

Stage 1: Demand Side

Step 1. Estimating the future level of aggregate GDP or output

- An occupational forecasting model is always based on a ***macroeconomic reference scenario***. The first step in occupational forecasting involves obtaining a projection of overall economic growth from this scenario. The macroeconomic scenario can be developed by an external organization, and is often based on a survey of forecasters.

- The macroeconomic scenario takes into account the external economic environment (e.g. US economic growth) and the domestic economic environment (e.g. fiscal and monetary policy, the exchange rate, and assumptions with respect to the industrial composition of the economy).

Note: In modelling systems for industry sectors, or for small open economies, large projects driving economic activity may be explicitly taken into account. The influence of such projects for occupational demand often vary, with some projects resulting in a larger than average demand for specific skills or skill sets.

Step 2. Estimating future output by industry

- The second step involves determining output by industry, based on the overall economic growth projection obtained in the previous step, and taking into account the changing structure of the economy.

- Final demand categories are obtained from the macroeconomic scenario, and are translated into industrial output using an input/output matrix or industrial output shares of total output.

Step 3. Estimating future employment by industry

- The third step involves determining employment by industry using the output by industry obtained in the previous step and labour productivity by economic sector. Labour productivity is often measured as hours worked per unit of output.

- Data on hours worked per worker may be needed to obtain the number of workers by sector in this step.

Step 4. Estimating future employment by occupation

- Occupational employment is determined by changes in employment between industries and by changes in employment between occupations within an industry, which can be calculated using different methods. One simple method involves using a (historical) industry/occupation matrix to obtain ***occupation coefficients*** or shares of occupations in industry employment, which are then extrapolated into the future.

- The projected employment for each occupation is then summed across industries to obtain future employment level by occupation.

Step 5. Estimating expansion demand by occupation

- Expansion demand or net job creation is measured as the change in the level of employment requirement by occupation from one time period to another.

Note: *Expansion demand is generally larger for occupations in the industries or sectors with the largest output growth (from Step 2), as these sectors are likely to have a larger employment growth (from Step 3.)*

Step 6. Estimating separation or replacement demand by occupation

- Separations are the total number of people leaving an occupation for any reason (retirement, death, migration, illness, disability, changing occupations, maternity leaves, etc.) *Net* separations refer to the number of workers leaving the occupation less the number of workers entering the occupation during any period.

- Similar to the concept of separations is the concept of replacement demand which refers to the number of workers required to replace the workers leaving an occupation. If employers want to maintain their employment levels, replacement demand is equal to net separations. If employers want to take advantage of departures to decrease the size of their workforce, then replacement demand is lower than net separations. In that case, *replacement demand can be calculated as separations less the decline in the level of employment*.

- To estimate separation or replacement demand, future mortality and retirement rates are estimated using historical data for the different age/sex groups. For simplicity, all occupations are assumed to have the same separation or replacement demand rates.

- The estimated rates are applied to the corresponding projected employment level for each group. The projected separations are then added up across groups, to obtain a projection of separation or replacement demand for each occupation.

- *Net* interprovincial migration by occupation and *net* inter-occupational migration estimates are included in projecting replacement demand, if resources and data availability permit.

Step 7. Estimating occupational demand

- Gross labour demand by occupation can therefore be calculated as expansion demand plus separations. *Net* labour demand by occupation is calculated as expansion demand plus *net* separations or replacement demand.

Step 7'. (optional step) **Estimating the educational distribution by occupation**

- Models that explicitly account for the distribution by education level often use 'fixed coefficients', that is, assume that past trends will simply continue into the future. Trends can therefore be obtained from historical data and used to project future education (skills) demand.

  Note: *Models using the* NOC *occupations do not require this step; because the NOC structure is based on skill levels, forecasting occupations by NOC code amounts in implicitly forecasting skills demand.*

Stage 2: Supply Side

Step 1. Estimating the number of graduates by age, sex and educational level

- Education models are often developed as separate models, outside the occupational forecasting model. Historical data on graduations by level of schooling as a share of age/sex group can be used (along with population projections by age or sex group obtained from an external source) to determine graduation rate trends, which can be projected into the future using extrapolative techniques.

Note: *Educational institutions may prefer to forecast the number of graduates by **field** of education.*

Step 2. Estimating the labour force participation and the labour force by age, sex group and educational level

- Labour force participation rate trends can be calculated from historical data and projected forward using an extrapolation technique. The trends are then applied to the corresponding demographic group population projections to obtain the projected labour force for these groups.
- If graduation trends were estimated, these rates can also be applied to the corresponding labour force estimates calculated in this step, to obtain estimates of the educated labour force by demographic group.
- The estimates by age/sex group are then added to obtain an estimate of the projected overall labour force.

Step 3. Including Interprovincial Migration

- In sub-national models, inter-regional migration is usually added to the model as an exogenous variable (i.e. changes in inter-regional migration are assumed to be independent from changes in the other factors determining the size of the labour force).
- *If estimates of interprovincial **out-migration** were included in the calculation of replacement demand (demand side), estimates of interprovincial **in-migration** can be included in the calculation of the labour force (supply side).* The number of interprovincial *in*-migrants is then added to the projected overall labour force from Step 2.

  Note: *If **net interprovincial migration by occupation** was included in the calculation of replacement demand, interprovincial in-migrants do not need to be included at this stage. Similarly, inter-occupational migration does not need to be accounted for at this stage because of the inclusion of net inter-occupational migration in estimating replacement demand in the previous stage (demand side).*

  Note*: Inter-occupational mobility can be expected to be higher for lower-skill and/or entry level occupations*

Step 4. Including Immigration

- In some models, such as Canada's COPS model, the number of immigrants entering an occupation's labour force are estimated and included in the model. The number of immigrants by occupation is estimated using the aggregate flow of immigrants into the workforce and fixed occupation shares (the distribution of immigrants by occupation) obtained from census data.

Step. 5 Including Re-entrants

- In some models, the number of workers re-entering an occupation's labour force after a period of non-employment are estimated and included in the model.
  Note: this step can be omitted if re-entrants are accounted for in the labour force participation estimates in Step 2.

Step 6. Estimating labour supply by occupation

- The occupational labour supply can be estimated by using historical trends of the occupational shares in the labour force, or by using an education to occupation matrix.

Stage 3: Balancing supply and demand – Identifying future imbalances

Step 1. Comparing estimates of labour demand (Stage 1) with estimates of labour supply (Stage 2) to identify imbalances
▪ The demand and supply estimates (projected employment level and projected labour force) are then combined to develop an indicator of labour market imbalances. Note: *For simplicity, labour supply and labour demand are generally modeled separately (a distinct model– the models developed in stage 1 and 2 respectively – is used for each); there is no interaction between the two, except the interaction that is implicit in the underlying macroeconomic model. In other words, occupational projection models do not account for the responses of firms and workers to changing occupational outlooks. For this reason the projected imbalances are said to be 'ex ante' imbalances.*
Step 2. Determining occupational outlook
▪ The labour market indicator (LMI) constructed in the previous step is usually translated into a qualitative assessment to make it easier for end users to interpret, and to avoid giving a false sense of precision. Note: *Because the LMI developed in the previous steps uses forecasted occupational demand and supply as <u>flow</u> variables, it does not take into account the initial labour market imbalances (existing imbalances at the beginning of the forecast period). Therefore, such an indicator must be interpreted with care: 'Excess supply' may be more accurately interpreted as a movement towards excess supply, and conversely 'excess demand' as a movement towards excess demand.*

F. Simplifying or Expanding the Model

Depending on the need of the forecaster, and the resources available to them, the baseline occupational forecasting model presented above can either be simplified or expanded further.

To simplify the model, some of the steps listed above can be:

- outsourced (e.g. obtaining a macroeconomic scenario and GDP forecast from an external source - Demand Side, Step 1.),
- omitted (e.g. some models do not take into account immigration – Supply Side, Step 4),
- simplified (e.g. calculating replacement demand only as deaths plus retirements. This is based on an assumption that other types of separations (on the demand side) can be cancelled out as potential re-entrants (on the supply side) – Demand Side, Step 6)

Conversely, the model can be expanded by adding additional steps, or including more components in various steps (e.g. including additional types of labour market separations in the calculation of replacement demand).

Alternatively (or in addition), to expand or simplify the model, the steps can be performed using approaches that vary in their complexity. For instance, estimating future

employment by occupation based on future industry employment can be done in various ways, including the following (listed by increasing complexity):

- using ‘fixed coefficients’ or shares, calculated from historical data. Here the assumption is that the distribution of occupations by industry does not change over time.
- allowing the coefficients to change over time, based on the historical trend only.
- Estimating the future coefficients or shares by accounting for various factors that may influence the occupational structure of industries (e.g. technological change, a change in organizational culture within industries, etc.).

A challenging but important expansion of the model would be to allow for demand and supply interactions, or to determine the two simultaneously. Very few models currently use this approach, due to its complexity and resource intensity. One notable exception is the Dutch ROA model, briefly outlined in Annex 3.

Another challenging expansion of the model would be to allow for a feedback effect from occupational demand and supply into the underlying macroeconomic scenario. This may be relevant for instance in models where the macroeconomic scenario explicitly accounts for large projects, the completion of which may be dependent on the availability of labour.

IV. Limitations of Occupational Modeling and Forecasting

There are several limitations to occupational modeling and forecasting. First, the accuracy of these models is a source of concern. To a significant extent, the accuracy of an occupational model's forecasts depends on the soundness of the macroeconomic scenario on which the model is based. If this underlying macroeconomic forecast is inaccurate, then the occupational forecast is likely inaccurate as well.

The difficulty of predicting and accounting for the impact of factors such as technological change (e.g. in terms of labour-capital substitution or new skills demand), and measuring important concepts such as inter-occupational mobility (or labour-labour substitution) constitutes a challenge for occupational forecasting. Measurement errors in these variables and wrong assumptions about them result in inaccurate forecasts. For this reason, occupational forecasts tend to be more accurate at a higher level of aggregation (for occupational groups rather than occupations). However, stakeholders and policymakers are generally more interested in forecasts at lower levels of aggregation.

A related limitation is the simple unavailability of reliable data underlying key assumptions at detailed levels. For example, COPS uses national 3-digit occupational data to project provincial 4-digit occupational data on retirements, and it uses only data on complete labour force withdrawals, ignoring partial labour force withdrawals such as reductions in hours worked. Given that future demand is in large part driven by retirements such limitations are not trivial.

The accuracy limitation is even deeper for occupational forecasting than for traditional forecasting because, unlike most traditional forecasting, occupational forecasts generally do not include measures of their accuracy. The large number of variables feeding into these models has made the measurement of accuracy difficult, and little energy has been spent measuring their past accuracy.[4] Given these significant limitations, even in mainstream models such as COPS, it is important to cross-check results of such projections with alternate indicators.

Another limitation of most existing occupational forecast models is that they do not allow for supply and demand interactions, and do not take into account the responses of workers and firms to changing occupational prospects.[5] This limitation is one of the main differences with traditional forecasting, and it stems in large part from the somewhat unique purpose of occupational forecasting, which is to inform key stakeholders whether actions to correct imbalances *should* be undertaken rather than to anticipate whether these interventions *will* take place.

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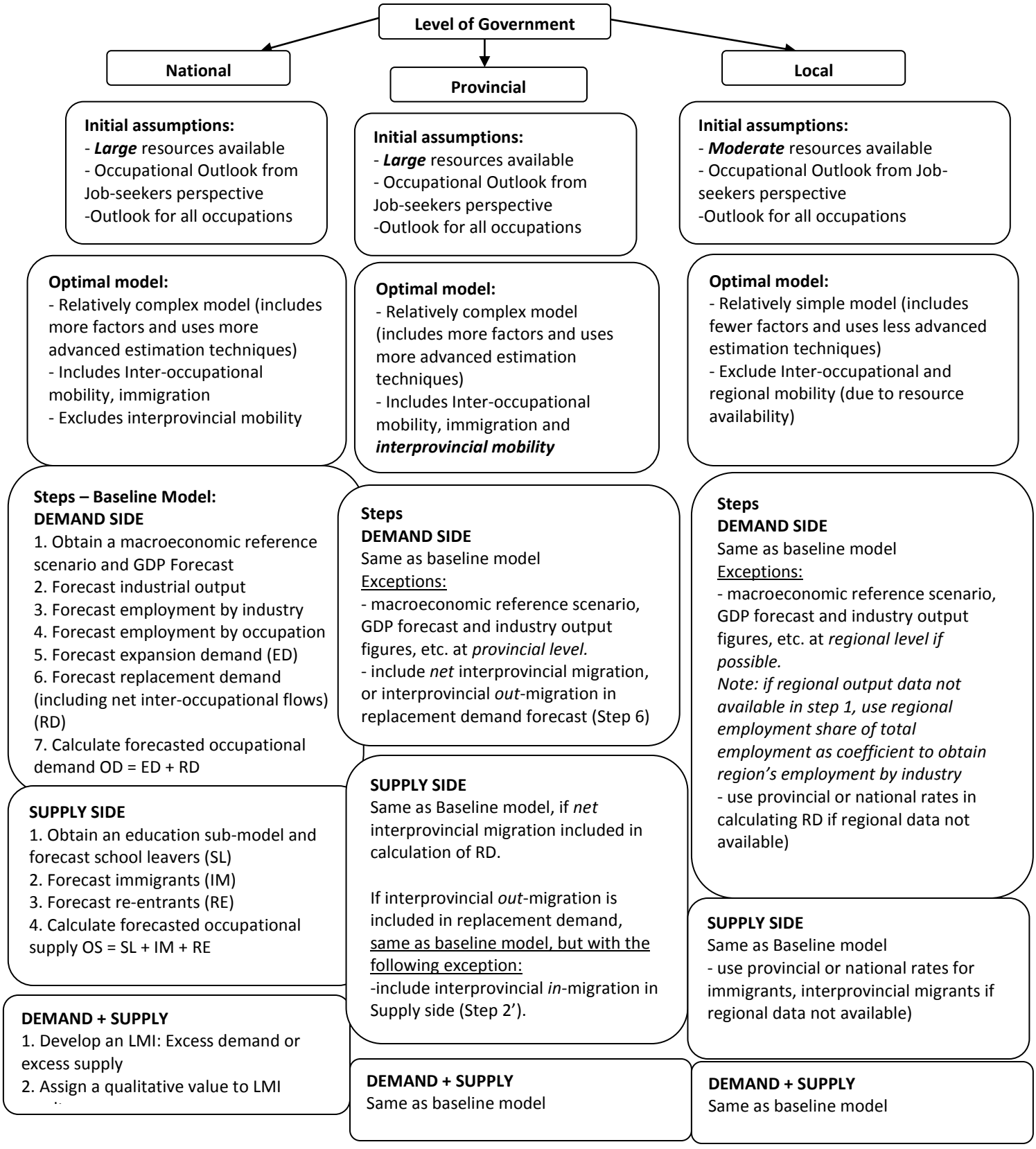
[4] Of course, measuring the accuracy of past occupational projections is of limited use given that the models do not account for supply and demand interactions, and thus are not constructed to be predictors of future imbalances, but rather to be indicators of future imbalances if no action were to be taken.

[5] Projections of occupational shortages or surpluses that do not take into account the inevitability of supply and demand adjustments are not wrong, they are merely misleading. If supply and demand adjusted perfectly to every forecast shortage or surplus, no *ex ante* shortage or surplus would ever be observed *ex post.*

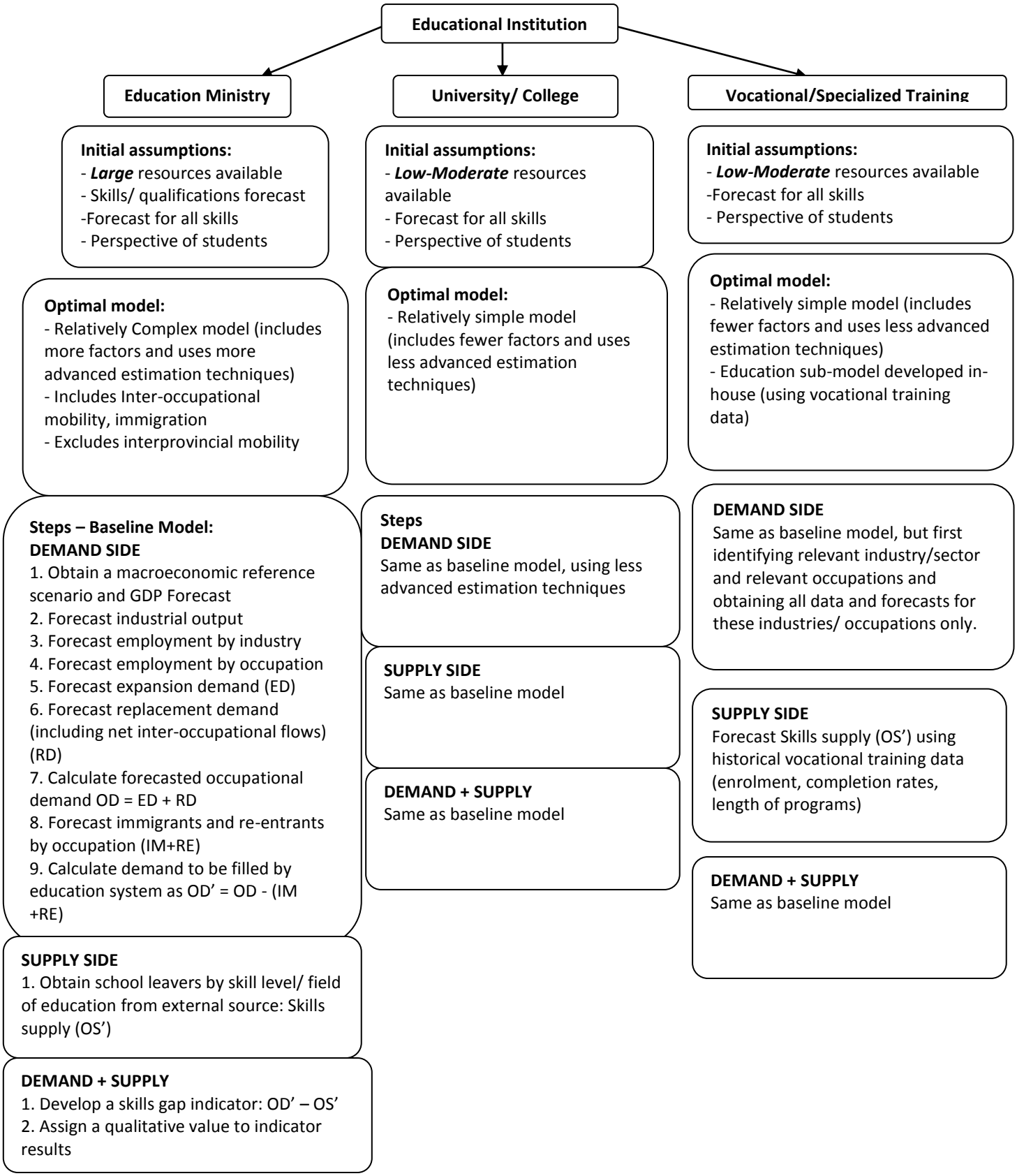
Finally, occupational models do not differentiate between workers in the same occupation or skill group who may have different levels of ability, or workers employed in occupations that do not directly correspond to their formal qualifications.

V. A Road Map to Undertaking Labour Supply and Demand Modeling and Forecasting

A Road Map for Government



A Road Map for Educational Institutions



A Road Map for Industry

Industry

Sector Councils/ Associations

Initial assumptions:
- ***Moderate-Large*** resources available
- Occupational Outlook from employers' perspective
-Outlook for sector's occupations

Optimal model:
- Relatively Complex model (includes more factors and uses more advanced estimation techniques)
- Includes Inter-occupational mobility and immigration

Steps – Baseline Model:
DEMAND SIDE
1. Obtain macroeconomic reference scenario and GDP forecast
2. Identify relevant industry/sector and relevant occupations
3. Forecast industrial output for relevant industry/sector
4. Forecast employment by industry
5. Forecast employment by occupation
6. Forecast expansion demand (ED)
7. Forecast replacement demand (including net inter-occupational flows) (RD)
8. Calculate forecasted occupational demand as OD = ED + RD

SUPPLY SIDE
1. Obtain an education sub-model and forecast school leavers (SL)
2. Forecast immigrants (IM)
3. Forecast re-entrants (RE)
4. Calculate forecasted occupational supply OS = SL + IM + RE

DEMAND + SUPPLY
1. Develop an LMI: Excess demand or excess supply
2. Assign a qualitative indicator based on LMI. Outlook from employer's perspective: Good if excess supply, bad if excess demand

Unions

Initial assumptions:
- ***Low-Moderate*** resources available
- Occupational Outlook from *workers'* perspective
-Outlook for members' occupations

Optimal model:
- Relatively simple model (includes fewer factors and uses less advanced estimation techniques)
- Includes Inter-occupational mobility and immigration

Steps
DEMAND SIDE
Same as baseline model, using less advanced estimation techniques

SUPPLY SIDE
Same as baseline model

DEMAND + SUPPLY
Same as baseline model, exception: Assign a qualitative indicator based on LMI. Outlook from workers' perspective: Good if excess demand, bad if excess supply

Companies

Initial assumptions:
- ***Low-Moderate*** resources available
- Occupational Outlook from *employers'* perspective
--Outlook for sector's occupations

Optimal model:
- Relatively simple model (includes fewer factors and uses less advanced estimation techniques)

Steps
DEMAND SIDE
Same as baseline model, using less advanced estimation techniques

SUPPLY SIDE
Same as baseline model, using less advanced estimation techniques

SUPPLY SIDE
Same as baseline model

Bibliography

Boothby, D. (1995a) "COPS: A Revised Demand Side," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-95-4, June.*

Boothby, D. (1995b) "COPS: A Revised Supply Side," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-95-5, July.*

Boydell, K., Gauthier J. and Hughes K. (1995), "COPS: A New Model for Occupational Coefficients," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-95-6, July.*

Canadian Council on Learning (2007) 'Is it possible to accurately forecast Labour Market Needs?' prepared for the British Columbia Ministry of Advanced Education, January.

Centre for Spatial Economics (2005) "Literature Review on Estimating Inter-occupational Labour Mobility in a Federal, Provincial and Territorial Environment" prepared for the Forum of Labour Market Ministers, Labour Market Information Group, March.

Centre for Spatial Economics (2006) "Consultations on Enhancing Canada's Labour Market Supply Modeling Capacity at Provincial-Territorial Level: Recommendations Report" prepared for the Forum of Labour Market Ministers, Labour Market Information Group, March.

Centre for Spatial Economics (2008) "Future Labour supply and Demand 101: A Guide to Analysing and Predicting Occupational Trends", prepared for the Forum of Labour Market Ministers, Labour Market Information Working Group, March.

Employment and Immigration Alberta (2009) 'Alberta's Occupational Demand and supply Outlook, 2008-2018', available at http://employment.alberta.ca/cps/rde/xchg/hre/hs.xsl/2656.html

Foot, D. and Meltz N. (1992) "An Ex Post Evaluation of Canadian Occupational Projections, 1961-1981," *Relations Industrielles/Industrial Relations,* Vol. 47, No. 2, pp. 200-211.

Henson, H. and Newton C. (1996) "Tools and Methods for Identifying Skill Shortages: A Cross-Country Comparison," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-96-3E.*

Herzog, D. (2007) "Labour Supply Monitoring and Forecasting Workshop, Summary Report," prepared for the Forum of Labour Market Ministers, Labour Market Information Group, October.

Infometrica Limited (1996) "COPS 1996 Macroeconomic Reference Scenario," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-96-1E, January.*

Meltz, N. (1996) "Occupational Forecasting in Canada: Back to the Future," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-96-4E, June.*

Smith, D. (2002) "Forecasting future skill needs in Canada," in *Forecasting Labour Markets in OECD Countries: Measuring and Tackling Mismatches,* Ed. Michael Neugart and Klaus Schömann Edward Elgar, http://books.google.ca/books?id=cdgrcJLlPoYC&dq=accuracy+of+occupational+forecasting+oecd&source=gbs_summary_s&cad=0.

Roth, W. (1995) "Canadian Occupational Projection System: A Presentation of Results using a Revised Framework," Human Resources Development Canada, Applied Research Branch, Strategic Policy, *Technical Document T-95-3.*

Annex 1 – Glossary of Basic Terminology

Aggregate Labour Shortage: occurs when there is (near) full employment and a general difficulty in finding workers to fill vacancies.

Cobweb Cycle: situation arising when students base their educational decisions on the market at the time they enter a course, rather than the market anticipated at their time of graduation. The cobweb model developed by Kaldor was first used to describe and explore the relationship between educational choice, wages and labour market outcomes by Richard Freeman in a series of articles.

Employment: the number of people working in all industries, in an industry or occupation.

Employment Rate (Employment-to-population ratio): the number of working people in all industries, in an industry or occupation (employment) as a percentage of the total population.

Flow (or Flow Variable)**:** measure of the change in stock or stock variable (change in a quantity over a period of time).

Quality Gap: when there are sufficient people with the essential technical skills, not already using them, who are willing to apply for the vacancies, but who lack other qualities that employers think are important.

Labour Force: the number of people available for work in all industries, or in a specific industry or occupation.

Labour Force Participation Rate: the number of people available to work (labour force) in all industries, in an industry or an occupation, as a percentage of the total population.

Labour Market Adjustment: shift in labour demand and/or labour supply towards an equilibrium (to offset an imbalance).

Labour Market Equilibrium: a situation where labour supply and demand are equal given a set of labour market conditions.

Labour Market Mismatch: has four basic sub-types:

- **Qualitative mismatch:** occurs when the qualifications of workers and the qualification needed to fill available vacancies are not matched. Can also be referred to as 'skills mismatch.' Is sometimes referred to as 'skills shortage.'
- **Regional mismatch:** occurs when the unemployed persons seeking work and firms offering suitable jobs are located in different regions, and the jobs and/or workers are immobile.
- **Preference mismatch:** refers to a mismatch between the types of jobs that unemployed people are *willing* to take on, and existing vacancies in the relevant region. Those out of work are unwilling to take certain types of work because of inadequate remuneration or working conditions or status, despite the fact that such jobs match their qualifications and skills profile, or are located in the relevant geographical region.
- **Information mismatch:** occurs when unemployed workers do not acquire information on relevant existing vacancies, and firms do not have the information necessary for finding persons with adequate qualifications. Supply does not meet demand because of the lack of information.

Labour Shortage (or Excess Demand)**:** occurs when the demand for workers for a particular occupation is greater than the supply of workers who are qualified, available and willing to work under existing market conditions.

Labour Surplus (or Excess Supply)**:** occurs when the supply of workers who are qualified, available and willing to work in a particular occupation is greater than the demand for workers under existing market conditions.

Occupation Coefficient: share of employment in an industry accounted for by each occupation.

Skill Shortage or Skill Gap:

- a divergence between the quantity of a given ***skill*** supplied by the workforce and the quantity demanded by employers under the existing market conditions (given the existing level of compensation and wage structure).
- a situation in which employers are hiring workers whom they consider under-skilled or in which their existing workforce is under-skilled relative to some desired level.
- a labour market situation in which there is a lack of people with the qualifications, skills or experience necessary to carry out the jobs in question. Sometimes referred to as 'qualitative skills mismatch.'

Stock (or Stock Variable)**:** a fixed measure at a point in time. Changes in stocks are 'flows.'

Unemployment: the number of workers who are available to work (in the labour force) but who are not working. Unemployment is calculated as the labour force less employment.

Unemployment Rate: Unemployed people as a percentage of the labour force.

> **Natural Rate of Unemployment**: a level of joblessness that is warranted even where the market is working 'ideally' because, for example, of the need for workers to look for new jobs or because of the random and unforeseen shocks to the economic system to which adjustment needs to be made. The natural rate of unemployment (NRU) was also originally identified as that point at which inflation would not accelerate or decelerate, along the vertical part of the Phillips curve. The persistence of unemployment and inflation in the 1980s led to the notion of the non-accelerating inflation rate of unemployment (NAIRU).

Annex 2 – A List of Additional Resources

Websites

Construction Sector Council (CSC) forecasts: www.constructionforecasts.ca/forecasts

Emploi-Quebec: http://emploiquebec.net/

FLMM: http://www.flmm-lmi.org/

Service Canada: http://www.servicecanada.gc.ca/

Government of Alberta, Employment and Immigration, Labour Market Forecasts: http://employment.alberta.ca/BI/2656.html

Labour Market & Career Information for Newfoundland and Labrador: LMIworks: http://www.lmiworks.nl.ca/LMIToolkit/Default.aspx

Statistics Canada:
http://www40.statcan.gc.ca/l01/ind01/l3_2621-eng.htm?hili_none

Publications

Construction Sector Council, *Construction Looking Forward*

Employment and Immigration Alberta (2009) 'Alberta's Occupational Demand and supply Outlook, 2008-2018', available at http://employment.alberta.ca/cps/rde/xchg/hre/hs.xsl/2656.html

Human Resources and Social Development Canada, *Looking-Ahead: A 10-Year Outlook for the Canadian Labour Market (2006-2015)*, available at http://www.hrsdc.ca/eng/publications_resources/research/categories/labour_market_e/sp_615_10_06/page00.shtml

Canadian Data Sources

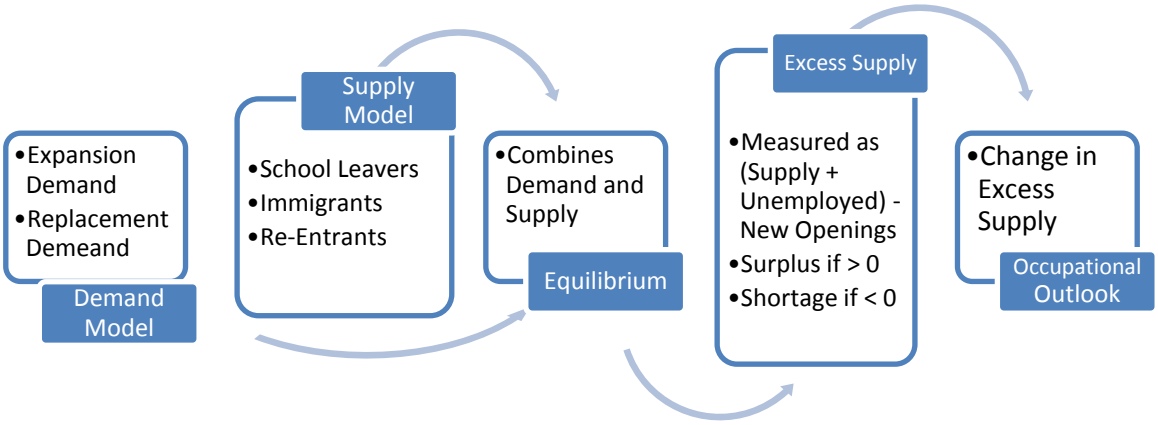
LMI data works: http://www.lmiworks.nl.ca:8080/webview/
Contains data by topic (Population, Labour Force, Education, Employment, Income), by geography (Canada, Provinces, and Territories, Rural regions, economic zones, CMAÉCAs and non CMAÉCAs, and communities) and by source (LFS, Census, Taxfiler).

Annex 3 – Examples of Occupational Forecasting Models

A. Canadian COPS model

The Canadian Occupational Projection System (COPS) model, developed by Human Resources and Skills Development Canada (HRSDC), produces occupational outlooks based on the NOC system. The COPS model was originally an occupational demand model, but was extended since the mid 1990s to include supply side information (Centre for Spatial Economics, 2005: 84).

The model involves 5 major components:



Demand Side:

Macroeconomic Reference Scenario

- A macroeconomic forecast for Canada and the provinces is based on a consensus view of the economy.
- Final demand categories from the macro forecast are translated into industry output using an input/output matrix.

Expansion Demand

- Expansion demand (ED) defined as future required employment level – required employment level in base year.
- Industry employment forecasts are derived (using data on industry output, capital and technology) and disaggregated into occupational classes using an industry-occupation employment matrix (based on Census and LFS data).
- Employment by occupation is obtained by summing the number of workers in each occupation across industries. Coefficients (occupation shares by industry) are allowed to change over time.

Replacement Demand

- Replacement demand (RD) = Deaths + flows from employment to non-employment (including retirements) – net job changers.

- A simple regression model of replacement demand as a proportion of required employment is estimated. The model is then used to project this proportion into the future. The projected proportion is multiplied by the projected employment requirement by occupation to obtain the projected level of replacement demand.
- Attrition rates used in this model are not occupation-specific: death rates are obtained by using mortality rates by age/gender and applying them to corresponding groups. Withdrawal rates for other reasons are estimated as changes in participation rates by group.

Occupational Demand
New openings = ED + RD

Supply Side:

Education Component (School Leavers):

- An education sub-model projects the number of graduates in a given year. The model uses historical data to calculate enrolment rates by age/gender for 6 levels of schooling. Trends in he historical rates are then used to project future rates, which are applied to the corresponding population groups. To obtain the number of graduates for the forecast year, a fixed proportion (the last observed proportion) is applied to the enrolment numbers of the year when graduates would have normally entered the program (e.g. for a four-year program, the projected number of graduates in 2010 is obtained by applying the fixed graduation rate (last observed) to the enrolment numbers in 2006). A similar process is used to estimate dropouts. Dropouts for each level are considered as graduates of the next lowest level.
- A transition matrix of field-of-study to occupation is used to convert data on projected graduates by level of education and field of study into projected entrants in the occupation labour force.

Immigrants

- Immigration numbers are determined for the initial year of the projection, based on the federal government's announced quota and assumed to be constant over the forecast period.
- Occupational distribution is determined using a Statistics Canada survey that identifies the occupations where immigrants work.

Potential Re-entrants

- The trend (adjusted for the business cycle) in historical data of the flow from employment to non-employment, expressed as a proportion of employment, is obtained from a simple regression model. The model is then used to project this proportion into the future. The projected proportion is then applied to the projected employment figures to obtain the projected number of potential re-entrants.

Occupational Supply
Occupational supply = school leavers + immigrants + re-entrants

Demand and Supply:

LMI Indicators
Excess Supply = (Occupational Supply + Unemployed) – New Openings

Outlook/Qualitative Assessment:
Change in Excess Supply
Surplus if > 0, Shortage if < 0
The labour market outlook from the job-seeker's perspective is qualified as 'good', 'fair' or 'limited.'

B. BC Education Model

- A large and detailed dataset is constructed using data on student records at the secondary and post-secondary level is prepared, educational programs are coded by 6-digit Classification of Instructional Program (CIP) level and further divided into length of program. The stock of BC students by current level of schooling is then projected into the future.
- BC Colleges and Universities Outcome Survey data are then used to transform the projected number of students by education to the number of potential workers by occupation (transition from CIP to 4-digit NOC).

C. Alberta Occupational Demand and Supply Outlook Models

Alberta Employment and Immigration has developed the Alberta Occupational Demand Outlook Model (AODOM) and the Alberta Occupational Supply Outlook Model (AOSOM). Each of the models is linked to a number of sub-models.

Demand Side:

Expansion Demand:
- An industry employment forecast is made based on a macroeconomic forecast, a forecast of output by industry and accounting for the changing employment structure of industries.
- Employment by industry is translated into employment by occupation.

Replacement Demand:
- Retirement rates and other separations are derived from the Alberta Labour Force Survey at an aggregate occupational level.
- Separation rates are assumed constant over the forecast period, with the exception of retirement rates which are assumed to rise over time, based on the age distribution by occupation (obtained from Census data).

- Emigration, out-migration and death rates by age/gender group are assumed to be the same for the general population.

Occupational Demand
New openings = ED + RD

Supply Side:
Population/Demographic Component:

- Population levels by age and gender groups are projected by single year cohort.
- Net-migration by age and gender is projected using historical trends. In-migration is calculated as projected net-migration plus assumed out-migration.
- Future immigrants are assumed to face similar occupational outcomes as existing residents of the province.
- Alberta's aboriginal population is assumed to have the same birth and mortality rates as the Canadian aboriginal population.
- Alberta's visible minorities' birth and mortality rates are assumed equal to Alberta's general population birth and mortality rates.
- A method is used to account for the population with activities limitations.

Education Component:

- Secondary and post-secondary school enrolment rates are assumed to follow historical trends.
- Graduation rates are calculated by level of schooling, field of study, age and gender, and kept constant over the forecast period.
- Drop out rates and mature student rates are calculated by level and field of study.
- Migration rates by educational attainment are adjusted to reflect demand conditions in the province.
- Educational attainment is projected by field of study.

Occupational Supply:

- Potential occupational supply is determined by using the historical distribution of occupation by educational attainment.
- Actual occupational supply is determined by using historical participation rates by occupation.

Demand and Supply:
LMI Indicators
A measure of labour market imbalances is calculated as the ratio of projected labour demand over projected labour supply.

Outlook/Qualitative Assessment:
Labour Market balance if ratio = 1, Potential shortage if ratio > 1, potential labour surplus if ratio < 1.

Note: In the updated version of the model, demand and supply are allowed to interact. In particular, changes in demand affect the coefficients of occupation by education.

D. Construction Sector Council Model

The Construction Sector Council (CSC) model provides an outlook for over 30 construction trades, for each of the Canadian provinces and for the Ontario regions.

Demand Side:

Macroeconomic Reference Scenario:

- A macroeconomic scenario is prepared, which takes into account building requirements related to construction projects (large and small, announced and unannounced), maintenance and repair construction activities.

Expansion Demand:

- Investment and employment forecasts are combined with a set of coefficients to forecast labour requirements by trade. Coefficients used often vary depending on the major projects included in the macroeconomic forecast, because different projects differ in their trades requirements.
- Forecasted labour demand by trade includes demand by the construction sector, and by all other sectors that employ trades workers.

Replacement Demand:

- Replacement demand is calculated as the number of retirements. Retirements are estimated using data on mortality rates and changes in labour force participation for workers over 55 years of age.

Occupational Demand:

- Expansion demand and replacement demand are combined to obtain the required labour requirements by trade for construction and other industries.

Supply Side:

Education (Apprenticeship) Component:
The number of graduates from apprenticeship programs is used, with data on the labour force by age group, to determine the available labour force by trade.

Immigrants:
Immigrants, aboriginals, women and youth are included in the initial calculation of the population available to enrol in training/apprenticeship.

Re-entrants:
The number of people entering the labour market after a period of non-participation are also included on the supply side.

Mobility:
The available labour force is adjusted for the mobility or workers across sector, industry and region.

Occupational Supply:
The occupational supply is calculated from population and training/apprenticeship data and from population data.

Demand and Supply:

LMI Indicators:
Because of the nature of construction activity, the CSC model calculates three unemployment rates: the annual rate of unemployment (which eliminates seasonal variation), the peak rate of unemployment (which accounts for cyclical variation) and the natural rate of unemployment.

Outlook/Qualitative Assessment:
The CSC model provides a 'Labour Market Ranking', ranging from 1 (excess supply) to 5 (excess demand).

E. Dutch ROA Model

The ROA model uses two econometric models to produce labour and demand forecasts for 127 occupational groups and 104 educational types.

Demand Side

Macroeconomic Reference Scenario
Sectoral employment forecasts are produced by the Dutch Central Planning Bureau (CPB).

Expansion Demand (ED)
Expansion demand is broken down by industrial sectors, occupations and type of education. Changes in occupational structure derived from a random coefficient approach using LFS data.
Additional step: Accounts for substitution effects ('switching jobs') per type of education.

Replacement Demand (RD)
Replacement demand is calculated by type of education, age and gender as expected outflow (deaths, retirements, etc.) of workers out of the labour force.
Due to absence of flow data, net inflows or outflows are calculated as changes in stock data.
Future net outflow rates are calculated from historical rates and adjusted for business cycle fluctuations.

Finally, future net outflow rates by age/gender are combined with population group projections for each occupation or education category to obtain future RD.

Occupational Demand
Recruitment demand = all job openings (ED + RD)

Supply Side

School Leavers
Educational forecasts of the flow of school levers by age and gender from formal (full-time and part-time) education system prepared by the education ministry, at an aggregate level.
ROA provides more detailed forecasts by using a matrix of full-time education and educational attainment, and projects the number of students by educational category.

Occupational Supply
Data on new supply by education are translated into new supply by occupation using data about newcomers from the 'education accounts' of Statistics Netherlands.

Demand and Supply
LMI Indicators
Labour Gap Indicator (LGI): Labour demand (ED+RD+ passive substitution effects) – Labour supply (expected new supply + number of people unemployed for less than a year with same educational background).

Outlook/Qualitative Assessment
Based on LGI, prospects for newcomers are characterized as 'good', 'reasonable', 'moderate' or 'poor'.