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OECD EXPERT WORKSHOP ON IMPROVING HEALTH EXPENDITURE FORECASTING

MODEL DEVELOPMENT ISSUES WHEN FORECASTING HEALTH EXPENDITURES

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Contact: Luca Lorenzoni, Email: luca.lorenzoni@oecd.org; Tel: +33 (0) 1 45 24 76 21;
Roberto Astolfi, Email: roberto.astolfi@oecd.org, Tel: +33 (0) 1 45 24 15 96 and
Jillian Oderkirk, Email: jillian.oderkirk@oecd.org; Tel: +33 (0) 1 45 24 76 03

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1. Introduction

1. This paper is intended to guide the debate about the critical aspects of forecasting models that should be better addressed to increase the relevance of these models for policy development. In particular, future development should be led by the questions policy-makers need to address and the modelling methods and the model specifications should respond to these questions.

2. Models provide some guidance about future health spending but have been weak in their support of decision-making about the policies that could change the future course of health spending. This is not always the case in other areas of policy development, where models are considered necessary before policy changes are made (e.g. road traffic) or at least usual (tax/benefit policy). Instead, we have lots of studies projecting forward health spending, but only a select few have built policy levers into their analysis.

2. Families of models

3. Forecasting models typically project health expenditure at the level of individuals, groups of individuals or the community as a whole (Hollembeck 1995). At the same time, models can focus on specific sections of health expenditure, such as public expenditure, social security, private insurance, or household out-of-pocket payments. By considering both the level of aggregation of the units analysed and the level of detail of health expenditure to be projected, it is useful to identify three broad categories of health expenditure forecasting models: macro-level models, component-based models and micro-models (Astolfi *et al* 2012).

4. *Macro-level models* focus on forecasting total health expenditure and include analysis of time-series and cross-sections of aggregate indicators. This class of models also includes computable general equilibrium models which allow for the measurement of broader consequences to the economy resulting from spending growth and for feedback or reaction from consumers and producers. Examples[1] of this category of models include the Australian Government Productivity Commission model (Productivity Commission 2005) and US Centers for Medicare and Medicaid Services Dynamic Computable General Equilibrium Model (Borger *et at* 2008; Friedman 2010).

5. *Component-based-models* include a large variety of forecasting models that analyse expenditure by financing agents, by providers, by goods and services consumed, by groups of individuals or by some combination of these groups. An important sub-class of component-based models is represented by cohort-based models where individuals are grouped into cells according to several key attributes. Age is the

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1 OECD carried out a comparative analysis to review 25 models that were developed by, or used for, policy analysis by OECD member countries and other international organisations. A description of the main features of those models is reported in Annex 1 of the OECD Health Division Working Paper n. 59 (DELSA/HEA/WD/HWP(2012)2).

principal criteria used to stratify the population of interest, while further refinements are obtained by sub-dividing the cohorts according to other commonly-used attributes, such as gender, health status, and proximity to death. Those models are often referred to as actuarial models or cell-based models, where the term cell identifies the subcategories into which each cohort is divided. Examples of this family of models include the European Union/Ageing Working Group model (European Commission 2011; European Commission 2012), the New Zealand Ministry of Health and Treasury model (Bryant *et al* 2004) and the Dutch Bureau for Economic Policy Analysis model (Besseling *et al* 2011).

6. The units of analysis of the *microsimulation models* are individuals. These individuals can be aggregated into policy-relevant groups and analysed using relevant indicators such as inequality and poverty indices. Microsimulation models reproduce the characteristics and behaviour of a large sample of individuals representing the whole population of interest. Major life-course events (e.g. exposure to risk factors) can be represented in the lives of the simulated individuals and, in the case of dynamic models, certain characteristics and behaviours can evolve over the life course. Micro models simulate entire populations and offer flexibility to test a range of “what if” policy scenarios related to prevention, treatment and the organisation and financing of care; and to examine forecast results by different characteristics included in the model, such as by diseases, age-groups, providers or treatments. The Canadian Population Health Model (Wolfson 1994; Statistics Canada 2011) and the Long-term Demand for Welfare Services developed by the Swedish Ministry of Health and Social Affairs (Klevmarken 2011; Brouwers *et al* 2011) are examples of this family of models.

3. Issues faced by model developers

7. Each of the three families of models presents challenges to model developers from both *limitations in the desired data* for model development; as well as *limitations associated with the model family* and *the impact of model assumptions on results*.

3.1 Macro-level models

8. Macro-level models restrict analysis to aggregate health expenditures. They depend on the presence of clear and undisturbed trends and on the absence of structural breaks. Thus they are most appropriate for short-term projections, as the extrapolation methods can benefit from the inertia in the health system.

9. Macro-level models are typically the least demanding in terms of data requirements (Bartozs 2010). This is particularly the case for pure extrapolation methods which use a single time series (Getzen and Poullier, 1992) and for regression-based models which very often include just a few explanatory variables. However, time series need to be relatively long and consistent. The presence of breaks in the series, due to either change in the methodology or to the implementation of specific policies, or to limitations in the availability of data points may harm the results. In addition, the identification of relevant explanatory variables in the regression based model is particularly tricky. In fact, swings from expansion to contraction in health spending (turning points) can be predicted only if explanatory variables are able to anticipate the peaks and troughs.

10. As an example, the Centre for Economic and International Studies (CEIS) at Tor Vergata University in Rome (Italy) has developed a macro-level model with explanatory variables which allows the estimation of future health expenditure by selecting statistically significant explanatory variables, estimating the coefficient of those variables on the basis of historical data from 1969-2009 and making assumptions about the changes in the value of those explanatory variables from 2010-2051 (Atella *et al* 2011).

11. The computational and data requirements for dynamic computable general equilibrium models (CGE), on the other hand, are generally much higher and depend on the specification of the equations included in the model. CGE models depend on assumptions of equilibrium that may not account for observed trends and rely on strong simplifying assumptions about the behaviour of individuals, firms and governments.

3.2 Component-based models

12. Component-based models are the dominant class, accounting for more than half of all forecasting models surveyed in the OECD study. Component-based models are typically more data demanding than macro-level models but less demanding than microsimulation models, and this partially explains their popularity. Basic versions of component-based models typically break down health expenditure into major spending categories and age classes and employ actuarial projections as the main driver of future health spending. The development of more sophisticated versions of these models requires additional information, such as health spending broken down by gender and disease categories, by descendent and survivor status or by end-of-life costs.

13. The implementation and maintenance of component-based models tends to be relatively simple and inexpensive, and they can be integrated into a broader framework that projects other spending; such as social security expenditure (e.g. including pensions). In these models, the impact of policy changes can be assessed by simply modifying the policy parameters that were included.

14. An example of this family of models is given by the OECD Economics Department health expenditure forecasting model (OECD 2006, updated in 2012). To project public health expenditure, per-capita expenditure profiles by age are estimated in the base year for two components: health care; and long-term care. The per-capita expenditure growth is projected according to specific assumptions about demographic-related factors (i.e. death-related costs; and healthy aging); income elasticity of health expenditure; and a composite residual growth factor that includes health-specific prices and technology. The growth rates are first projected for each country and they are then adjusted to allow for convergence across countries towards a common target.

3.2.1 How could we further develop component-based models?

15. Health expenditure projections by age and gender could be enriched by *taking into account the epidemiological projections for a specific set of diseases*. A feasible opportunity for model development would be to include leading diseases as individual model components in order to examine and compare expenditure growth patterns by disease, which may well differ as they can be determined by different drivers.

16. The price of health care relative to the general price level was reported as a significant driver of health spending growth. Several models (Goss 2008; CMS-OATC 2010) included excess medical prices among the non-demographic drivers when forecasting current health spending growth and health expenditure as a share of GDP. Other models reviewed ascribe it to the residual category when no measures of health-sector inflation are available. *Explicitly modelling health prices and volumes of health care services* as independent drivers of expenditure growth would provide insight into drivers of expenditure growth; particularly those related to the intensity of care provision. Development of data that distinguishes health-specific price and volume would be needed.

17. The general consensus is that growth in real spending on health care is mainly the result of the emergence of new technologies and services, and their adoption and widespread diffusion. However, when it comes to measuring how much this factor accounts for growth in health spending, the effect of

technological change is often proxied. One proxy is to ascribe technological change to the residual after all other factors have been controlled for (“excess growth”), while another uses a time index to control for the effects of technological change on health expenditures. *A data collection strategy to better measure the introduction, adoption and use of new technologies* (e.g. therapies, ICTs in health care) represents an important area for development. This strategy should not only predict the level of technological development but also its type (Chandra *et al* 2011).

18. It has generally been accepted that variations in per capita national income are closely correlated with variations in per capita health spending, and higher levels of GDP contribute to higher levels of spending. One possible explanation for this is that as nations become richer, people place higher value on health and want to spend a larger share of their income on improving their health (Fogel 2008). However, the “income elasticity” varies a lot in empirical results and whether health care is a luxury good or a necessity has not been settled. There is a need for research to unpack the difference between family income growth and family health spending and national income growth and national public health spending in order to *make more empirically informed assumptions about “income elasticity”*.

19. *Focussing on total expenditure*, which is public and private health expenditure, and on the relationship between the two will allow estimating – at an aggregate level - the distributional impacts of policies to control health expenditures.

20. Addressing the need to *understand how institutional/policy changes influence health spending growth* represents another area for model development. This could be done by identifying the relevant macro dimensions that can be used to describe the distinctive features and constraints of a health system in terms of financing and organizational arrangements and then estimating how those features could impact public and private health spending growth.

3.2.2 Component-based models have limitations that will be difficult to address

- It is difficult to explore distributional impacts of different policies to control health expenditure growth without exploding the number of cells in the model.
- There is limited ability to test “what if” scenarios about the impacts of new policies to control expenditure growth.
- The models will only be able to test assumptions about the future burden of disease/health status of the population.
- Estimating the population’s engagement in healthy lifestyles and behaviour and its impact on health expenditures would explode the number of cells in the model.

3.3 Microsimulation models

21. Microsimulation models require large amounts of data to effectively assemble a sample that adequately represents the whole population of interest and includes all of the characteristics of interest. Data are often gathered from a variety of sources, and sophisticated statistical techniques are often required to standardize the various databases so that they can be used to populate all of the desired attributes of individuals included in the sample.

22. For example, the US Future Elderly Model (RAND 2011) is a dynamic micro-simulation model that investigates the impact of different interventions aimed at influencing health risk factors, such as body mass, on the potential health and health care expenditure of the future elderly population. It has also been

used to assess the impact of the introduction of sets of specific health technologies on future health, health system use and expenditures. The Population Health Model (POHEM) is a dynamic micro-simulation model developed by Statistics Canada. It has been used to evaluate the possible impact on acute-care and home-care costs of an out-patient/early discharge strategy for breast cancer surgery patients, as well as the prospective impacts of new drugs and cancer screening. In addition to characterizing the state of the population, for instance, when performing the economic evaluations of cancer control interventions, POHEM typically uses a simulation sample size of one million individuals and draws together information on risk factors; disease incidence by age, gender and cell-type; stage distribution at the time of diagnosis; and the 'standard' or typical diagnostic and therapeutic approaches used. Moreover, data on disease progression after initial diagnosis (depending upon age, gender and stage at diagnosis) are required, in addition to follow-up patterns of practice, treatment at relapse, and terminal care. Therefore 23 different datasets are used which include various cancer registries and hospital registries, data from pharmaceutical associations, population health surveys, screening studies and clinical trials.

23. For dynamic microsimulation, a second data requirement concerns the design of realistic behaviours for all of the individuals over their life course. Estimating relative risks or hazards of transition from one state to another require analysis of longitudinal data or a review of the health and economic literature where relative risks or hazards of transitions have been reported. Degrees of response that individuals may have to changes in an external variable (elasticities) may be estimated through econometric regressions based on the individual's past experiences and choices or may be taken from the health and economic literature.

3.3.1 How could we further develop microsimulation models?

24. Feasible opportunities for model development within a microsimulation framework include the following.

- Develop models that include leading diseases (those at the top of the burden of disease estimates) in order to capture the major health drivers of expenditure growth.

- Address the need to understand the distributional impacts of policies to control health expenditures by extending the model to describe and project the variability within country populations: by ethnicity, by immigration status, by education, and by family income.

- Include health care pathways including service providers, details about the therapies used and the costs of health care consumed.

- Explicitly differentiate health care paid by public sources, by personal insurance and out of pocket for each family in the model.

- Project total health expenditures, and also life expectancy, healthy life expectancy, and disease burden.

3.3.2 Microsimulation models have limitations that will be difficult to address

- Health system characteristics and policies that determine the supply and provision of healthcare services and may modify diagnostic and therapeutic pathways are difficult to include.
- Components of expenditure growth like administration and research/investments are difficult to include.

- These models are not conceived to explicitly include the broader economic environment in which the "virtual" individuals live.

4. Could the three families of models be complementary?

25. While many approaches to forecasting health-care expenditures have been around for a very long time, new approaches are appearing on the horizon that take advantage of increases in data granularity and in computing technology to bring a fresh look to the issue of explaining trends in health expenditures. Recent decision-support models offer enhanced opportunity to test policy scenarios and to understand the broader social and economic implications of policy changes. There are emerging systems of models (combined models) where different modelling approaches are designed to work together coherently. In this way, techniques with different strengths are amalgamated and a broader range of policy questions may be explored.

4.1 How could a component-based model and a microsimulation model work together?

26. Microsimulation model could be used to test the impact on health expenditures, the health status of the population, the burden of disease, treatments provided, and family's out-of-pocket share of their health care costs of new policies to, for example:

- Introduce new health services,
- Prevent or postpone disease,
- Cut back on health services,
- Change insurance options, and
- Change the public-private payment split.

27. Projected results of trends in health care consumption, population health status, and health services used could provide important inputs to inform the component-based model in order to develop full forecasts of health expenditures including supply-side factors and components of expenditure growth, like administration and research investments, that are outside of the microsimulation framework.

28. As an example, the Congressional Budget Office (CBO) has developed a sophisticated long-term model known as CBOLT to analyse the budgetary effects of social security programs in the United States (Congressional Budget Office 2009). CBOLT is a forecasting platform that amalgamates both component-based or actuarial methods and dynamic microsimulation methods.

4.2 How could a macro-level model and a microsimulation model work together?

29. A notable example in that direction is the NATSEM-CHE-CoPS Micro-Macro Chronic Disease Prevention Model (Brown 2009) which combines a microsimulation approach to model the effects of population health initiatives to tackle diabetes with a macro model simulating the labour market and the full economy. In particular, the linkage is performed through a bottom-up process where decreases in the prevalence of people projected to have type 2 diabetes in response to interventions leads to changes in the aggregate labour supply which then permeates through the Australian economy to impact overall productivity.

4.3 How could a component-based model and a macro-level model work together?

30. The macro-level model could be used to introduce in the component-based model brakes/constraints on health spending growth from the economy by:

- Separately estimating the tax burden required to support the government share of health care expenditures and testing scenarios regarding the public's willingness to support such tax levels; and
- Separately estimating the impact of the growth of health care costs on the disposable incomes of families and, therefore, on their ability to consume other goods and services and testing scenarios regarding the public's willingness to support such health care costs.

31. The macro-level and component-based model types could also work together to model total – that is public and private – health spending. As an example, the US Centers for Medicare and Medicaid Services combines a component-based cohort or actuarial approach for Medicare and Medicaid spending with a macro-level model for private health spending (Centers for Medicare and Medicaid Services 2010).

4.4 Development of an international decision-support platform

32. Advances in computing technology and in detailed health and economic data enable the development of models that can more accurately disentangle the set of drivers of health expenditure growth; and can better help to test the potential future impact of policy interventions before they are implemented in the "real world". Such models can help to direct efforts to where they may be the most effective. Emerging onto the scene are approaches that enable detailed "what if" questions about the introduction of policies related to prevention, treatment, organization and financing of care, technological innovation and health sector productivity.

33. On the horizon are systems of models, where a set of policy questions drives the development of a modelling platform. In those systems, a forecast from one model can provide a needed input parameter for another model, and all models in the overall architecture can be designed to work well together. Such systems enable a broad range of policy questions to be addressed and thus can become an on-going decision support tool capable of adapting to new questions as they arise.

34. There is an opportunity for modellers to develop and implement an international decision-support platform for health expenditure forecasting, benefiting from the lessons learned from model development in different countries/organisations. Advantages of an internationally comparable forecasting platform include the opportunity to:

- Produce comparable forecasts through the standardisation of model specifications, assumptions and data;
- Estimate and compare the relative impacts of potential policy reforms; and
- Begin to examine global issues, including the pressures associated with cross-border movement of patients, personnel, services and capital.

35. An international platform would allow countries with weaker data the possibility to benefit from parameters from other countries where richer datasets are available. The platform could be used to estimate and compare the potential impact of new policies in different countries which would further validate the effectiveness of particular policy responses.

5. Questions for the experts

- What is weak in your current modelling?
- What is the right direction for future international modelling efforts?
- How should we prioritise?
- How should we best engage health policy makers in the use of models?

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