THE 7TH WORLD CONGRESS

INTERNATIONAL MICROSIMULATION ASSOCIATION

National University of Ireland, Galway

June 19-21, 2019
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Welcome to the 7th WC of the IMA
in NUI Galway

The 7th World Congress of the International Microsimulation Association will be hosted by the National University of Ireland, Galway from Wednesday, June 19 through Friday, June 21, 2019. The International Microsimulation Association, launched in October 2005, aims to promote the free inter-change of experience and ideas between practitioners of microsimulation worldwide.

The National University of Ireland, Galway will host the conference. Founded in 1845, NUI Galway is one of Ireland’s leading Universities and is ranked in the top 1% globally. Beautifully situated on the banks of the river Corrib, just minutes from Galway city centre, NUI Galway’s 260 acre parkland campus is an ideal location for conferences and events. From contemporary meeting spaces and comfortable accommodation to a choice of dining options and first class recreational amenities, the campus facilities available to delegates are excellent.
Conference Organisers

Prof. Cathal O’Donoghue
Dean of Arts, Social Sciences and Celtic Studies at the National University of Ireland, Galway

Dilovar Haydarov
Teagasc, Walsh Fellow
NUI Galway, Ph.D. Candidate
Speakers

Prof. Herwig Immervoll
Senior Economist and Head of Employment-Oriented Social Policies at the OECD

Prof. Deborah Schofield
Director of GenIMPACT: Centre for Economic Impacts of Genomic Medicine at Macquarie University

Prof. Andreas Peichl
Director of the ifo Center for Macroeconomics and Surveys
Professor of Macroeconomics and Public Finance, Faculty of Economics, University of Munich

Prof. Eveline Van Leeuwen
Professor and Chairholder of the Urban Economics Group, Wageningen University
General Information

Food

There are seventeen restaurants on campus operated by five different catering companies. Local seasonal produce forms the key ingredient across menus on a daily basis and the five catering companies providing services on campus are enthusiastically working with growers/ producers and wholesalers to create nutritional, tasty dishes for our campus community of approximately 20,000. We also welcome over 10,000 conference delegates and visitors to campus annually. In recent years local, artisan and craft producers have exhibited at receptions for international delegates which has added enormously to the enjoyment of their experience in Galway and we hope to repeat this at IMA. We know that food is central to the delegates’ experience and having such a wealth of wonderful fresh produce on our doorstep adds enormously to the delegates’ enjoyment. Testament to the quality of food is the recent success of campus caterers. One company won the Celebrate Local and Seasonal Category organised by the London based Sustainable Restaurant Association and two other companies received Irish Hotel & Catering Review Gold Medal Awards; one for Event Caterer of the Year and the other was placed 2nd in the Ireland’s Site Contract Caterer 2018. These awards recognise initiatives to support food culture in the region.

Galway City

As a conference destination, Galway offers the best of all worlds, providing the peace and seclusion essential for a truly focused conference. Meanwhile, the beautiful scenery, fresh air and wide range of activities on hand give delegates the chance to unwind, recharge their batteries and mix with their colleagues. Social event can be organised for delegates during their stay including a trip to the world renowned and truly breath-taking Burren of north Clare and the Cliffs of Moher which is a one hour drive. Additionally, majestic, rugged Connemara is another option again just 30 minutes Galway City.
Conference Venue:

The conference plenary and parallel sessions will be held in Arts Millennium Building and James Hardiman Library of National University of Ireland, Galway. (Please click above highlighted links to open them in Google Maps).

For Discussants:

The first presenter of the session will be acting as a discussant for the second paper of the session. The second presenter of the session will be acting as a discussant for the third paper and so on. The last presenter of the session will be acting as a discussant for the first paper of the session. We also kindly ask the last presenter of the session to be the chair of the session.

Poster Presenters:

Posters should be printed on an A0 Portrait size and will be presented in the foyer of the Arts Millennium Building.

What else I need to know:

Bringing an umbrella might be a good idea, as it rains quite often in Galway.

Computer Access:

The following is the WIFI code for access for all delegates (NUIGWIFI). Please note this logs out when inactive.

Network: NUIGWIFI

User ID: 9876001t

Password: rbhzi7872

Parking On Campus:

Please note there are restrictions on campus Monday to Friday, weekends have no restrictions (delegates staying in Corrib Village can park in Corrib Village). Please read the following information;

1. Paid Parking:

   a) P&D (Pay and Display – blue lined spaces only on campus, there are a limited number directly in front of the Quadrangle).
b) Cathedral Car Park is approximately 5 minutes’ walk, charges apply, cost is approximately €3-5 per day.

2. Free Parking: Permits have been organised for delegates in the P&R (Park & Ride) carpark on campus however, no shuttle is in place outside of term. It is approximately a 15 minute walk to the conference venue. Please find below permit which must be displayed on your car if using this option. Entrance to the P&R car park is via Corrib Village Entrance, Upper Newcastle Road, Galway. Please ensure to park in white lined spaces only. Please display your permit at all times or your car will be clamped.

Please follow this link for parking locations on campus: [http://www.nuigalway.ie/media/buildingsoffice/files/maps/M12122_150818_Parking_CampusMap-Web.pdf](http://www.nuigalway.ie/media/buildingsoffice/files/maps/M12122_150818_Parking_CampusMap-Web.pdf)
Conference Delegate Parking Permit

VALID ONLY FOR THE FOLLOWING CAR PARKS

Park & Ride                  Park & Ride

WARNING! DO NOT PARK BETWEEN BLUE LINES (PAY & DISPLAY SPACES) UNLESS YOU HAVE A VALID PAY & DISPLAY TICKET!

CONFERENCE & LOCATION

World IMA Congress

VALID FROM:  19/06/2019

VALID TO:    21/06/2019

WARNING! CLAMPING IN OPERATION - PLEASE OBSERVE THE FOLLOWING RULES:

- Delegates must clearly display this permit on the vehicle dashboard.
- Park only in marked spaces – do not park anywhere else.
- This permit does not allow delegates to park in Pay & Display (“P&D”) spaces free of charge. To use P&D, you must park only in spaces marked “P&D/I&T” (with blue lines) and you must obtain and clearly display a valid P&D ticket or you will be clamped. These spaces are generally adjacent to the P&D meter only. Please do not purchase a ticket and then park in any other space other than the ones marked “P&D/I&T”.
- Do not leave your car overnight, except by prior arrangement.
Directions to NUI Galway

Travelling by Car

From the South
- From Cork or Limerick, approach Galway on the M18. You will by-pass Ennis & Gort and join the M6 Dublin-Galway motorway west of the city.
- At the M6 junction follow signs for Galway city. You will arrive at a roundabout at the end of the M6 just outside Galway city. Take the second exit at this roundabout.
- From here follow signs for Clifden. This will take you on a series of dual carriageways around the city.
- Cross the Quincentennary bridge (a long dual-carriageway bridge over the River Corrib) and turn left at the traffic lights towards Lower Salthill. Look out for a University symbol on the signage.
- Continue on until the next traffic lights, and turn left into the Newcastle Road entrance to the University.

From the East
- From Dublin continue onto M4 (signs for Sligo). At junction 11, exit onto M6 towards Galway and follow signs for Galway.
- Arrive at roundabout at end of M6. Take the second exit at this roundabout.
- From here follow signs for Clifden. This will take you on a series of dual carriageways around the city.
- Cross the Quincentennary bridge (a long dual-carriageway bridge over the River Corrib) and turn left at the traffic lights towards Lower Salthill. Look out for a University symbol on the signage.
- Continue on until the next traffic lights, and turn left into the Newcastle Road entrance to the University.
- From Belfast, take the A1/M1 in the direction of Dublin. Travel around the M50 and exit for the M4 to Sligo (Galway). Follow the directions above from Dublin.

Travelling by Public Transport
Galway is easily accessed by public transport.
- **Trains:** Galway's train station is just off Eyre Square in the city centre. The city is very well serviced by rail and only 2.5 hours away from Dublin. Find out more information on services and timetables.
- **Buses:** You can travel to Galway using frequent services offered by our public bus service, or use one of the private bus services such as CityLink or GoBus.
Direct (non-stop) buses from Dublin airport and Dublin city centre take 2.5 hours.

- **Galway City public transport:** From the city centre, you can take a taxi to the University, or take the No.404 Bus in the direction of Newcastle from Eyre Square, near the train station, which is the normal drop-off point for buses.
- However, the NUIG campus is only a 10 minute walk from city centre.

**Travelling by Air**

The University is within easy reach of Shannon Airport, Ireland West Airport Knock and Dublin Airport.

- **Shannon Airport** and **Ireland West Airport Knock** are both just an hour’s drive from Galway. To get to Galway, you can travel by bus with **Bus Éireann** or **CityLink**. Alternatively, car hire is easily available at these airports.  
  *See directions for travelling from the South (From the airport join the N18/ M18)*

- **Dublin International Airport** is 2 hours 15 mins drive from Galway city. There are also a number of frequent and reliable bus services to choose from to travel to Galway, including: **Bus Éireann**, **CityLink** and **GoBus**.  
  *See directions for travelling from the East (From the airport take the M50 southbound until junction 7 and join the M4)*

Please follow this link for additional information:  
[http://www.nuigalway.ie/events/traveltogalway/](http://www.nuigalway.ie/events/traveltogalway/)
1

Modelling migration between municipalities in Flanders using Liam II

Authors: Ingrid Schockaert (Presenter) and Gijs Dekkers

The paper discusses the implementation of the Pageant algorithm for migration (Chénard, 2000) as built into the generic microsimulation program Liam II (de Menten, 2014; Dekkers, 2015) for the simulation of internal migration between small scale municipalities. The exercise is part of the development of a spatial microsimulation model to simultaneously estimate the population and household dynamics for each of the 308 municipalities in Flanders. The Pageant algorithm for migration simulates the spatial migration of households, while aligning to exogenous numbers of spatial migrations recorded at the individual level. Up to now, this algorithm was used for simulating migration in large samples. In spatial microsimulation models, however, internal migration between small municipalities plays an important role. In this paper we examine to what extent the Pageant algorithm yields acceptable results when applied to small numbers. We first present the general framework of the spatial migration module. Because of technical limitations of Liam II and because of the instability of small number estimates, the use of a migration matrix between all municipalities is not feasible. We propose a framework based on emigration and immigration probabilities mimicking a migration matrix. Secondly, we empirically test several versions of the migration model using National Population Register data. The population and household structure on the 1st of January 2014 serve as a baseline. We test the validity of the simulations comparing the estimated internal migration figures for 2014 with the observed ones. We analyze potential bias by size of municipality, age and household type.
Medium-term projection for Belgium of the at-risk-of-poverty and social exclusion indicators based on EU-SILC

Authors: Ekaterina Tarantchenko (Presenter), Gijs Dekkers, and Karel Van den Bosch

The Federal Planning Bureau has developed within the “Nowcasting” project a dynamic microsimulation model for nowcasting and medium-term forecasts (currently up to 2020) for Belgium. It is mainly based on the EU-SILC 2014 cross-sectional dataset, complemented by more detailed variables from the Belgian questionnaire. The cross-sectional dataset is used as input data for the model to produce synthetic datasets for each of the subsequent projected years. The model is aligned to medium-term demographic and labour market projections by Belgian Federal Planning Bureau (FPB), while incomes are updated based on macro-economic expectations and current policies on indexation of benefits. The Nowcasting project was jointly funded by the European Commission (project VS/2015/0179) and the Federal Public Service Social Security.

This model delivers experimental estimates of the at-risk-of-poverty rate (AROP), the very low work intensity rate (VLWI) and the index of severe material deprivation (SMD). That is, all three components of the overarching AROPE (“at-risk-of-poverty or social exclusion rate”) indicator. Nowcasting models used by Eurostat, based on EUROMOD, predict only the AROP and VLWI rates. The advantage of such a model is that it allows to assess the impact on indicators of poverty and social exclusion of policy reforms and of economic and demographic developments. Key messages of this project are that nowcasting and medium-term forecasting for Belgium are now possible using a full-dynamic microsimulation model. The model shows that the overall poverty risk would remain stable. Furthermore, the increase of overall inequality would come to a halt and the level of inequality would become more stable. Finally, the VLWI would continue its decrease, driven by the continuing increase of the employment rate among the working-age population.

Apart from the general set-up and the results, we will discuss some methodological advancements made in the development of the Nowcasting model, that might be relevant to the developers of microsimulation models at large. In contrast to most dynamic microsimulation models, the Nowcasting model allows an individual to change his/her socio-economic state at any time during the year, and therefore to serially occupy two different states over the course of the year.
3
What are the consequences of the AWG 2018 projections and hypotheses on pension adequacy? Simulations for three EU member states

Authors: Gijs Dekkers (Presenter), Riccardo Conti, Raphaël Desmet, and Olle Sundberg

Pension cost takes up a large part of public expenditures in the EU member states, so pensions and pension reforms are a point of focus of the Ageing Working Group (AWG), a subgroup of the Economic Policy Committee of the EU Council. It publishes regularly an ‘Ageing Report’ which maps the prospective development of public (pension) expenditures under an “unchanged policy scenario” and identifies the main drivers of these expenditures. However, the current and prospective adequacy of social security benefits including pensions is also a dimension of social protection that requires and gets attention on the EU level. The EU Council’s Social Protection Committee (SPC) prepared a “2018 Pension Adequacy Report” (2018 PAR) to examine current and projected pension adequacy trends.

As part of the 2018 PAR, microsimulation teams from Belgium, Sweden and Italy use their dynamic microsimulation models to simulate the possible development of pension adequacy while taking into account the set of economic and demographic projections developed by the AWG, as well as the joint assumption of unchanged policy besides already legislated pension reforms. Contrary to the Sweden and Italy, the cost of pensions shows a continuous increase in Belgium. This is because demographic ageing is stronger than the cost-reducing effects of, among other things, the increasing employment rate and the increase of the average exit age. The latter developments however result in a higher pension benefit after retirement, thus bringing down the poverty risk among pensioners. In Italy, the development of pension spending relative to GDP would remain stable at first, then increase until about 2040, after which a strong decrease would set in again. This decrease would be the result of the gradual replacement of the stock of pensioners that had earned a benefit under the old DB regime by those that have a benefit under the NDC regime that was implemented in the 1995 and 2011 reforms. This would drive the benefit ratio down and may push the poverty risk up.

Gross pension expenditure in Sweden is expected to remain roughly constant relative to GDP, among other things driven by comparably high net immigration. However, the actuarial correction for longevity produced by the adoption of the NDC system in 1996 would drive the benefit ratio down. This decrease would be reinforced by the AWG assumption of a constant labour market exit age and would result in a considerable increase of the poverty risk among the elderly. Although the three models used in this project differ in scope and size and have not been developed with a focus on international comparison, this presentation demonstrates how dynamic microsimulation can be used to bridge the gap between the assessment of pension sustainability and adequacy in comparative perspective.
Feasible Smooth Income Tax Schedules: Benefits and Distributional Implications

Authors: Diana Estevez Schwarz and Eric Sommer (Presenter)

Personal income taxation constitutes one of the main tools for income redistribution in developed economies (Joumard et al., 2012). Tax schedules are usually defined in a piecewise manner, consisting of polynomials of order less or equal to two in different tax brackets. This implies non-differentiable and often non-continuous marginal tax rate functions. Even flat tax regimes with a non-taxed threshold feature a discrete jump at this threshold. This is considered undesirable, as jumps in marginal tax rates (kinks) alter individual behavior compared to a hypothetical situation with smooth functions, causing additional societal costs (Saez, 2010). In addition, the tax liability disproportionately increases particularly at these discontinuities if gross wages increase. Another complaint against existing tax-benefit systems is their complexity, imposing significant compliance costs on taxpayers (Shaw et al., 2010).

In this contribution, we address these issues by deriving a new class of smooth income tax tariffs and discuss their advantages vis-à-vis currently existing tax functions. They are easy to define and could be used instead of the piecewise defined polynomial functions. In particular, we derive two classes of tax tariffs, defining the effective (average) tax rate \( E(x) \) as a function of taxable income \( x \), the general exemption \( x_0 \), the taxable income at which half the maximum average rate is charged \( x_h \), the maximum average tax rate \( E_{\text{max}} \):

\[
\text{Rational Function: } E(x) = E_{\text{max}} \cdot \frac{x - x_0}{x - 2x_0 + x_h}
\]

\[
\text{Composed Function: } E(x) = E_{\text{max}} \cdot \frac{x_h - x_0}{x - x_0}
\]

Defining tax schedules in terms of the marginal tax rate is attractive for policy-makers by making distributional objectives explicit. Particular attention has been devoted to the top marginal tax rate, both in the policy debate and in the optimal taxation literature (Diamond and Saez, 2011). Our approach results in a tax function that depends on two parameters only, the general exemption \( x_0 \) and \( x_h \) indicating the taxable income for which average tax rate equals half the maximal rate. This implicitly maintains the top marginal tax rate, along with the general exemption, as a key policy parameter. By design, it however becomes harder to alter the top marginal tax rate without changing the tax function for lower incomes at the same time. This potentially hinders policy-makers from targeting specific income groups when implementing tax reforms.

In order to investigate the distributional effects of our approach, we apply our smooth tax functions to Austria, Germany, Hungary, Spain, each country representing a different type of tax schedule. The distributional analysis is carried out with EUROMOD H1.0+. This is related to empirical studies on distributional impact of simple tax schedules such as the flat tax (see e.g. Paulus and Peichl (2009), Duncan (2014) and Gouveia and Strauss (1994)). By calibrating our class of smooth tax functions to the national context (i.e. maintaining current values of \( x_0 \) and \( E_{\text{max}} \)), we find that it is possible to maintain both tax revenue and the income inequality (as measured by the Gini coefficient) at today’s levels.
5 Evaluating the policy effects of out-of-pocket health payments on household incomes in Finland 2010-2018

Authors: Jussi Tervola (Presenter)

During the recent years out-of-pocket payments of health care and social services have been increased in Finland. In 2016, all flat-rate fees were raised by 27.5% (Tervola et al. 2018), however, the payment ceiling remained unchanged. The impact of the reforms on livelihood and income inequality remains unidentified. Even internationally, few studies have scrutinized the distributional impact of changes in out-of-pocket payment legislation or if they are, out-of-pocket payments are analyzed separately from the tax-benefit legislation (e.g. Hennessy et al. 2015; Gross et al. 1999). Therefore, the effect of out-of-pocket payments on inequality is often missing from the policy analyses.

In this article, distributional impacts of legislative changes are evaluated using microsimulation. We provide an integrated static microsimulation analysis of legislative changes in Finland 2010-2018 including both changes in tax-benefit legislation as well as out-of-pocket payment legislation. We concentrate on how the reforms have affected different poverty measures such as risk of poverty rates and so called reference budget poverty rates. We also assess the impacts by gender and age.

We use Finnish tax-benefit microsimulation model SISU which is complemented with exceptionally detailed microdata on the use of public health care and social services by individual and date. The data used consist of a population sample of 800,000 individuals in 2016. The reforms of out-of-pocket payments during 2010-2018 have increased the poverty rates quite modestly, by 0.1 percentage points (appr. 5,000 individuals). Also relative poverty gaps have stayed almost intact. The modest effects are partly explained by the fact that reforms concerned mostly aged individuals whose incomes are above poverty line. In future, the model will complemented with behavioral/dynamic dimension which enables assessing reforms’ impact on the use of health care services.
Replacing rules by Neural Networks - a framework for agent-based modelling

Authors: Georg Jager (Presenter) and Manfred Fullsack

For every agent-based model it is necessary to define the agents of the modelled system via certain qualitative or quantitative properties and to find rules or equations that govern how the agents interact with each other and with their environment. The rules should use the information the agents have access to as an input and yield what action they take in this situation as an output, considering bounded rationality. While the input that the agents use for their decision is relatively easy to find and to justify, specifying the rules that lead to a decision is much more difficult and often relies on assumptions from psychology or economics, which are often hard to back up empirically or by theories. This makes the search for valid rules for agent behaviour one of the biggest challenges in agent-based modelling.

In this study we present a framework that uses an Artificial Neural Network to simulate the decision making process in an agent-based model. The framework is generic enough that it can be used for any kind of agent-based model, since the training of the Artificial Neural Network is included in the process and therefore independent of the investigated system or model. UnAMIA (Universal framework for Agent-based Models featuring Intelligent Agents) is related to reinforcement learning, but there are important differences. While the goal of reinforcement learning is to arrive at an optimal solution, UnAMIA focuses on a realistic decision process. This also includes the possibility of wrong decisions or misjudgement, allowing us to model a wide range of systems, in which agents are not able to find the optimal solution.

In order to showcase the presented framework we apply it to the well-know Segregation Model by Schelling. Agents are distributed randomly on a grid. Each agent is a member of one of two groups. Every time step agents can choose to stay at their position or move to a random place on the grid. In the original model, one has to define a certain percentage of neighbours from the other group, above which the agents should move away. Depending on this value, one can observe weak or strong segregation. Using UnAMIA, there is no need to determine rules, we simply define how to calculate a score: Agents gain a point for every neighbour in the same group and lose a point for every neighbour in the other group. In the training phase, agents make random decisions. They store their sensory input and their decision as a positive experience, if the score increased and as a negative experience if it decreased. In the application phase, agents use a Neural Network trained with the experience data in order to classify all possible actions as positive or negative and choose what they think is the best option. Without
specifying any rules, this is sufficient to be able to observe segregation (Fig. 2 left). Furthermore, we are able to train the agents in one environment and then use them in a different environment, leading to completely different agent behaviour (Fig. 2 middle). We can also limit their sensory input to find out how agents would behave if they do not have access to a certain type of information (Fig. 2 right). This goes beyond what is possible in a rule-based framework and can be applied to any problem suitable for agent-based modelling.

Figure 2: **Left:** After training agents maximise their score without the need for pre-defined rules. **Middle:** When trained in an environment with only few agents of a certain type (here: red), this type is satisfied with a lower score. **Right:** When limiting the sensory input, agents make suboptimal choices, which is realistic behaviour that is extremely difficult to achieve using a rule-based framework.

We show that by using the UnAMIA framework it is possible to implement an agent-based model without the need to manually find rules or equations for agent behaviour, which is the most challenging step for most agent-based models. We demonstrate the advantages of this approach by applying it in order to reproduce the results of the prominent Segregation Model. To highlight the difference between a perfect decision (like one would have in reinforcement learning) and a realistic decision we truncate the sensory input that agents receive. As expected, agents are then unable to correctly judge some of the possible situations and behave differently. Again, the model provides realistic results without the need to manually define agent behaviour.
Mobility and the lifetime distributional impact of tax and transfer reforms

Authors: Levell, Barra Roantree (Presenter) and Shaw

The distributional impact of tax and transfer reforms plays a central role in policy debates. This is typically assessed by comparing the gains and losses across different income groups: reforms are classified as progressive if they result in a greater proportional gain (or a smaller proportional loss) for households with low incomes, and regressive if the converse is true. However, such analyses suffer from an important limitation: the incomes used to rank households – and the changes in transfer entitlements or tax liabilities – are usually snapshot measures derived from cross-sectional data. These may provide a poor guide to the distributional implications of reforms because snapshot incomes are a not a good proxy for well-being. Individuals’ circumstances often vary a great deal across life and resources can be transferred across periods of life through borrowing and saving. As a result, well-being may be better measured using longer-run income measures (see, for example, Bönke et al., 2015 and Aaberge and Mogstad, 2014).

In this paper, we contrast the snapshot and lifetime distributional impacts of two sets of reforms, one targeting the bottom of the distribution and the targeting the top. At the bottom, we investigate reforms to the working-age benefit system that have played an important role in the policy response to widening inequality (Blundell, 2006): an expansion in work-contingent transfers (like the EITC in the United States) versus an increase to out-of-work benefits (like jobseekers benefit in most European economies). Previous work examining the lifetime distributional impact of taxes has tended to focus on consumption taxes, showing that, while they look highly regressive when assessed against annual income, the same is not true when lifetime income or – as a proxy – annual consumption if used. Similarly, we find that while, at a snapshot in time, increasing out-of-work benefits looks far more progressive than equally costly increases to work-contingent benefits, from a lifetime perspective, increases to work-contingent benefits are – on average – just as effective as increases to out-of-work benefits at redistributing resources to the lifetime poor. The reason for this is that the lifetime poor spend most of their working lives in low-paid work, whereas many of those who benefit from increases to out-of-work benefits are experiencing temporary periods of joblessness.

The set of reforms we consider that primarily affect on the top half of the distribution are changes to rates of income tax. We show that, despite being levied on an annual basis, increases to higher rates of income tax are an effective way of targeting the lifetime rich. This is because higher earners tend to exhibit greater persistence in their incomes over time with the result that high income at a point in time is quite a good predictor of high lifetime incomes. In contrasting the snapshot and lifetime distributional impact of these reforms, we add to a recent literature that has highlighted the importance of considering the long-run impacts of transfers. These include studies of their impact on individuals’ education (Blundell et al., 2016), employment (Hoynes, Schanzenbach and Almond, 2016), earnings (Dahl et al., 2009; Neumark and Shirley, 2017) and health (Evans and Garthwaite, 2014), as well that of their children (Bastian and Michelmore, 2018). Our results suggest that taking a longer-run perspective can also alter the perceived equity-efficiency trade-offs policymakers face in deciding between increasing work-contingent and out-of-work transfers. Increases to the former are regarded as less effective at reaching very low-income households (as in-work recipients have some private earnings so tend to be located higher up the income distribution) while increases to the latter are thought to have more – and potentially large – distortionary effects on labour supply. We show that this apparent trade-off is much less stark from a lifetime perspective. Given their typically less
damaging effect on work incentives, this suggests policymakers seeking to redistribute resources to the long-run poor might favour increases to work-contingent benefits.

To assess the distributional impact of reforms from a lifetime perspective we require longitudinal data which not only tracks individuals over the entirety of their adult lives, but which also includes all the necessary information for computing individuals’ tax liabilities and for determining their eligibility for different transfers. Unfortunately, even in the few countries where sufficiently long-running administrative or longitudinal survey data are available, they do not include all the information needed to calculate individuals’ disposable incomes under counterfactual tax and transfer systems. Instead, we adopt a dynamic microsimulation approach, using a model of earnings, employment, health, housing tenure and family composition over the life-cycle to simulate lifetime profiles for individuals born in the ‘baby-boom’ cohort (1945–54). Our approach deploys a method proposed in Levell and Shaw (2016), who compare the performance of alternative lifetime simulation methods. It involves first estimating transition equations for annual outcomes, conditioning on a rich set of demographics and outcomes for previous years using an 18-wave panel survey. The resulting estimates are then used to construct a simulated dataset for individuals that contains all the relevant characteristics for calculating tax and transfer payments. In order to ensure that our resulting simulated life-courses are representative of the experiences of our cohort of interest, estimates from the relatively short panel we use are combined with information from a much longer-running cross-sectional survey. Specifically, the transitions estimated using our panel data are adjusted to match cross-sectional averages for the baby-boom cohort at each age. This approach allows us to minimise the risks of conflating age, period and cohort effects that would otherwise occur when generalising processes estimated across different cohorts using a relatively short panel.

Our modelling approach incorporates insights from recent research on earnings dynamics, including the stylised facts that negative (positive) earnings shocks are more persistent for high (low) earners (Guvenen et al., 2015) and that the variance of shocks to income varies with age (Blundell, 2014). Incorporating these more realistic income dynamics has been shown to have important implications for understanding the variance of lifetime earnings (Altonji, Smith and Vidangos, 2013), observed patterns of wealth inequality (Castañeda, Díaz-Giménez and Ríos-Rull, 2003; De Nardi, Fella and Gonzalo Paz-Pardo, 2016), and consumption decisions (Arellano, Blundell and Bonhomme, 2015).
The stabilising effect of tax-benefit systems on gender earnings inequality in Europe

Authors: Karina Doorley and Claire Keane (Presenter)

Recent research suggests that the wages of men and women are converging in many countries. This is largely due to the fact that women are catching up with men in terms of education and skills. However, a sizable gap in wages remains which can be attributed, among other factors, to occupational segregation, work-force interruptions and discrimination (Blau & Kahn, 2017; Redmond & McGuinness, 2017). Gender differences in participation in the labour market are also large and the extent of these differences varies across countries (Olivetti & Petrongolo, 2008). Women are less likely to work and working women tend to work fewer hours, on average, than working men. The result of the gender wage and gender work gap combined is an earnings gap between men and women that is unlikely to close in the immediate future. This gap has knock-on effects on the career trajectories of men and women with implications for equality and poverty both during working life and into retirement.

Factors such as equal pay legislation, collective bargaining and minimum wages have all been shown to close the gender wage gap. Additionally, policies such as the individual taxation of spouses, parental leave for both parents and childcare subsidies have contributed to increasing the labour force participation of women in many countries. A small literature has begun to examine how the tax-benefit system as a whole contributes to closing gender income gaps by redistributing between men and women. Figari et al (2011) show that the tax-benefit systems of a selection of European countries decrease income inequality between members of a couple. Focussing on Germany, Gallego-Granados and Geyer (2015) go a little further and map how the gross gender pay gap is transformed into the net gender wage gap, showing that the design of the German tax-benefit system reduces gender income inequality.

In this paper, we build on this literature and study the effect of policy on gender differences in income by evaluating the capacity for tax-benefit systems in the EU-28 to cushion the gender earnings gap. Although tax-benefit polices are not typically targeted at either gender, the fact that they are usually progressive means that women pay less tax, on average, than men and benefit relatively more from the welfare system. The degree to which the gender earnings gap is affected by the tax-benefit system depends on the size and source of the gender earnings gap and the nature of the tax-benefit system. For example, in countries with low female labour force participation, the gender earnings gap will be cushioned if there is a strong welfare component to the tax-benefit system. In countries with large gender wage gaps, the gender earnings gap will be cushioned more if the taxation system is progressive.

We use the harmonised EU microsimulation model, Euromod, linked to EU-SILC survey data to estimate raw and adjusted gender earnings gaps for a selection of countries in the EU-28. We then estimate the gender gap in disposable income for each country and decompose the difference between the gender gap in earnings and the gender gap in disposable income into the relative contribution of taxes and benefits in each country. Finally, we simulate an increase in the gender earnings gap (which could be brought about, for example, by an inflow of lower skilled women to the labour force through increased participation rates or by a divergence in the average hours worked between men and women). We show how each tax-benefit system “stabilises” gender earnings inequality in the wake of such a shock. Conclusions are drawn about the redistributive nature of each EU country’s tax-benefit system from a gender perspective.
Expenditure imputation and microsimulation of VAT

Authors: Zuzana Siebertova (Presenter), Jana Valachyova, Norbert Svarda, Matus Senaj

In our study, we present a microsimulation module that simulates the value-added tax liabilities of households that can be straightforwardly used within the framework of tax-benefit calculator SIMTASK. A microsimulation model SIMTASK simulates the Slovak taxes from labour and social transfers in detail and enables to evaluate the disposable income of individuals as well as households. The advantage of having the common environment is that reform changes in direct taxes from labour, in social transfers and indirect tax policies can be evaluated simultaneously. In other words, this approach immediately allows to evaluate fiscal and distributional impacts of policy changes by comparing the reform state to the baseline. SIMTASK as a tax and transfer calculator enriched with the VAT module can be conveniently integrated into our labour supply (Senaj et al., 2016) and general equilibrium micro-macro estimations (Horvath et al., 2018) and can be used to evaluate behavioural and long-run reactions to reform changes (Senaj et al., 2019).

The study documents several issues. In the first step, a combined micro-level dataset that integrates information on individual disposable income and households’ expenditures has been created. SIMTASK runs on the survey data SK-SILC that contains an extensive information on different sources of income, but it does not contain information on consumption. Micro data on households’ consumption is available in the Slovak Household Budget Survey (HBS). Using the parametric regression technique of Engel curves estimations developed by Decoster et al. (2014), we estimated the variant of their expenditure allocation model. In this modelling setup, consumption expenditures are estimated separately for durable and non-durable goods. Based on the regressions estimates, the information on households’ consumption has been imputed into the underlying SK-SILC data. In the next stage, VAT liabilities of households were simulated based on the estimated households’ consumption by applying the appropriate tax rates to the corresponding expenditure amounts. Validation of simulations, i.e. the amount of simulated households’ consumption expenditures and VAT revenues, is examined and the results are compared to the official statistics taken from the national accounts. Using a so called “coverage approach” (Barrett et al., 2015), we provide an insight to the sources of variation that result to the substantial gap between household expenditure survey data and expenditure measured in the national accounts.
Projections of economic impacts of early retirement in informal carers: Results from a microsimulation model Care&WorkMOD

Authors: M.J.B. Zeppel (Presenter), D Schofield, R. Tanton, J. L. Veerman, S.J. Kelly, M. Passey4, R. Shrestha

The need for informal care is projected to increase significantly due to an ageing population and the projected increase in the number of children with a disability. Providing informal care can have an impact on the capability of informal carers to maintain employment and thus require them to leave the labour force early. Early retirement is a significant economic burden both to informal carers in terms of lost income and savings; and to the government in terms of lost taxation revenue and increased welfare payments.

We have developed a microsimulation model, Care&WorkMOD, to estimate the long-term economic costs of early retirement of informal carers aged 15 to 64 years old up to 2030. The base population of Care&WorkMOD is based on the Australian Bureau of Statistics 2003, 2009 and 2012 Surveys of Disability, Ageing and Carers. Population and the labour force participation projections from the 2015 Intergenerational Report and the projected primary carers and the projected estimates of income, taxation, income support payments, savings and superannuation from microsimulation models APPSIM and STINMOD were synthetically matched with the base population to project forward the economic impacts of early retirement of informal carers.

The model estimated that about 106,000 people aged 15 to 64 years old would leave the labour force prematurely to provide informal care in 2015, which was projected to increase to 127,000 by 2030. The total national economic impacts of this lost labour force due to informal caring were estimated at $3.6 billion in 2015, increasing to $5.3 billion in 2030 in lost incomes for informal carers annually. These results highlight the need for effective prevention or treatment of illness and implementing targeted programs that increase the labour force participation of carers in order to reduce negative economic consequences of caring for families and the government.
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Social sustainability of the Norwegian pension system

Authors: Elin Halvorsen and Nils Martin Stølen (Presenter)

The main goal of the Norwegian reform of the national insurance system in 2011 was to improve long run fiscal sustainability, not least through stronger labour supply incentives. At the same time, the reform tried to maintain much of the redistributive effects built into the former pension system. Distributional consequences of the 2011 reform have been thoroughly analysed both before and after the reform and documented in several research papers. Most of these analyses were made by using Statistics Norway’s dynamic microsimulation model MOSART. The main results from these analyses show that the original strong redistribution through the national insurance system was maintained. While the former early retirement scheme in private sector was adopted to the new national insurance system in 2011, this was not the case for the early retirement scheme in the public sector, and the occupational old-age pension system in the public sector was also only partly adopted. Through new negotiations between the trade unions and the employers’ organisations an agreement to adapt the early retirement scheme as well as the occupational old-age pension system in the public sector to the national insurance system from 2011 was reached in March 2018. Extensions and improvements of the MOSART-model during the past years by including these schemes into the model have made it possible to carry through more comprehensive distributional analyses of the pension system.

The aim of the paper is to extend the former analyses for distributional effects by considering the effects from the early retirement scheme for employees in the private sector and the newly proposed reform of occupational pensions in public sector. While a ceiling at 115 per cent of yearly average labour incomes for accumulation of entitlements is an important redistributive element in the national insurance system, entitlements in the public occupational pension system are accumulated up to twice the average labour income. Since the public occupational system thus fully compensates higher incomes, the system becomes highly regressive and counteracts the distributional properties of the national insurance system. Furthermore, the early retirement scheme in the private sector is also expected to weaken the distributional properties of the pension system because the share of firms taking part in the system in private service industries with several low-income workers is rather low. Finally, the pension reform is also expected to have made the early retirement scheme more regressive because it was changed from a scheme paid to those who retired in the age 62-66 to a life-long benefit favouring those with long life-expectancy correlated with high labour incomes. In the analysis we will first compare the total life-time benefits from the different part of the pension system (national insurance old-age pension system, early retirement scheme and the occupational pensions in the public sector) with the total life-time labour incomes for the relevant groups and the entire labour force for a selected cohort entirely encompassed by the new system (probably the 1963-cohort). The analysis will be done separately for men and women. Secondly, we will carry out a traditional analysis of horizontal distribution of incomes by comparing 2017 with 2060 using indicators such as the Gini-coefficient, the share of population below poverty limit and S80/S20, showing the effects from the main elements of the pension system as outlined above.
The Dynamic Cross-sectional Microsimulation Model MOSART

Authors: Leif Andreassen, Dennis Fredriksen, Hege Marie Gjefsen, Elin Halvorsen and Nils Martin Stølen (Presenter)

MOSART is a dynamic microsimulation model based on a cross-section of the Norwegian population and a comprehensive set of characteristics. The model was developed in the beginning of the 1990s, and the main use has been projections and policy analyses regarding the design of the Norwegian pension system. The analyses to initiate the planning of the reform were carried out in the end of the 1990s. MOSART was used in the entire planning process leading to a reform of the old-age part of the National Insurance System (NIS) implemented in 2011. Afterwards the model has been used to evaluate effects of the reform and developed to include analyses of adjusting occupational pensions in the public sector to the new system. The model is also used in projecting the labour force by level and field of education. Education is an important co-factor for labour market participation and incomes. The aim of the paper is to provide an updated overview of the model with technical platform, comparison with other dynamic microsimulation models, the main events included and its main use. The model starts with either the entire population or a representative sample in a base year, currently 2017. All samples are stratified by gender, age, birth histories and household status. Diseased and emigrated persons are also included. The data are collected from various administrative registers. In addition to be the starting point of the simulation, the initial population is also used to estimate transition probabilities. These probabilities may be adjusted to make the expected number of simulated events equal to external constraints by using adjustments from last year with historical data at an aggregate level and the underlying projected demographic development based on public population projections from Statistics Norway. Being programmed in C# the model is truly multi-platform, as compilers for C# exists for virtually every operating system. We mainly run the model on a Linux platform using a compiler provided by the Mono project. Because the size of the base population is relatively large (more than 7 million individuals), a powerful computer is required. The paper will include more information about:

- Data basis and basic population
- Technical platform and simulation
- Demographic development
- Education
- Labour participation, man-years and labour income
- Projection of pension expenditures and contribution rates
- Analyses of distributional effects from design of the pension system
- Calculations of accrued to date entitlements for each individual
A New Measure of Intra-generational Redistribution within PAYG Pension Schemes and its Application to German Micro-data

Authors: Jonas Klos, Tim Krieger and Sven Stöwhase (Presenter)

Inspired by existing measures of inequality and redistribution, this paper proposes a new index for measuring intra-generational redistribution in PAYG pension schemes. This index solely requires information (either actual or simulated) on contributions and pension benefits of retirees, enabling us to measure intra-generational redistribution isolated from possible inter-generational redistribution. Our index incorporates both the polar case of a Bismarckian pension system as well as the other polar case of a Beveridgean system. As an application, we use contribution records of approx. 100,000 German individuals, who progressed into retirement in 2007-2015, to measure intra-generational redistribution in the German statutory pension scheme (GRV). We use a reform of childcare benefit provision, which became effective in 2014, to show that our index responds in the predicted direction.
Microsimulations and uncovering the structure of botnets from real-world data

Authors: Agnieszka Werpachowska (Presenter)

Botnet is the most dangerous weapon in modern hackers’ arsenal (Abu Rajab, et al. 2006). It consists of a network of computers (“zombie army”) that have unknowingly been infected by malicious software (spread by e.g. hijacked emails or websites), and taken over by a remote source (Command & Control centre) for nefarious purposes. These may include spamming, phishing, hosting illegal materials, mining Bitcoin, DDoS attacks, penetrating corporate networks, stealing sensitive data, or sabotaging strategic country infrastructures, thus posing a national security threat. Botnet attack prevention, detection and mitigation is the major task of cybersecurity organisations like NASK.

Currently used forensic procedures are based on low-level analysis of malicious software and tracing the activity of operating botnets. An important network security indicator is the actual size of the zombie army, so far estimated in a crude and ad hoc fashion, based on tracing zombies’ communication with C&C centres infiltrated and seized by cybersecurity teams (sinkholes). Existing theoretical models of botnets are too simplistic to be used in practice and don’t exploit information from the acquired data, see e.g. (Santos & Moura 2017).

Our goal was to build a simulation of a large-scale computer network exposed to a cyberattack in order to model the lifecycle of a botnet, find statistical estimators of infection rate and botnet size, recognise cybersecurity threats via the analysis of possible attack scenarios, as well as test interventions. We achieved it using a spatial microsimulation (Monte-Carlo) technique with elements of multiagent modelling (Werpachowska 2017, Werpachowska & Werpachowski 2017), which exploits available information about the analysed Internet infrastructure, computer systems and configurations, Internet providers’ and users’ nuanced practices and behaviours. Finally, our microsimulation in combination with statistical optimisation methods (Shahriari, et al. 2016) enables us to reverse-engineer of the likely size, structure and operation of the botnet based on the stream of data about the activity of zombies tracked by sinkholes.
The figure shows an example of a botnet lifecycle in the environment of 355,000 computers (desktops and laptops) connected in (and sometimes moving between) 80,000 household and 3,750 corporate networks with varying grade of susceptibility dependent on the OS type (Windows or Linux) and version, antivirus, administrator maintenance and user habits. The zombie computers switch between the mode of propagating the malicious software (via infected emails), working on other tasks assigned to them by the C&C centre or going dormant. The OS and antivirus software providers publish patches and upgrades, which can be applied by network administrators or computer users.
Economic sustainability and adequacy of social security systems is under severe pressure. Numerous studies prepared for Slovenia during the last decade clearly show that the ongoing pension reform will not be enough to compensate the negative effects of demographic changes after 2025. Without further reforms the sustainability of the public finance and pension system would therefore steadily deteriorate, reaching one of the highest public finance deficits among the EU member countries. The Slovenian pension microsimulation model DYPENSI addresses these issues, allowing to assess both the future pension expenditures and the adequacy of pensions under various reform proposals.

The aim of this paper is to present the DYPENSI model, paying special attention on its technical architecture and design. As a continuous-time model allowing for realistic sub-annual spell durations of processes like unemployment, maternity and parental leave, and corresponding policies and benefits it follows a non-classical approach in the context of most other European models. Together with its high modularity and elaborate (optional) alignment routines we found this approach very powerful in various important dimensions: First, the design enables us both to reproduce and to challenge external scenarios as used e.g. in the Ageing Report. Second, it supports the further development of the model to a multi-purpose tool covering various additional policy domains including social assistance, health, and health care. DYPENSI is implemented in Modgen, a freely available programming language developed and maintained at Statistics Canada. This choice has proven to be very efficient in handling a large interacting population based on administrative data, maintaining family links, and implementing the various Slovenian policies which frequently include population wide relative measures like average wages in its benefit formulas.

DYPENSI has recently received new funding for substantial updates and extensions. In this context, this paper also aims at stimulating discussion on modelling choices, their trade-offs, and the consequences for the further development of DYPENSI to a multipurpose policy tool.
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Labour market microsimulation model with spatially distinct labour markets

Authors: Tjaša Bartolj (Presenter) and Sašo Polanec

In a recent article, Monte, Redding, and Rossi-Hansberg (2018) provided theory and evidence that the elasticity of local employment to a labour demand shock is heterogeneous depending on the commuting openness of the local labour market – their estimates on US data range between 0.5 and 2.5. Authors argue that this elasticity is of crucial importance as it determines the employment impact of local policies, such as infrastructure investments, local taxation, and regional development. Local employment elasticity is of equal importance for the microsimulation model since local employment demand shocks may or may not be met with supply response, depending on the incentives of workers. A policy intervention targeted at the reduction of unemployment will have varying effects in local labour markets with a different degree of commuting openness and will be less efficient than under the assumption of complete commuting openness. For example, a policy reform subsidizing the hiring of the long-term unemployed persons might evenly increase the demand for such workers in companies throughout the country, but if the firms are not evenly distributed across the country, the unemployment rate in areas with high commuting costs and low concentration of firms will be less affected. In addition, some of the job vacancies might not be filled. Thus, models cannot simply aggregate demand over all locations and match it to aggregate supply.

We will show how commuting costs, which define spatially distinct labour markets, can be included in random utility–random opportunity (RURO) type of microsimulation models. In our model, the commuting directly affects utility due to time consumption (and expenditures if employers do not cover the cost of transportation) and the random opportunities as high commuting cost limit the alternatives available to a specific individual. Our paper thus contributes to the literature on microsimulation models of labour markets that account for labour demand, which are still relatively scarce as the majority of models still focus only on supply side decisions of workers, while assuming away the effects of labour demand on these choices. Such models groundlessly assume a perfectly elastic demand curve, which has been empirically proven to be inconsistent multiple times (e.g., Hammermesh, 1993; Arellano and Bond, 1991). Perhaps even more importantly, our model presents a rare example of inclusion of commuting costs in the labour market microsimulation model.
Micronsimulation of the Value Chain

Authors: Cathal Geoghegan (Presenter)

Objectives
This paper aims to explore the use of microsimulation to simulate the impact of value chains within the context of the spatial economy.

Research
Questions Value chain analysis has become a widely used methodology for examining the distribution of value within firms but also within entire economic sectors. A criticism of the value chain approach has been its lack of spatial context, with analysis often taking place at a very high level of spatial aggregation. This paper asks how spatial microsimulation can be used to provide a spatial dimension to value chain analysis.

Methodology
This paper reviews the evolution of value chain analysis over recent years, highlighting the aggregated nature of the methodology. The methodological choices available to modellers in terms of linking microsimulation to value chain analysis are examined, including scope, unit of analysis, data sources, and model choice. Scope includes analytical scope, policy scope and geographical scope. Choices regarding unit of analysis focus on the units necessary to simulate impacts associated with value chains. Data sources reflect the informational requirements for simulating the value chain. Model choice pays particular attention to models that combine macro and micro levels of analysis.

Results
This paper conceptualises a value chain model in the context of microsimulation. Microsimulation can widen the scope of value chain analysis by highlighting how value is distributed across the chain in both economic and spatial terms. The distribution of impacts is especially important in the context of regional development, where the spatial distribution of impacts is of concern to policymakers. Microsimulation can provide such a spatial analysis, providing a clearer picture of the geographical spread associated with a value chain.
China's Personal Income Tax Reform in 2018 and Its Impact on Income Distribution

Authors: Peng Zhan (Presenter), Shi Li and Xiaojing Xu

In the context of the tax reform in 2018, this paper studied some hot issues of personal income tax reform and income distribution. According to the CPITMS model, this paper compared the differences between the personal income tax system of the year 2011 (PIT2011) and that of 2018 (PIT2018), and finds that residents relying on different income sources may face a large degree of real tax rate changes; Once the tax system is altered to PIT 2018, the coverage of personal income tax for wage earners will reduce from 46.9% to 27.9%, the income redistributive effect will drop from 1.95% to 1.24%, and the fiscal revenue function will also be badly affected. However, if individual income continues to grow, the fiscal revenue function is expected to return to the level of 2018 in 2022, but the income redistribution function is difficult to recover in the short term. It is found that the key point of the effect of PIT on income distribution is the adjustment of the tax structure. Gradually altering to “Entire Comprehensive” tax system when conditions become ripe is a way to achieve better income redistribution results at a lower average tax rate.
Poster
Using sequence analysis to illustrate and validate model transitions

Authors: Janne Salonen (Presenter) and Jyrki Möttönen

Discussant: Ms. Anna Bugala

Objective
Dynamic microsimulation models often produce outcome datasets that reflect the modelling choices and assumptions. These modeller choices manifest themselves in population heterogeneity. In large models with substantial population heterogeneity, the validation of model outcomes can be challenging. The challenge can be taken into account with statistical techniques. Sequence analysis (SA) is one useful tool in examining discrete model outcomes. The SA has rarely been used in microsimulation context although the technique has been established and available for some years now. The analysis is readily available in many statistical software packages (R, STATA). The SA together with trajectory analysis could be useful for simulation practitioners testing their models or simply illustrating the results in a new way.

Theoretical framework
SA, a statistical study of successions of states or events is one of the promising venues of sociological methodology. SA models processes. It compares chronological sequences of states within a holistic conceptual framework instead of observing allegedly independent observations over time. The method accounts both for individual and structural dynamics.

Methodology
SA has been applied in social sciences with longitudinal categorical data. The state sequences have two properties: cross-sectional state and longitudinal position. The statistical approach analysing state sequences are based on computing the optimal-matching edit distance between pairs of sequences.

Results
We demonstrate SA with labour market and population transitions of the Finnish dynamic microsimulation model ELSI. The model has transitional matrices to adjust for transitions during life-course within the model. Current and simulated individuals are placed in a total of 12 states during the simulation period 2018–2085. We also present a decomposition of sequences using an agglomerative hierarchical clustering. A five-cluster solution is given as an example.
Figure 1. Transition sequences of cohort 1975 at age 55 to 70.
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SociaLab: A Census-based Microsimulation Tool for Policy Inquiry

Authors: Peter Davis (Presenter)

Objectives
We develop a microsimulation-based inquiry tool – SociaLab – that allows us to use counterfactual modelling to test a series of real-world policy scenarios organised around the New Zealand experience and the potential that the five-yearly New Zealand Census has to help us interrogate these questions. We test this as a “proof of concept” and report results.

Methodology
Our SociaLab model is based on linked longitudinal New Zealand census data, at a unit-record level, covering the period 1981 to 2006 at five-year intervals. This is the core data set which we use for multiple purposes: as the source for drawing a starting sample, for statistical estimation of transition probabilities, and for calibration and alignment of simulated results. We create a “complex” of key components that together make up SociaLab. First, we establish a data foundation from the Census consisting of a starting sample, and analytical sets from which we derive a set of model equations. Secondly, we develop simulation software (Simario) to read the data and to implement the equations (as well as to make model adjustments). Thirdly, we construct a user-friendly tool (Shiny app) which is now only used for visualisation but could be made fully interrogable as the front-end to the simulation software.

Results
The “base” simulation (of the status quo) is able to approximate variable distributions – overall and by demographics - in actual NZ census data for the period 1981 to 2006. These results confirm a time of major demographic and social changes in NZ society (“base” trends). Results of scenario testing show little impact of change in a single factor on downstream factors, though what we do observe are changes in the expected directions (according to our conceptual framework), and indications of differences by sub-group with effects more pronounced in women and Maori. We also show that change in multiple factors is required to stimulate greater impact. Projection of the “base” simulation beyond 2006 and up to 2038, show continuation of current base trends into the future.

Discussion
The primary achievement of SociaLab is as a “proof of concept”; that is, demonstrating the worth of a simulation based counterfactual methodology in a social science and public policy context. A fundamental strength of SociaLab is its grounding in a whole-of-society data collection – the five-yearly Census. A further strength is the opportunity that SociaLab had to draw on new developments in open-source software architecture. However, the linked data system that allows us to estimate individual trajectories – New Zealand Longitudinal Census – has its weaknesses. The linkage rates are not complete and therefore there is the risk of bias since certain kinds of people are more likely to be hard to connect between censuses. A further shortcoming lies with microsimulation itself, its technical and logistical demands in particular. SociaLab was built from the very basics, absorbing around four person years of work. Future work would involve including household structure and details, as well as the potential synergies with other administrative data; data matching and imputation could be used with other data sets to enhance the otherwise rather spartan social and demographic information available from the standard Census. Finally, there is the
opportunity to develop a user-friendly tool in the public arena, freely available to non-governmental organisations or to citizen groups, as a source of information that could support their decision-making.
Going public with model family calculations: Finnish Household Income Calculator for visualizing the earnings, taxes, benefits, and housing costs in Finland

Authors: Ilari Ilmakunnas, Susanna Mukkila, Pasi Moisio (Presenter) and Jussi Tervola

National Institute for Health and Welfare (THL) and We Foundation have developed an Household Income Calculator for visualizing the household’s disposable incomes, benefits and taxes with different earnings, for different family types and varying housing costs. The calculated is based on model family calculations. It enables temporal comparisons of income levels between the tax and benefit legislations applied in different years. The calculator also illustrates how the disposable income varies based on the changes in salaries or rent. The calculator is available for all by web browser. The calculations and visualizations are available from 1994 until the year 2018, and all the data is downloadable for the users own further analyses. This paper can be used as a manual and reference for the calculator.

The need for a calculator like this is urgent in Finland. There is no equivalent open access tool for estimating and visualizing changes and components of household incomes. The OECD tax-benefit calculator has been practically the only available tool for studying a tax-benefit system in Finland, but it is rather coarse. For instance, compared to the OECD tax-benefit calculator, the users can choose the level of earnings, the level of earnings before unemployment, and the level of rent in the Household Income Calculator. These can be chosen using intervals of approximately 100 euros. The calculations of Household Income Calculator are produced using the SISU microsimulation model maintained by Statistics Finland. The tax-benefit code of the SISU model is downloadable free of charge. However, the SISU model requires SAS skills and license. The potential users of the open access income calculator are numerous: researchers, students, journalists, officials, and citizens interested in tax-benefit system. The Household Income Calculator is actually an elaborate visualizing tool for the dataset containing several million calculations for four household types in different life-situations, different earnings and different housing costs comparable on over two decades timespan. Thus, using the calculator a large amount of information can be simplified and illustrated. The data for the calculator is produced and updated annually with the open access tax-benefit code of SISU model using SAS.

The calculator serves many possible purposes. The calculator assists in studying and comparing the household incomes and its components in different life situations and receiving different benefits. It provides possibility to inspect the effects of housing costs on benefits and net incomes of households. The Finnish Household Income Calculator is an easy to use and versatile tool just for this.
A Microsimulation Model for the Agricultural Land Rental Market in Ireland

Authors: Jason Loughrey (Presenter) and Thia Hennessy

Agricultural land rental markets contribute towards structural change in the farming sector by offering farmers the opportunity to adjust their farm size without committing to a transfer of land ownership. Land rental markets have the capacity to redistribute land to those farmers with relatively low land ownership and those farmers with the greatest economic potential for expansion. In Irish agriculture, the share of agricultural land being rented is however, among the lowest in Europe. Many Irish farmers continue to produce output and remain in agricultural employment despite persistently negative market returns. This implies that land-use decisions are not solely influenced by the profit motive. In this paper, we analyse the agricultural land rental market in Ireland with a newly developed Agent-based micro-simulation model (ABMM). In this model, we attempt to address the question of how an increase in profit maximization behaviour could affect the agricultural land rental market. ABM models have previously been used to develop simulated agricultural land market auctions (See For Example, Balmann 1997 and Arsenault et al 2012). We compare the results of the ABM model with those derived from a standard equilibrium model based largely on the methods outlined in (Hennessy et al 2009). The ABM model has a number of advantages over the equilibrium model in addressing path dependency, the interaction between landowners and tenants and the farm size concentration. The ABM approach provides flexibility around price determination where there is bilateral trading between landowners and tenants. We find that the equilibrium modelling approach performs well in modelling the impact of farm subsidies on land rental prices. The ABM model results point to the significant differences between regions in terms of the dynamics of the agricultural land market. The results show that an increase in profit maximisation behaviour leads to a substantial increase in farm size concentration and a transfer of agricultural land from the cattle and sheep sectors and towards the more profitable dairy sector. The increase in farm size concentration would be likely to occur in the absence of countervailing forces such as may arise from an influx of highly-trained new entrant farmers into the land market or through targeted reforms to the system of farm subsidies.
Poster
Long-term evaluation of Disease Management Program (DMP) for Diabetic nephropathy patients using medical claim data: a retrospective cohort study

Authors: Hirohito Watanabe (Presenter)

Objectives
The aim of this study is to evaluate the long-term, 5-years effects of community-based disease management program (DMP) for diabetic nephropathy patients.

Research questions
Is DMP effective for preventing the aggravation and medical care expenditure regulation in 5-years? (Most of previous study reported the effectiveness of DMP for 36 months or less.)

Theoretical framework
This is a retrospective propensity score matching cohort study. We conducted the DMP in the one-group pretest-posttest design. Because previous study reported that DMP improved patients’ situations such as improvement of glycemic controls, modification of patient behavior and controlled medical expenditure. Considering these trends, it’s much difficult to set the control group. Therefore, we used medical claim data to extract the control group by propensity score matching and compared the two groups.

Methodology
For 5-years evaluation, we used the data of total 105 patients who completed 6-months program of 2011 and 2012 DMP for the DMP group. As a control group, we extracted 7,730 patients who fulfilled the DMP eligibility but not participated DMP from the Kure city national health insurance claim data. By 1:1 matching, we extracted 105 matched patients. The medical Claim data include age, sex, medical costs, number of physician visits, inpatient days, primary comorbid diagnosis, pharmaceuticals of hypoglycemic, hypolipidemic, hypotensive, anti-platelet, renal and cardiac drug. Those covariates were assessed in each year before the intervention, and used in multivariable logistic regression model for estimation of the propensity scores. We compared between the two groups by log-rank test and Cox proportional hazards model in 5years. The outcomes were occurrence of cerebral infarction, myocardial infarction, heart failure as a macrovascular disease which is countable for major adverse cardiac events (MACE) and diabetic retinopathy, neuropathy, nephropathy as a microvascular disease. Additionally, we evaluated mortality, medical cost, hospitalization, unplanned physician visits, intensive and emergency care use and healthy life expectancy. Attritionary, a cost-benefit performance using matched-pair-comparison was performed.

Results
We evaluated the time from the start of intervention to first occurrence of events. Control group had a significantly higher risk and shorter duration for the onset of macrovascular aggregation events based on MACE (Hazard ratio [HR] 0.19, 95% CI 0.04 - 0.87; P = 0.03; Plog-rank = 0.02), emergency care (0.53, 0.30 - 0.94; P = 0.03; Plog-rank = 0.03), healthy life expectancy (0.16, 0.04 - 0.71, p = 0.02; Plog-rank < 0.01). For the period of first occurrence of hospitalization event, log-rank test indicated the statistically significant difference. Hazard ratio, however, is not significant (0.71, 0.50 - 1.00; P = 0.052; Plog-rank = 0.049). For cost-benefit performance, the 5-year total medical costs between the two groups were compared. It
showed that the total cost of the intervention group was 124 million Japanese yen lower than the control group. In the subgroup analysis of patients who initiate dialysis and MACE, we extracted the matched pair, and compared. It showed the total cost for 5 years of the intervention group were 56 million Japanese yen lower than the control group. The same analysis for MACE, the intervention group showed 39 million Japanese yen cheaper than the control group.
Measuring economic insecurity with microsimulation

Authors: Matteo Richiardi (Presenter)

We propose a new measure of economic insecurity and investigate how employment and wage dynamics and social protection affect it. Specifically, we simulate individual life course trajectories in order to obtain a simulated time series of disposable equivalised household income for each individual in the population. We replicate this procedure n times, hence obtaining a distribution of trajectories for each individual. This distribution of future individual trajectories reflects the economic uncertainty each individual is facing, based on his/her individual characteristics, household structure and employment status, and is driven not only by the uncertainty over individual future labour market outcomes, but also by the uncertainty over future household composition and labour market outcomes of all household members. We then measure economic insecurity at an individual level by appropriately defining summary measures of these simulated trajectories.
Who pays more? A microsimulation analysis on the effective VAT burden of migrant and native households in 16 European countries

Authors: Michael Christl (Presenter)

There is a long-lasting academic discussion on the fiscal impact of migration ongoing. Especially in times of strong immigration waves, that could be observed in recent years, the topic on the fiscal impact of migration pops up not only in academics, but also in politics and in the general public. Many studies have discussed the financial impacts of migration (see e.g. Dustmann and Frattini (2014) or Hansen et al. (2017)) but typically those studies accumulate the annual fiscal transfers and fiscal contributions of migrants. Hinte (2014)1 argues that it is not sufficient to identify fiscal impact of migration. What is really needed in his opinion is a "measure of the present value of taxes contributed and transfers received by individuals over their lifespans". In this discussion the impact of migration on income taxation as well as on transfers are covered well in the literature. Life-cycle approaches on the impact of migration are still rare, but are facing more and more attention lately. But what is still missing in the literature is the detailed fiscal impact of migration on indirect taxation.

Indirect taxation in general is probably one of the areas in taxation, that is less developed, mostly due to the lack of high quality data. Research on the re-distributional and fiscal impact of both direct and indirect taxation is heavily discussed in the taxation literature. There are several studies that focus on the redistributinal effects of indirect taxation (see e.g. Decoster et al. (2010)), but for example differences in indirect tax burden across other socio-economic groups are less frequently analyzed. This paper tries to fill this research gap by taking a closer look on the impact of indirect taxation for migrant as well as native households, in specific we analyze differences of value added taxes (VAT) paid by native and migrant households. Typically migrant households show different consumption behaviour than natives, but also their savings behaviour could potentially differ. Since states allow for (several) reduced VAT rates, as well as VAT exemptions, the differences in consumption pattern might lead to a different effective VAT burden between migrant and native households. Additionally, the savings behaviour of migrant households typically differ as well. In the literature it is well known that migrant households often send remittances to their home country and they save more due to higher labour market uncertainty2. On the other hand, migrant households have typically lower incomes meaning that they are probably (on average) not able to save as much as natives can. This additionally might cause differences in the effective VAT burden for those two socio-economic groups.

In this paper, we use the HBS data set from 2010 that has detailed information on house- hold expenditures for several EU countries. 2010 is unfortunately the last available year of the survey. The HBS is a sample survey where the statistical units of interest are private households and which are carried out regularly under the responsibility of the National Statistical Offices (NSIs) in each of the twenty eight EU Member States. They provide information about household final consumption expenditure on goods and services with considerable detail in the categories used, plus information on income and some demographic and socio-economic characteristics3. We set up a model that simulates indirect taxes for 16 European countries and covers all the applicable VAT rates - the standard VAT rates and the main reduced rates from the year 2015. Excises (applicable to goods consumed by households) are so far not included in the analysis. The calculations of the VAT covers the standard rate, the reduced rates, the zero VAT rate and the VAT exempted goods. Since we assume full pass through of indirect taxes on to the consumer, the model does not distinguish between a zero rate and VAT...
exemption. We not only try to distinguish consumption patterns of natives and migrants. The HBS contains information on citizenship as well as country of birth, split in three groups: National, Non-National but EU-National, Non-National and Non-EU-National for most of the countries. We are mainly interested in whether those three groups show different consumption patterns and additionally, whether this groups are bearing a different indirect tax burden. As already mentioned, on the one hand, migrants might tend to save more, therefore consuming less and paying less VAT. But on the other hand, migrants have often lower incomes and those groups typically bear a higher share of indirect taxes. Therefore it is rather unclear, whether there are differences between natives and migrants regarding the effective VAT burden.

We find substantial differences in the average effective VAT burden between migrants and natives, as shown in table 1. While in some countries, such as Spain, France and Portugal the effective VAT burden is substantially higher for migrant households, in other countries, such as Estonia, Hungary or the Slovak Republic native households pay a higher share of their income in indirect taxes as migrant households do. In other countries, such as Germany, we find no differences in the effective taxation of migrant and native households. In a second step, we try to disentangle the difference in the average effective VAT burden in the observed countries by a simple decomposition method. We want to identify whether the differences in a country is driven by the differences in consumption patterns or by differences in the savings behaviour. To our best knowledge our paper is the first to investigate on a cross-country level differences in effective VAT rates. While fiscal impacts on income taxation and on transfers of migration is already well covered by the literature, the micro evidence on the fiscal impact on value added taxation is rare. Our paper shows that there are server differences in the effective VAT rate between migrants and natives. Those differences stem not only from different consumption behaviour but also from different savings behaviour. Additionally, we can see that those results are not in line across countries, which might be attributed to different types of migration patterns in the examined countries (high-skilled migration, migration from outside the EU,...).
<table>
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The use of wood biomass from Austrian forests is affected by changes of various kinds. Large-scale damaging events, for example, can change the timber markets sustainably. Technical innovations, such as the introduction of wood biorefineries, could also lead to serious changes in the medium term (Stern et al., 2015). Political processes affect the use of wood biomass, such as the consideration of carbon storage in long-term wood products (Braun et al., 2016).

This study deals with the analysis of these changes within the framework of simulations with a system dynamics based timber market model. The simulation of several scenarios shows the effects and interactions and enables important conclusions drawn regarding energy, climate and economic policy. The studies reviewed are based on several projects carried out in recent years. As a rule, this resulted in various adaptations of the simulation model of the Austrian forestry and timber industry (FOHOW) (e.g. Schwarzbauer and Stern, 2010).

The model covers the entire Austrian forestry and timber industry, from forests to intermediate to semi-finished products, and covers two regions: Austria as a region that interacts with a hypothetical Rest of the World (RoW) region depending on economic development. While one module simulates wood reserves and rivers along the wood product chain (structure cf. Schwarzbauer, 1993), a second module considers wood flows for wood from other sources. A third module carries out a GHG balance taking into account sink effects. The present model was tested and validated with the aid of older results from the FOHOW model, which has already proved its worth for more than 30 years. By means of a back-casting approach (i.e. the model is operated for past periods or backwards) simulations for the period 1965-2010 were carried out and the model validated with historical data. For this purpose, the three main variables softwood and hardwood lumber, chip- and fibreboard as well as paper and paperboard were compared by means of a time series analysis. The analysis showed that the mean values of the historical data are adequately represented by the model and that the correlation between the two time series is very high. The following topics, for example, were investigated:

- Implementation of biorefinery approaches and their impact on energy use
- Impact of an abandonment of forest areas for nature conservation purposes
- Effects of increased use of wood on carbon storage

The various analyses lead to a multitude of interesting results. For example, with regard to the development of wood biorefineries, it can be stated that in addition to the paper industry, forestry, sawmills and energy producers in particular are not expected to suffer any negative effects from the introduction of biorefineries. Rising timber prices can be expected in the forestry sector, which will boost gross value added. The increased efficiency of wood use also has positive effects on forest sustainability, as it counteracts possible overuse. The sawmill industry can benefit from rising prices for sawmilling by-products. Effects on the labor market are a key socio-economic indicator. Overall, these and other results demonstrate the possibilities offered by the FOHOW simulation model for answering biomass policy questions.
Longitudinal dynamic microsimulation models generally use marriage algorithms to create unions from the synthetic individuals in their representative population databases. The quality of such matches directly affects a variety of critical model outputs, including survivor pensions, the likelihood and lengths of widowhood, distributions of individuals by family type, and levels of various taxes and benefits. As well, the marriages and their characteristics serve as major inputs to other major demographic processes involved in the simulations, e.g., fertility, labour force participation, divorce, and mortality. Yet, despite diligent, sustained efforts to create good quality matches, microsimulation models’ synthetic marriages regularly fail to reflect program and survey distributions with respect to actual new marriages, e.g., the distribution of the partners’ age differences. Moreover, the computational demands required by these existing approaches are often substantial.

We believe that the issue may lie with the current underlying approaches. These often consist of identifying individuals likely to marry, and in conjunction with a target number of matches, pairing up those individuals, often using some variant of associative matching. Validation, when conducted, then consists of looking at the synthetic marriages and assessing the degree to which they look like actual marriages. This approach stands in contrast to common event alignment algorithms, which first describe the target results, and then proceed to generate events that achieve those targets.

The alternative marriage algorithm we describe here hues more closely to that traditional approach to event alignment. It begins with a characterization of the desired marriages, e.g., the combinations of partners’ ages, and then uses an algorithm to generate the appropriate numbers of the couples for each such combination. This paper addresses the development of the targets, as well as the data structures and the calculations required to create the matches to satisfy them, down to the level of pseudo-code. Assessment of the resulting matches would use the same standards and measures currently used to assess the output of contemporary marriage algorithms. We believe that the approach exhibits a number of desirable features beyond guaranteeing that synthetic marriages resemble actual marriages on dimensions that matter. It makes extensive use of the well-established alignment-by-sorting technology. It lends itself to generalization to other characteristics found or believed to be important to marriages, e.g., education levels or region. Further, one can easily apply it to a variety of subpopulations of interest, e.g., second marriages, cohabitation partnerships, or same-sex marriages.
The labour income tax system in Sweden is relatively complicated for those on low-incomes, with many income brackets, tax rates, and several deductions that overlap. Although the existence of tax incentives to increase employment, they are hard to intuitively understand. For upper-middle and high incomes the schedule is less complicated, with high marginal taxes on relatively low incomes in comparison to other countries. This paper examines whether it is possible to construct a system that is both considerably simpler and at the same time increases incentives for production (labour supply) and productivity (investments in skills, abilities, etc.), without increasing the income inequality or eroding the tax revenue. We thus try to fulfil three requirements; lower marginal taxes, same or less inequality in the distribution of disposable incomes, and same or higher tax revenue. In a first step, a search method (a genetic algorithm) is used to find minima of a penalty function, that satisfies the three terms. In a second step a dynamic microsimulation model, provided by Statistics Sweden, is utilized to measure how the proposed tax schedules affect the households’ production and productivity. The results show that the current design of the tax schedule can be modified in a way that sustains the tax revenue and the income distribution, while at the same time the tax base increases due to dynamic effects on labour supply and efforts. We hope these insights will contribute to the debate on a much talked about forthcoming major tax reform in Sweden.
And When I Die: Modeling End of Life and After-death Costs as Part of Financial Planning

Authors: Marvin Avery and Richard J. Morrison (Presenter)

For many longitudinal microsimulation purposes, as regards financial implications, death “just happens.” Public and private pensions, and government benefits cease, typically with the month of death. Occasionally, survivor pensions begin, or family-based benefit levels change. Health-oriented models may track likely end of life health expenditures, often focusing on costs incurred by publicly-funded health institutions. These kinds of understanding are valuable, but they are of relatively little use at the level of individual financial and estate planning. There, the “going concern” treatments usually applied to the analysis of the accumulation and decumulation of retirement savings cease to be applicable. Although death itself may be a point-in-time event, the associated transactions leading up to death, as well as those after the death of the subject, may have significant implications for financial planning. Some of them, e.g., probate taxes, executor costs, or the income taxes payable in respect of liquidated assets, will be largely deterministic. Others, such as medical expenses, will be stochastic, e.g., depending on the manner of death. Still others, e.g., funeral costs, may depend on the size of a subject’s financial situation. All of these factors will affect both the financial impact on the government sector, and the value of the estate, if any, remaining for distribution to the subject’s heirs. All of them are thus properly included in modeling the outcomes of a financial strategy.

This paper uses features recently added to Ruthen modeling to explore the impacts of death financial planning. These include the extra pre-death costs stochastically occasioned by that death, e.g., costs for uninsured medical costs, modifications to the accommodation, or caregiver costs. They also include a variety of post-death costs – taxes, the costs for a funeral, the expenses incurred by an executor, and the fees for executor services. Further, some of these costs will be conditional on the value of the financial assets at death, and thus affected by the degree of annuitization that may have occurred.

The Ruthen analysis will address the means and distributions for a number of output measures relating to the cost of death, and should be relevant for both governments and financial planners. Some involve the tax system, e.g., the additional tax revenues generated directly and indirectly by a subject’s death. Others include the costs that may be drawn against the subject’s assets either prior to death or after the subject’s death. Both types of charges affect the estate remaining to be passed on to the heirs. Another set of measures addresses the extent to which assets at death will be sufficient to cover typical costs for end-of-life costs, funerals, executors, etc., and the extent to which that sufficiency depends on the subject’s financial strategy.
Your Money and Your Life: Decumulation Strategies from Real Retirees, and Their Consequences

Authors: Marvin Avery and Richard J. Morrison (Presenter)

With the baby-boomer generation now entering retirement, decumulation, i.e., the spending down of retirement savings, has become a topic of growing interest. Many of the analyses, stochastic and otherwise, have understandably placed a heavy emphasis on sustainability. Questions include -- “What level of income or consumption can be maintained until death?” Or “For Level ‘X’ of consumption, what is the probability of running out of money before death?” And “What is the distribution of ages over which such ruin might occur?” One then proceeds to derive appropriate financial strategies for presumed objectives such as sustainability. However, one rarely sees a behaviourally-oriented approach that addresses strategies that retirees appear to actually use, or might use, in pursuit of their objectives, and then assesses the consequences of such strategies.

This paper takes as a starting point selected actual retiree strategies as identified by a practicing financial advisor, and compares them to selected “planned” strategies. Using the Ruthen microsimulation modeling package, it assesses the consequences of the various strategies for a variety of measures likely to be of interest to governments, policy analysts, and the retirees themselves. These measures address both the means and distributions of risk-dependent outcomes such as the consumption in retirement, the probability of ruin, and the size of the estate remaining at death. More directly relevant for policy purposes, it addresses the impacts of the different strategies on tax revenues that governments receive, and publicly funded benefits paid out to retirees. The comparisons speak to several issues that have policy relevance for governments. They include:
• The inclination of some retirees to spend down their retirement assets relatively quickly, and spend the later portions of their retirements receiving benefits that governments provide to low-income households,
• The degree to which government requirements for minimum withdrawals from registered savings may foster unsustainable levels of consumption,
• The incentives and disincentives to postpone the age at which retirees take up public pension benefits whose levels are actuarially adjusted for age at retirement, and
• The availability and effectiveness of adaptive self-managed decumulation strategies that preclude ruin.

The comparisons also include the results of several sensitivity analyses, particularly with respect to mortality tables and rates of return on retirement savings.
Experiences of spatial microsimulation with ‘big’ and ‘little’ data: A comparison of models for (parts of) the United Kingdom and New Zealand

Authors: Ben Anderson (Presenter), Tom Rushby, Bakr Bahaj and Patrick James

Increasing but heterogenous uptake of new appliances that consume and/or generate (prosume [1]) electricity is likely to have spatially uneven consequences for local electricity distribution networks. In some areas, familiar peak demand periods (often 16:00 – 20:00 in developed nations in temperate climates [2]) may increase in severity whilst in other areas the opposite may be the case. This presents challenges both for national systems which need to balance supply and demand and also for local network operators who usually wish to avoid costly infrastructure reinforcement if households can be incentivised to reduce peak demand or shift demand to other times of day. Over the last few years we have developed a number of IPF-based small area estimation models [3]–[5] to develop baseline electricity demand profiles for small areas and explore potential future scenarios using spatial microsimulation [6], [7]. These have combined appropriate small area Census tables with large-n time-use surveys to impute temporal power demand (UK, NZ); large-n randomised control trial samples with whole house ‘smart meter’-like monitors (UK) and small-n study samples with per-power circuit level ‘smart meter’-like monitors (NZ). This paper will compare and contrast these models and the approaches and assumptions that underpin them via case studies of local area demand models for selected areas of the City of Southampton (UK) and New Plymouth (New Zealand). In particular it will discuss the relative (dis)advantages of using large scale samples of households which produce very large observational datasets as a basis for such models and outline the misunderstandings and misapprehensions that can arise. It will also illustrate the problems of using both large-n time-use survey samples to impute energy demand and small-n observational data to represent small area populations which, while technically functional (doing what they are supposed to), are often substantively dysfunctional (generating nonsense). We conclude with an attempt to draw generalisable recommendations about what to do next.
Modelling the economic impact of next generation sequencing on childhood cancer management—a microsimulation approach

Authors: Owen Tan (Presenter), Deborah Schofield and Rupendra

The cost effectiveness of cancer care could be improved via the implementation of precision medicine (that is, the use of genetic information to guide personalised treatment). The aims of this study is to develop a microsimulation model called PECANMOD of i) hospital utilisation and costs for childhood cancer patients in current practice; and ii) to evaluate the costs and benefits of applying next generation sequencing (NGS) in the management of childhood cancer. The model will be flexible to allow for updating input parameters and comparing treatment approaches.

We used linked datasets of children under 18 year of age, living in New South Wales (NSW), Australia, who have had cancer, as the base population. The children’s records were extracted from the NSW Central Cancer Registry and were linked to the NSW mortality database and NSW hospital datasets. The model will be used to simulate actionable genetic variants identified, and change in management due to the NGS result. Individuals in the model will then go through a Markov cycle of health outcomes—disease free, disease progression, and death—including imputation of associated costs and quality of life. The simulation will be repeated 5000 times and the output will be benchmarked against the current evidence. Sensitivity analysis will also be performed.

Acute lymphoblastic leukaemia, neuroblastoma, and Hodgkin's lymphoma, accounted for 30% of the reported cases. The median annual cost of hospitalisation for all cases of childhood cancer in NSW was $114,000 per person. Early diagnosis and treatment before the cancer has spread are critical drivers associated with to lower costs and hospital utilisation. In our simulation model, 43% of the patients would be diagnosed with actionable variants based on published evidence. We will present simulation outcomes in patients who have a change of management due to NGS, and the resulting economic impact on costs of care.
IDMOD: A microsimulation model of the economic and psychosocial impacts on families affected by intellectual disability

Authors: D. Schofield (Presenter), O. Tan, R. Shrestha, R. Rajkumar, N. Kasparian, M. Rice, L. Rynehart, S. West, J. Boyle, L. Christie, M. Leffler, L. Murray, T. Roscioli and M. Field

Data on the financial and psychosocial costs incurred by families affected by intellectual disability (ID) is scarce. Thus the capacity to value the benefits of diagnosing and preventing ID through the application of genomic testing is limited. We report on the first large scale microsimulation model of the economic, psychosocial and potential reproductive impacts of whole genome sequencing (WGS) for ID.

Given the limited available data we undertook primary data collection from families attending the Genetic of Learning Disability (GoLD) Service. We developed a survey instrument to assess quality of life, psychosocial impacts, education, employment, income, wealth, welfare dependency, living arrangements and family out-of-pocket costs. Eligible families had WGS to determine the cause of ID. Data on 175 individuals with ID (100 families) has been collected and used as the base file for the microsimulation model. The base file of the economic model will consist of a patient health history component, and a cost component. A probabilistic sensitivity analysis will be performed in order to estimate the impact of simultaneous uncertainty across all parameter estimates in the model.

Preliminary data from the model showed combined costs to the Australian and State Governments, and private costs to families totalling $13.1 million per family up to the age of 69. Families bore a significant financial burden ($4.8 million per family) mainly due to lost income and out-of-pocket expenses. Families were under enormous psychosocial strain and most carers reported having a poor quality of life. Costs to Governments were $10.7 million per family, with the main costs being for special education, residential care and welfare. Among the families who have had WGS results returned, 46% have had a diagnosis with a further 11% having a potential diagnosis.
40
Long-term economic impacts of exome sequencing for suspected monogenic disorders

Authors: Deborah Schofield, Luke Rynehart (Presenter), Rupendra Shresthra, Sue White and Zornitza Stark

Background
Exome and genome sequencing (ES/GS) has high diagnostic and clinical utility in rare genetic disease diagnosis. However, the current health economic evidence base to support widespread adoption and reimbursement is very limited.

Aim
To undertake the first microsimulation cost-effectiveness analysis of ES for suspected monogenic disorders in comparison with usual diagnostic care, incorporating forecasting of both patient and family outcomes over a 20-year horizon.

Methods
Individual patient level data was collected on a cohort of 80 infants who underwent ES and usual diagnostic care in parallel were used to model incremental cost and health outcomes (using quality adjusted life years, QALYs) attributable to ES diagnosis. Three models were developed: (1) outcomes in patients only, (2) outcomes in patients and first-degree relatives as a result of cascade testing, (3) outcomes in patients and first-degree relatives including parental reproductive outcomes.

Results
When the directly observed cost and health outcomes of the cohort participants were forecast over 20 years, the use of WES resulted in a total gain of 8.05 QALYs for the cohort and an incremental cost effectiveness ratio (ICER) of $28,593.75 per additional QALY gained. When cascade testing in first-degree relatives was added to the model, cost effectiveness was substantially increased, generating a total gain of 12.69 QALYs and an ICER of $19,075.41. When parental reproductive outcomes were added to the model, this produced the most cost effective outcome, with a total QALY gain of 37.08 and an ICER of $13,822.68.

Discussion/Conclusions
ES in suspected monogenic disorders becomes more cost effective as the benefits of cascade testing and reproductive outcomes are realised.
Implementing Caregiver Leave Benefits – A Microsimulation Analysis for Germany

Authors: Lena Calahorrano, Kathrin Gunkelmann, Mara Rebaudo (Presenter), Regina Kühne

In 2007, Germany introduced state-financed parental leave benefits, applicable to both mothers and fathers on parental leave. – According to the World Policy Analysis Center (2018), 32 out of 34 OECD countries now have similar benefits, although their duration varies. – These are widely acclaimed and were found to enhance the long-term involvement of parents and especially fathers in childcare while speeding up mothers’ return to the labor market. Due to population aging, the share of workers looking after their elderly or sick relatives is likely to grow compared to the share of workers looking after their young children. Since in Germany there are to date no comparable benefits for caregivers who take leaves from work, introducing this kind of benefits is a hotly debated policy issue.

We use a microsimulation model to calculate the costs of a publicly financed leave benefit for caregivers contingent on a reduction in work hours, taking into account caregivers’ possible labor supply responses. Benefits are designed to be analogous to parental leave benefits. This means that monthly benefits amount to between 300 and 1,800 euros, with a default replacement rate of net labor income of 67%. The replacement rate is higher for very low incomes and lower for high incomes. Any caregiver may receive benefits for up to twelve months. If several caregivers share caregiving duties, the total time frame for benefits extends to 14 months. We also set floors on the minimum hours of caregiving and the severity of the need for care in order to be eligible for benefits. We use data from the German Socio-Economic Panel Study (SOEP) and focus on working age individuals who either already spend time on informal care or who live together with a person in need of care. By including the latter, we allow for individuals engaging in informal care in response to the policy reform.

In our model, individuals face a discrete labor supply decision. The possible working hour categories determine income, hours of leisure and hours of informal care. We estimate a utility function with income and leisure being the main factors explaining the labor supply decision. Keeping preference parameters fixed, we analyze to what extent individuals adjust their labor supply if the relative attractiveness of the different work hour categories changes because of the introduction of caregiver leave benefits compensating for income losses as working hours are reduced.

The number of beneficiaries and hence total costs will be larger for a transition period of two years after the implementation of the reform, because initially all caregivers are entitled to benefits, regardless of how long they have been engaged in informal care. In contrast, eligibility in the following years reduces to caregivers who have not yet taken up the benefit. Interestingly, estimated costs of leave benefits for caregivers are lower than total costs of parental leave benefits in Germany, despite the fact that the number of people in need of care who live at home and have the required care level is much larger than the number of children below the age of two (2.6 million compared to 1.6 million). Limited labor supply reactions represent a possible explanation for this finding. Another reason for low equilibrium costs, is that some of the 2.6 million individuals in need of care may have been in need of care for some time. However, not only estimated equilibrium costs are relatively low, but also costs during the more expensive transition phase after implementation.
One challenge associated with demographic ageing is the increasing need for long-term care. This is an important public policy issue since the health care system has to deal with a growing demand for health care and carry out a sustainable public support for the elderly needs. In this paper, we realize a projection of the elderly population using a dynamic micro-simulation model and thus show how micro-simulation provides relevant guidance for public policies implementation.

Our methodology relies on three steps. First, we define an epidemiological measure of each dependency state and the process followed by individuals who move from one state to another. The definition of the dependency states is based on an epidemiological framework: we measure functional limitation relying on the Rosow scale as well as indications of limitations in instrumental activity daily living (IADL) and in activity daily living (ADL). We model the loss of autonomy process as described in figure 1. The survey “Capacités, Aides, et Ressources des seniors” (CARE) allows us to measure the initial prevalence of dependency in France in 2015, according to the previously mentioned framework. The second step is the estimation of the underlying dynamic process which makes individuals switching from one state to another. We compute transition matrices which provide, for each gender and age range, the probability to move from one state to another. We rely on the European Health survey SHARE to estimate such a process.

Lastly, we align our model with the demographic forecasts of the French Statistics Institute, which consists in adjusting transition probabilities to mortality projections. We rely on a single projection of mortality evolution, however we build three main scenarios regarding the variation of the transition probabilities. In each case, we make the hypothesis that the probability to die decreases for each initial state, however scenarios differ in the way those gains of life expectancy are allocated across other transitions.

Our main result is that we can expect 0.4 million elderly individuals to be dependent in 2060, which correspond to states 2 and 3 in Figure 2. We consider to which extent our results are sensitive to several hypothesis regarding the initial prevalence, transition matrices and hypothesis regarding the allocation of life expectancy gains. Importantly, we find that the modification of the transition matrix changes the share of the dependent elderly individuals in 2060 in a much more important way than changes due to the initial prevalence or due to hypothesis regarding the allocation of life expectancy gains. It has important consequences in terms of public policy: containing the dependency of elderly people does not only induce postponing the time at which individuals become dependent, but also that they should switch from one state of dependency to another more slowly.

This paper contributes to the literature in several ways. First, we develop an epidemiological scale of dependency with more states than what has been realized so far. Second, we define dependency relying on health data instead of administrative ones. Lastly, we provide updated projections for the long-term care in 2060.
Figure 1: Transition process from one state to another

State 0  
Autonomous

State 1  
Functional limitations

State 2  
Restrictions IADL

State 3  
Restrictions ADL

State 4  
Death

Figure 2: Projection of dependency states: homogeneous gains
The Take-Up of Health Benefits in Ireland: Insights from Microsimulation

Authors: Claire Keane and Mark Regan (Presenter)

The Irish social welfare system consists of cash and non-cash benefits. One strand of the non-cash benefit stream relates to subsidised healthcare in the form of Medical and GP Visit Cards. Medical Cards offer a range of heavily subsidized access to GPs, prescriptions drugs and overnight hospital stays whilst GP Visit cards offer holders free access to GPs. Both these schemes are means tested and have the ambition of providing accessible healthcare to low income families.

We use SWITCH, the ESRI’s tax-benefit microsimulation model, to model eligibility for both schemes. We use the 2015 Survey of Income and Living Conditions (SILC) as input data to simulate entitlement. The means test is detailed, with certain sources of income being exempt and certain expenditures being deducted for means (e.g. childcare costs, housing costs). The detailed income data in SILC facilitates this modelling. Another technical feature of SWITCH is the use of recalibrated weights. The Central Statistics Office provides a sample weight, “euroweight”, with SILC. This weight controls for demographic traits by region within Ireland. We use the euroweight as a base weight and using the SAS macro CALMAR created by the INSEE, the French counterpart to the CSO, we derive a new sample weight which additionally controls for taxable income and social welfare receipiency. This means that SWITCH better represents the Irish income distribution and the population of social welfare recipients, two key ingredients for a tax-benefit model. This is also of importance in accurately estimating take-up rates for means tested schemes such as the medical and GP visit cards.

Comparing those eligible for one of the cards to self-reported card status, our results indicate that 72% of eligible families avail of a Medical Card whilst just 11% take-up their entitled GP Visit card. After establishing the extent of this non-take-up, we then seek to explain why this phenomenon occurs. To do so we utilise a probit model to explain the binary choice of an eligible family opting to take-up or not avail of a Medical Card. We focus on explaining the utilisation of Medical Cards as the sample size of those taking up a GP Visit Card is very low.

We find the following:
1. The non-take-up of Medical Cards can be explained by a mixture of social stigma associated with availing of social welfare and a lack of information about eligibility status.
2. Families whom may have greater demand for healthcare, proxied by the health status and prevalence of chronic health conditions amongst family members, are more likely to hold a Medical Card.
3. Families with unmet healthcare needs for financial reasons were less likely to take-up a card and families with private health insurance also tended to not avail of a Medical Card.

This suggests that families are unaware of their entitlements as some are avoiding medical consultations for financial reasons and others are availing of private health insurance and associated premia whilst not availing of costless insurance provided through a Medical Card. The regression highlighted why some families are more likely to take-up a Medical Card than others. A natural follow up to this is to ask, by how much are families worse off by not availing of a Medical Card?

To answer this question we turn to another dataset, the 2015/2016 Household Budget Survey (HBS). Households participating in the HBS record all their expenditures on items for two weeks. The item list is very detailed and we are able to determine the amount a household spent on items which would are covered under the Medical Card scheme e.g. GP visits, prescription drugs etc. We first simulate eligibility for Medical Cards in the HBS. As a validity check, we noted that the rate of take-up of Medical and GP Visit Cards were similar in SILC and the
HBS. After we have determined the card status of households, we estimate the portion of household disposable income spent on medical items. We find that households whom forego their entitled Medical Card typically spend a greater portion of their income on healthcare related expenditure. This indicates that there is a real welfare cost to not availing of a Medical Card as families incur needless out-of-pocket expenses. We conclude that non-take-up is a sub-optimal outcome and that frictions surrounding take-up lead to welfare losses of at least €3.75 per week for a typical family.
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Forecasting the Pension wealth of the Danish population in SMILE

Authors: Tobias Markeprand (Presenter)

The Danish pension system consists of three pillars: the social/public pillar, the semi-mandatory occupational pillar, and the individual pillar. While the former has been stable albeit since 1964, the second pillar was extended to cover most of the workforce, including a large part of the privately employed only as late as in the early 1990’s and even then the contributions were very meek. The latter, the privately funded pensions, has been the subject of extensive regulatory changes in later years. These historic conditions imply that the Danish pension system is far from being mature, and which is why analyses of pensioners’ income, distributional concerns, marginal effective taxation rates are not properly suited for static simulation models.

We have extended the microsimulation model SMILE, a dynamic microsimulation model of the Danish population and households, to allow for a pension model. This requires a modelling of the individual income, individual savings decision, and the modelling of pension funds. The model generates a life span of pension contributions depend on the individual’s degree of labour market affiliation and earned income and thus how large the individual’s pension deposits are at any time of possible retirement age. The extension of the model allows us to carry out analyses such as: How many poor pensioners will live in Denmark in 2050 or 2080? And, thus what is the potential pensioners the government needs to support? How many will potentially be confronted with the fact that their income as pensioners drop dramatically from their labour income? As the pension deposits increases many contributors to pension schemes may find them self at a point where the extra income as pension when contributing is very small or perhaps negative. How large is the population will experience this issue of negative contributions benefits? The model may be beneficial in policy analysis, e.g. as to the effect of including non-working individuals into forced pension schemes.
A Comparison of EUROMOD and SWITCH, Two Microsimulation Models of the Irish Tax and Benefit System

Authors: Karina Doorley, Tim Callan and Maxime Bercholz (Presenter)

This paper compares two microsimulation models of the Irish tax and benefit system, the European Commission’s EUROMOD model and the Economic and Social Research Institute’s SWITCH model. This comparison is threefold: it starts with the input and output data, goes on to evaluate costings against external figures, and looks at levels of and changes in income distribution indicators from before and after a policy change. We further decompose these differences into three components: the input data, the weights, and other differences such as uprating factors and the modelling of certain policy instruments. We do so by constructing two other versions of EUROMOD and comparing them to the standard EUROMOD and SWITCH models. In the first, we eliminate most differences in the input data between the two benchmark models by feeding EUROMOD with SWITCH’s underlying data, the more detailed Research Microdata File (RMF) of the Survey on Income and Living Conditions (SILC), keeping the default EUROMOD weights. The second is also based on the RMF but uses the SWITCH weights. To rule out other sources of discrepancy, this comparison is entirely based on 2010 data.

The degree of precision of EUROMOD’s input data is found to lead to substantial differences in simulations. Using the more detailed RMF changes benefit eligibility and amounts, and the results tend to be closer to external administrative figures and to the SWITCH model. Second, when there is a mismatch between the data year and the policy year, much of the difference in simulation results between EUROMOD and SWITCH can be explained by the fact that SWITCH reweights the data to be representative of the policy year in terms of demographics, the income distribution, and social welfare recipiency. This reweighting tends to make SWITCH perform better in comparisons with administrative figures of tax revenue and welfare expenditure. There are further differences between simulations from the two models which are harder to categorise. Certainly, the difference in the income reference period between SWITCH and EUROMOD must play a role. SWITCH represents a snapshot of the income distribution at a particular point in time, and is therefore able to simulate more closely the entitlements of individuals to benefits, which typically are assessed on the basis of current income and circumstances. EUROMOD, on the other hand, models annual income distributions, which take account of the fact that incomes fluctuate over a calendar year. Uprating assumptions and modelling choice differences are also likely to contribute towards differing results between the models but are more difficult to tease out.

Lastly, despite these variations, poverty and inequality indices calculated by the two models tend to be of broadly similar magnitude. Additionally, in the counterfactual scenario discussed in this paper, changes in these indices tend to move in the same direction. This paper illustrates the impact of using the SILC RMF instead of the more detailed SILC UDB (EUROMOD’s input data) in a microsimulation input database, and the positive impact recent UDB developments of disaggregating benefit variables should have on model performance.
IRPETDIN: A DYNAMIC MICROSIMULATION MODEL FOR ITALY AND THE REGION OF TUSCANY

Authors: Mairia Luisa Maitino, Letizia Ravagli (Presenter), Nicola Sciclone

IrpetDin is a dynamic microsimulation model, developed by IRPET (Regional Institute for Economic Planning in Tuscany), able to project into the future the evolution of a representative sample of the Italian and the Tuscan population. The model allows to analyse the evolution of the socio-demographic structure of the population and of public expenditure for social protection in the medium to long term. Results are based on certain assumptions about exogenous variables (on life expectancy, GDP, etc.) and on the current legislation on social benefits. The model can also be used to evaluate what would happen by modifying the assumptions about exogenous variables and by simulating reforms on current legislation on social benefits. IrpetDin is based on EU-SILC, the Eurostat Survey on Income and Living Conditions, a survey with representativeness even at regional level. The base year survey is EU-SILC 2008, while the simulation horizon is from 2009 to 2050. The unit of simulation is individual, but information on household structure and on its changes in time is taken into account. A model validation is made for years from 2009 to 2016, for which is it possible to make a comparison between real and predicted data.

The model is divided in modules.

I) The demographic module, which simulates the lifelong trajectories of the Tuscan population for a over thirty-year time horizon. It starts with mortality and includes fertility, partnership dissolution, marriage, immigration and emigration.

II) The education module, which estimates the enrolments in the different types of secondary schools, the number of pupils repeating years and dropping out, those who pass the year, those going to university, those dropping out or graduating.

III) The labour market and income module, which simulates whether each individual will have a job and what he will earn. A sort of matching between labour supply and labour demand, aligned to a macro model, is made for each sector and year of the simulation period.

IV) The social security module simulates the entitlements to the benefits of the social protection system. In particular:

- Old age pensions, seniority pensions, survivor’s benefits and social assistance for old people;
- Long term care health services;
- Health care services.

Economic and demographic transitions can be deterministic or stochastic. For stochastic transitions the MonteCarlo method is used. Transition probabilities are estimated by distinguishing Italy and the Region of Tuscany, for which more detailed data are available. The main results predicted by the model are the following. The Italian and Tuscan population will decrease in the future. The education level will increase. As a result of demographic and pension dynamics, unemployment will decrease, and in the long run there will be a shortage of labour supply. Public expenditure on social protection will continue to increase dangerously for many years and will decline only in the very long run.
AN EVALUATION OF THE EFFECTS OF THE TWO MOST RECENT ITALIAN PENSION REFORMS ON SUSTAINABILITY, ADEQUACY AND INCOME DISTRIBUTION IN THE MEDIUM-LONG RUN

Authors: Mairia Luisa Maitino, Letizia Ravagli (Presenter) and Nicola Sciclone

In Italy, given the ageing of population and public finance constraints, the pension system has always been subjected to important reforms, aimed at making the system financially sustainable and fair between generations. Typically, the implementation of these reforms has been postponed over time or revised, in order to make them more acceptable to current generations, ending up downloading costs on future generations. The most important reform, the so called Dini Reform of 1992, had exactly these characteristics. The reform, which shifted from a Defined Benefit (DB) to a Defined Contribution (DC) system, was not applied to individuals who were retiring in those years but to those entered the labour market since 1995. More recently, the Italian pension system was changed with two important reforms, with opposite objectives. In 2011 the law 214 (so called Fornero Reform) increased the retirement age and extended, partially, the DC system to all people retiring, even to the current generation. The reform was decided in a period of strong budget constraints, in order to make the pension system financial sustainable and fair between generations. The opposite direction was followed last year with the so called "Quota 100" reform (decreto legge 4/2019). The "Quota 100" reform decreased the retirement age and the number of years of contributions needed to retire, with the aim to facilitate people close to retirement in 2019, 2020 and 2021.

Unavoidably, these two recent reforms do have effects on the sustainability and the adequacy of social protection system and on the income distribution in the medium-long run. The objective of this work is to evaluate these effects by using a dynamic microsimulation model, IrpetDin. IrpetDin is a dynamic microsimulation model, developed by IRPET (Regional Institute for Economic Planning in Tuscany), able to project into the future the evolution of a representative sample of the Italian and the Tuscan population. The model allows to analyse the evolution of socio-demographic structure of the population and to evaluate the effects of pension reforms from 2016 to 2050. It is based on EU-SILC, the Eurostat Survey on Income and Living Conditions, a survey with representativeness even at regional level. IrpetDin is divided in modules: the demographic module, the education module, the labour module and the social protection system module. In the latter, entitlements to pensions (old age pensions, seniority pensions, survivor’s benefits and social assistance for old people) are simulated. With respect to macro models a microsimulation model, based on individuals sample surveys, allows to analyse the effects of pension reforms by taking into account individual heterogeneity. In details, in this work we use IrpetDin to simulate three different pension rules: i) the pension rules before the Fornero Reform (before 2012), ii) the pension rules after the Fornero Reform (from 2012 to 2018) and iii) the pension rules after the "Quota 100" reform (from 2019). Then, we compare the results of the three simulations in terms of sustainability, adequacy and distributive effects. The main results are the following.

According to our simulations, the Italian pension system will experiment a strong increase in the ratio of public expenditure on GDP in the medium term (until 2040) and then, in the very long run, it will become more financial sustainable. In the long run, the adequacy of pensions, measured by replacement rates, is destined to decrease radically. The net present value will decrease over time, so the pension system will be more equitable between generations. Anyway, the income distribution will get worse in the future. In particular, the share of poor old people and, consequently, the burden on social assistance scheme to old people will
increase. The so called Fornero Reform managed to avoid a probable financial crisis in Italy in the short-medium run, by postponing the retirement of many people close to retire. On the other hand, the reform only minimally increased the adequacy of the retirement income. The "Quota 100" reform will facilitate the retirement of the current generations with a strong increase in public expenditure in the short run. People more advantaged by the reform are especially male workers with high level of education and high retirement income.
An operationalizing theoretical framework for the analysis of universal health coverage reforms: First test on an archetype developing economy

Authors: Sameera Awawda and Mohammad Abu-Zaineh (Presenter)

This paper seeks to lay out an operationalizing theoretical model that enables to assess ex-ante the potential impact of Universal Health Coverage (UHC) in developing countries. Particularly, we build a dynamic stochastic general equilibrium (DSGE) model that is calibrated in a way to capture the salient features of a representative economy of a developing country. The model enables to examine the effect of an exogenous expansion of health insurance coverage at both the micro- and macro-level. Enhancing financial risk protection and improving population health are often cited as the main goals of the UHC. Therefore, we are particularly interested in assessing the extent to which these goals may be achieved under alternative UHC-financing policies. This has been done by assessing the responsiveness of heterogeneous groups – defined in terms of socio-economic and health characteristics – vis-à-vis labor supply and savings-spending patterns. The expansion of health insurance coverage is captured by increasing the share of covered population (the breadth) as well as the share of the covered healthcare costs (the width). We also assess the impact on government budget assuming a government-sponsored health insurance scheme and a fixed debt-GDP ratio. The potential impact of expanding the breadth and width of insurance coverage is assessed under different policy scenarios such as direct vs. indirect taxes, which may offer a different degree of financial risk protection. The theoretical framework we propose can be easily adapted and contextualized to a particular developing country setting.

When applied to a hypothetical country, results show that, first, the implementation of UHC can improve the general population health – captured in our model by health capital accumulation – through shifting resources towards health investment on the part of both households and the government. Secondly, under conditions of low-coverage and limited fiscal space, a parallel expansion of both the UHC breadth and width appeared to exercise a budgetary pressure on existing resources and ultimately crowd out expenditures on other public sectors. A policy adjustment that can mobilize additional resources for UHC and restore the budgetary position of the government may be required. Thirdly, the overall impact of UHC-oriented reforms on households’ behaviors with respect to labor supply, saving-spending patterns, as well as health capital appeared to be relatively comparable under different scenarios. The degree of financial risk protection appears to vary across heterogeneous households and UHC-financing policies, depending on the associated benefits and the additional burden borne by each group.
Projected Prevalence for Alzheimer’s disease and other Dementias in Korea from 2010 to 2065 using a Micro-simulation Model

Authors: Young-Eun Kim (Presenter), Yunsun Jung, Dun-Sol Go, Munkhzul Radnaabaatar, Arim Kim, Hyunggin An and Seok-Jun Yoon

Background
In 2000, the Korean elderly population accounted for 7.3% of the total population, and Korea became an aged society within 17 years of becoming an aging society. This transition is the fastest in the world, and Korea is expected to enter the category of super aged society in 2026. According to a Korean National Burden of Disease study (KNBD), the highest disease burdens (DALYs) in elderly people over 70 years of age in 2015 were Alzheimer’s disease and other dementias. Globally, Alzheimer’s disease and other dementias (AD) are known to be highly prevalent in the elderly population. In order to predict prevalences in the future, traditional forecasting methodologies should be based on sufficient historical data to elucidate trends. In Korea, it is difficult to apply traditional statistical techniques due to lack of past data.

Objectives and Research Questions
In this study, we aimed to estimate the prevalence of future AD in the Korean elderly population (over 60 years) using a population-based microsimulation model based on prevalence, incidence, mortality, and future population estimates.

Theoretical Framework and Methods
Based on the Population Health Model (POHEM)-neurological model developed by Statistics Canada, we estimated the prevalence and number of patients with AD among the Korean elderly population. Based on the results of the “Nationwide Survey on the Dementias Epidemiology of Korea in 2010,” we created a virtual population that includes AD status. The incidence, mortality, and newly entering 60-year-old population were used to perform yearly updates. Through this method, we predicted the number of patients with AD by 2065. Model validation focused on calibration and was performed by comparing projections to observed estimates for a given calendar year. We compared the projected estimates of dementia prevalence in this study to the results of the “Nationwide Survey on the Dementias Epidemiology of Korea in 2016.”

Results
The prevalence of AD over 60 years was 5.16% in 2010 and is expected to increase by about 2.24 times in 2065. The sex difference in the prevalence of AD was 4.45% higher in females than in males in 2016, and this gap is projected to increase over time. The number of patients with AD is estimated to increase by about two-fold in 2019, compared with 2010, and is predicted to increase three-fold in 2028, four-fold in 2037, and five-fold in 2044. The prevalence of each age group is estimated to increase by 2.70 times for people in their 60s in 2065, compared to 2010, 4.85 times for those in their 70s, and 6.18 times for those in their 80s and above. Using a microsimulation model, the prevalence of AD in 2050 was predicted to be 3.1% lower than the frequency derived from predictions of standardized prevalence by age, sex, region, and education level, when applied to a future population.
Income inequality in Latin America: the role of personal income tax

Authors: Cristina Arancibia, Mariana Dondo, H. Xavier Jara (Presenter), David Macas, Nicolás Oliva, Rebeca Riella, David Rodriguez and Joana Urraburu

Latin America is one of the most unequal regions in the world and the fiscal system shows modest results in reducing income inequality. According to Lustig (2017), tax benefit systems in Latin America decrease the Gini coefficient by 2.7 points, on average, when market income is compared to disposable income, while it does by around 20.9 points on average in European countries. This modest redistributive role in Latin America can be explained by three main factors (Gómez Sabaini et al. 2017): (i) the modest size of tax systems, despite their growth in recent decades; (ii) the composition of the tax systems, with a high participation of indirect taxes and, a weak design of progressive income taxes; and (iii) low social spending, despite the increasing size of conditional cash transfers. Designing reforms to improve the redistributive impact of the tax and social protection systems requires evaluating the fiscal policy of each country, as well as learning from the comparative analysis between systems of different countries.

The aim of this work is to analyse the effect of direct taxes and cash transfers on the income distribution of six Latin American countries: Argentina, Bolivia, Colombia, Ecuador, Uruguay, and Venezuela. Our analysis makes use of recently developed tax-benefit microsimulation models based on harmonized household survey data and developed within the structure of EUROMOD (Sutherland and Figari 2013). Our paper represents the first study making use of microsimulation techniques to assess the redistributive role of tax-benefit systems in the region in a comparable manner, and highlights the advantages offered by microsimulation models to evaluate the effect of policy reforms aiming to improve fiscal capacity and social protection in the region. In particular, we focus on the redistributive role of personal income tax and perform a simulation exercise whereby the most progressive income tax system of our set of countries is applied to the rest and assess its effect on income inequality and government revenue. Our results show a wide variation in the effect of tax-benefits systems on income inequality across the six Latin American countries based on microsimulation data. The most redistributive tax-benefit system is that of Uruguay, where inequality decreases by 9 percentage points (pp) when measured by the difference between Gini from market income relative to disposable income’s Gini. In contrast, the least redistributive impact is found in Colombia and Bolivia, where the tax-benefit system reduces inequality but by less than 2.4 pp. The Uruguayan personal income tax achieves the largest degree of redistribution compared to other countries. Moreover, applying Uruguay’s personal income tax to other countries increases the redistributive effect of the tax-benefit system, although to a modest degree in most cases. This policy swap is particularly important in Venezuela, where Uruguay’s tax structure would reduce inequality by 1.1 pp. Argentina, Colombia and Bolivia would also experience a decrease in income inequality but by a lower 0.15, 0.14, and 0.53 pp respectively. In Ecuador, this swap would have no major effect. Additionally, as a result of this policy swap we would observe large increases in tax revenue for all countries.

Our analysis highlights the importance of microsimulation models as a tool for assessing the effect of tax-benefit policies on the income distribution. In this sense, modelling the existing tax-benefit systems and understanding their potential in reducing income inequality is a first step to be considered when designing public policies in developing countries. We expect that future improvements in our regional microsimulation model will represent an important opportunity for policy developments and collaborations within the region with the view of strengthening Latin America’s so much needed social protection.
A dynamic microsimulation model for Argentina’s social security system

Authors: Leonardo Eric Calcagno (Presenter)

Argentina’s main social security system is run by the National Social Security Administration (ANSES). It covers the vast majority of formal workers and provides most pension and family benefits, and both its expenses and sources of revenue in 2017 were close to 11% GDP. Despite its importance, there is no model that projects ANSES future expenses or income. The lack of such a model hinders a rigorous evaluation of the middle to long-term economic sustainability of Argentina’s social security system. It also makes it impossible to evaluate ex ante the impact of social security reforms either on social security accounts or on its beneficiaries. This is all the more worrisome that Argentina’s social security system experimented significant reforms both in December 2017 and throughout 2016. Also, the system is de jure due for a systemic reform by 2019, most likely after October’s presidential elections.

To fill this gap, I developed during my PhD thesis the first dynamic microsimulation model of Argentina’s social security system run by ANSES, which is also as far as we know the second of its kind for a developing country. This model is developed on LIAM2 and respects various counter-factual economic and legislation scenarios, allowing for an ex ante evaluation of the 2016 and 2017 reforms on social security’s economic sustainability, adequacy and redistributive impact.

Starting from a wave of Argentina’s Continuous Permanent Household Survey EPHc (2003-2015), it simulates individual labour-market behaviour but also socio-demographic events (births, deaths, marriages, unions, divorces and separations) and education. Individual behaviour is calibrated on the EPHc (2003-2015) through behavioural logistic equations, as well as Mincer wage equations. We also use other datasets, such as the 2010-2040 demographic projections from the National Institute of Statistics and Census (INDEC) or information from the health and education ministries, to get plausible individual transitions not measured by the EPHc. The macro-level consistency of the model is ensured by various alignment by sorting procedures, which ensures that both historic (1970-2017) and projected labour-market, socio-demographic and education proportions are respected throughout the simulation. The model first carries out a retrospective simulation of past careers to simulate for each respondent a plausible formal labour career, which gives us an estimation of his or her retirement rights at the time of the survey. It then simulates individual behaviour up to 2040, projecting future ANSES social security benefits and contributions at the individual level. From there, it is possible not only to extrapolate aggregate social security sustainability, but also the future impact of social security on real agents’ net revenues.

This methodological paper will present the overall architecture of this model, describe its most relevant modules and calibration, explain some modelling choices that represent a contribution to the dynamic microsimulation field, and give a brief account of how it can project the sustainability of social security, its adequacy and redistributive impact. This paper will not include a thorough study of Argentina’s social security system or the full projected results of Argentina’s social security system for the 2040 horizon. The latter will be the object of a distinct paper, and both these elements as well as a full exposition of the model are studied in detail in my PhD thesis. It is available, together with all the relevant code, in the following URL https://doi.org/10.5281/zenodo.1420273.
Estimating sub-national behaviour in the Danish microsimulation model SMILE – a general approach for estimating transition probabilities with numerous high dimensional covariates

Authors: Marianne Frank Hansen (Presenter), Tobias Markeprand and Peter Stephensen

The SMILE model is a Danish dynamic microsimulation model, which forecasts demography, household formation, housing demand, socioeconomic and educational attainment, income, taxation, and labour market pensions until the year of 2040. In the most recent version of the model, selected behavioural patterns are allowed to vary across the 98 municipalities in Denmark. Especially, this provides the model with a detailed description of sub-national moving behaviour, which is essential when seeking to identify geographic areas characterized by exodus and depopulation. Modelling behavioural patterns by a large number of potentially high dimensional covariates allows for a detailed description of individual behaviour, but simultaneously reduces the number of observations with identical characteristics. Hence, due to data sparsity the curse of dimensionality following from introducing detailed sub-national behaviour significantly challenges the estimation of municipality dependant transition probabilities. This paper suggests the use of a combination of Principal Component Analysis (PCA) and classification by Conditional Inference Trees (CTREEs) when estimating transition probabilities depending on a large number of high dimensional covariates, hence overcoming the curse of dimensionality. The method is described and results are given.
Introducing health and care in the Danish microsimulation model SMILE

Authors: Marianne Frank Hansen and Søren Skotte Bjerregaard (Presenter)

The health state and care need of the Danish population is projected until 2040 using the SMILE microsimulation model. Health is measured by an index ranking all individuals from low to high levels of health based on register data on prescriptions, hospitalization, and doctor visits. Including prescription data in the composite health measure ensures that health can be characterized for almost the entire population, hence capturing as much variation as possible. Care need is represented by limitations in ADLs and is linked to the health index and other individual demographic and socioeconomic characteristics. Modelling behavioural patterns by multiple high dimensional covariates allows for a rich description of individual behaviour, but simultaneously reduces the number of observations with identical characteristics. This curse of dimensionality challenge is overcome by estimating transitional probabilities between health and care states using conditional classification trees. Health dependent mortality is estimated using the same approach. Further health and care transitions are adjusted for the future expected decrease in mortality. The selection of covariates is assessed by cross-validation and projection results are presented for various choices of both individual and spouse specific characteristics included in the transition probabilities.
Modelling value-added tax (VAT) in South Africa: Assessing the distributional impact of the recent increase in the VAT rate and options for redress through the benefits system

Authors: Rebone Gcabo, Boitumelo Moche, Wynonna Steyn (presenter), Boikhutso Moahlodi, Jukka Pirttilä, Michael Noble, Gemma Wright, Helen Barnes and Faith Masekesa

Using SAMOD, a tax-benefit microsimulation model for South Africa, this paper examines the joint distributional impact of the increase in the value-added tax (VAT) rate and increases in benefit amounts in 2018. The results demonstrate that the combination of these two policies did not increase poverty and inequality; however, the poorest still saw a reduction in their purchasing power. As expected, this is due to the fact that many of those in the lowest decile do not receive any social benefits. The paper also explores the consequences of eliminating zero-rating in VAT and using the generated revenues to finance new social benefits also covering such households that do not currently receive any benefits. The simulation results suggest that a policy package of a uniform VAT and an expanded set of social benefits would lead to reduced poverty and inequality in comparison to the current practice of zero-rating of some consumption goods in VAT. These results demonstrate the superiority of using direct taxes and benefits as opposed to provisions in indirect taxes in achieving redistribution.
The supply of informal work in Colombia: a microeconometric approach

Authors: David Rodríguez (Presenter)

Labour informality, initially analysed as a segmented market phenomenon, has more recently been studied as an optimal choice. Thus, the focus changed from the barriers that prevent informal workers from becoming formal, to understanding the determinants of the rational choice of not being formal. This paper argues that these conflicting perspectives could be analysed within a labour supply framework. In order to do so, we extend the RURO (Random Utility-Random Opportunity) labour supply model to capture on the one hand sector choice (formal-informal) and on the other, restrictions on sectoral jobs’ availability. Using Colombian data, we first estimate the model along simpler labour supply versions with and without restrictions on job availability. We compare model fit and preferences for leisure and consumption. Lastly, we simulate the likely effects of different policy reforms on the size of the informal sector to test the segmentation hypothesis. We find important differences in preferences between labour supply models. Moreover, using our more comprehensive model, we found significant differences in formal jobs’ availability for informal workers, pointing to the existence of segmentation in labour markets in developing economies.
How does frugal innovation emerge and lead to sustainability in developing countries? A case study in Malian agricultural areas

Authors: Yosr Abid Fourati (Presenter)

In order to understand the main drivers of welfare inequality in Egypt and Tunisia, the present paper presents an Oaxaca-Blinder decomposition approach used to decompose differences across distributions of household expenditures, based on counterfactual distributions in the two countries of analysis. We purposefully take as case studies Tunisia and Egypt in order to perform a cross-country welfare inequality analysis. In each of these countries, large-scale protests took place beginning from late 2010 in Tunisia and spreading to Egypt in January 2011. Even though it is difficult to precisely identify the sources of these discontents, it is recognized that inequality has been a catalyst of these anti-regime social movements. Understanding the determinants of welfare inequality will help designing the right policy measure for reducing it. The fact that the level of inequality has repercussions on the future institutional developments of countries gives it a high level of significance and importance because it might have a direct impact on the future development process. Our paper aims to understand the main sources of differences in welfare inequality (as captured by the level of household expenditures’ distribution) between Tunisia and Egypt. In this paper, we apply a comparative inequality analysis to these two countries. As far as we know, there is no study which explores the sources of the differences in welfare inequality across these countries using comparable data and applying a decomposition analysis based on a full distribution of welfare. The differences in welfare inequality between the two countries are decomposed into the contribution of labour market, expenditures and demographic factors. This is achieved by generating sequences of counterfactual distributions of welfare in each country if these factors were imported from the other country. For simulating the counterfactual distributions of household welfare, we build a parametric household welfare generation model for each country. The counterfactual distributions are used to decompose the differences in welfare inequality between countries using the Oaxaca-Blinder approach. Regressions’ results show that spending gaps are mainly due to education, working status, sector of employment and spatial differences (region, rural/urban). Taking Tunisia as a reference country, simulations show that changes in the expenditures’ structure and demographics are inequality decreasing. Changes in the characteristics of the labour market has however no or very limited impact on inequality as captured by the Gini Index. From a policy-making point of view, implementing public policies to reduce spatial inequality might have an important equalizing effect on the distribution of revenues, essentially in Tunisia where the issue of regional inequality is more pronounced. Policy reforms related to education might have an important welfare equalizing effect. On the contrary, reforms to the labour market structure need to follow a different model that the one currently prevailing either in Egypt or in Tunisia.
Reducing the probability of moving to a nursing home in the Netherlands: a static microsimulation approach

Authors: Evelien Eggink (Presenter), Isolde Woittiez and Debbie Verbeek-Oudijk

Objectives: As in many other Western Countries, population ageing increases the need for informal, privately and publicly financed long-term care in the Netherlands. Although residence in a nursing home or other care facility is relatively more common for the Dutch population with disabilities compared to other countries, the overall preferred care is received at home. The objective of this study is to better understand what characteristics reduce the probability of moving to a nursing home and make ex-ante assessments of the impact of policy measures that influence this.

Research questions: Which type of care and support enable people with disabilities to live at home and which of these help prevent moving to a nursing home?

Theoretical framework: The starting point of our model on long-term care use is the well-known framework of care use by Anderson and Newman (1973). Since societal factors and the health services system are more or less equal to all residents across the Netherlands, we relate long term care use to individual characteristics: predisposing factors, enabling factors and illness level.

Methodology and data: We combine a survey on people living at home and a survey on users of residential care. Weighted properly, these data provide a representative dataset on the Dutch population of 18 years or over in the period 2014-2016, with over 9000 observations. The combined dataset contains self-reported information on the use of care and personal characteristics such as age, education and health status. We identify seven types of care: no care, informal care, privately financed care, publicly financed domestic help, individual support, personal and nursing care and nursing home care. The relationship between care use and characteristics of the population is modelled using a multinomial logit. The explanatory model yields the probability of using each of the types of care. We use these probabilities in a static microsimulation to investigate alternatives for the types of care used. A decreasing availability of care is mimicked by decreasing the probability of that care type for each user, and distributing this proportionally to the other types of care.

Results: Preliminary results indicate that apart from age, chronic disorders and disabilities, also social economic factors determine which type of care is used. For instance, people living alone receive more care than others, while a higher income and higher education level are associated with less use of (publicly financed) care. Preliminary simulation results show that the probability of entering a nursing home by 25%, while insufficient availability has an even larger impact on nursing home care (47%).
Forecasting Child Poverty in Scotland using Microsimulation

Authors: Howard Reed and Graham Stark (Presenter)

Objectives: The devolved Scottish Government has put into law and ambitious set of targets for the reduction of child poverty over the period 2018-2030. In this paper we describe the microsimulation exercise that informs the delivery plan for this policy.

Theoretical framework/Methods: The analysis used the Landman Economics the Landman Economics/IPPR/Resolution Foundation tax-transfer model the Family Resources Survey. We used reweighting and uprating to produce forecasts. The model was originally developed in 2008-09 by Landman Economics for the Institute for Public Policy Research (IPPR) and was subsequently shared with researchers at the Resolution Foundation which provided additional funding for improvements in the model functionality and performance. The model is now used by all three organisations. Other comparable models in use in the UK include the distributional analysis models used by HM Treasury and the Department for Work and Pensions; the Institute for Fiscal Studies (IFS)’s TAXBEN model; and the UK version of the Euromod model which is hosted at the University of Essex. As such, our analysis is an essentially conventional exercise using a static microsimulation and our own implementation of standard weighting routines. There are however a number of interesting points of detail, such as our treatment of the take-up of means-tested benefits. Our analysis largely ignores Brexit, except for the consideration of some alternative, zero net immigration, demographic forecasts.

Results. The results paint a bleak picture. The four standard measure of child poverty (relative and absolute, and before and after housing costs) are all forecast to rise over the period. This is largely because of a freeze in most benefits announced in 2015, the replacement of tax-credits and housing benefits with a new integrated Universal Credit and a restriction on the number of children that benefits can be claimed for. Benefit policy is mostly ‘retained’ by the Westminster Government; we show that the measures the Scottish Government have been able to introduce will mitigate these measures, but only to a limited extent.
This paper introduces the MicroWELT model developed alongside an international research program studying the distributional effects of four welfare state regimes - Liberal, Universalistic, Conservative, and Mediterranean - in the context of demographic change. The study uses four country examples representing the welfare state regimes: UK, Finland, Austria, and Spain. MicroWELT is a continuous time interacting population model implemented in Modgen, a freely available microsimulation language developed and maintained at Statistics Canada. While reproducing existing demographic projections in aggregate outcomes, MicroWELT accounts for fertility and mortality differentials and differences in partnership careers by education. The resulting family-demographic and educational projections are integrated with National Transfer Accounts (NTAs). National Transfer Accounts break down National Accounts by age and capture transfers within and between families and through the tax-benefit and social insurance system. While being cross-sectional measures, NTAs are heavily used in studies on the economic and policy implications of demographic change. In a first application of MicroWELT we start by reproducing existing literature based on macro projections. By stepwise dis-aggregating NTA data by sex, school enrollment, educational attainment and family type combined with the corresponding detailed socio-demographic projections of MicroWELT, we explore how findings change when adding detail to projections - and challenge the realism of some published findings.
DYNAMIS-POP – A Multi-Country Portable Dynamic Microsimulation Model for Population, Education and Health Applications in Developing Countries

Authors: Martin Spielauer (Presenter) and Olivier Dupriez

Detailed socio-demographic projections are key for policy making and planning. In this paper we introduce the dynamic microsimulation platform DYNAMIS-POP. In its core, DYNAMIS-POP is a population projection model, able to reproduce existing macro (cohort-based) population projections in their aggregate outcomes, but with the additional possibility to simulate in more detail some geographic, education, ethnicity, child mortality, partnership status, fertility and health characteristics.

DYNAMIS-POP is a continuous time interacting population model implemented in Modgen, a freely available programming technology developed at Statistics Canada. The code is also x-compatible with openM++, a platform-independent open-source implementation of Modgen. All components of DYNAMIS-POP are freely available and documented on line. Most statistical analysis scripts and scripts for post-processing and visualization of the results are implemented in R. Aiming to support portability, the model code and the R scripts are generic. Adaptation of the model to a specific country only requires adapting a single setup script and simulation module. The model is provided with test data of an imaginary country. Required data are available for most developing countries. To date, the model was tested using data from Mauritania, Nepal and Senegal.

Designed as a modular and versatile microsimulation platform, DYNAMIS-POP can be adapted for a variety of applications related to population issues, education and health. In this paper we give some illustrations from an application to Nepal, including the projection of the new World Bank Human Capital Index (HCI) and studies on child vaccination.
Towards a simulation-based understanding of biorefinery development

Authors: Julia Wenger (Presenter), Raphael Asada and Tobias Stern

To cope with the problems associated with the fact that today’s energy carriers and chemicals are to a large extent based on fossil resources, and to promote regional and rural development, moving towards a more bio-based economy is discussed as a potentially viable option. For this, biorefining, defined by the IEA task 42 as the sustainable processing of biomass into a spectrum of marketable bio-based products (chemicals, materials) and bioenergy (fuels, power, and/or heat), is expected to play important roles (De Jong et al., 2011). Research is essential for the development of new technologies, but most ideas that are followed in research fail to reach the market – possibly because the focus is often mainly on technological development, but challenges along the whole value chain need to be tackled for the development of profitable and sustainable biorefineries.

Therefore, the aim of this work is to make a first attempt to model underlying innovation systems based on the current state of research and development. The following main objectives are pursued:

• Investigation on how different feedstock classes and products have been described in the scientific literature on the development of biorefineries, and comparison of these results with information on the practical implementation of biorefineries (systematic literature review);
• Investigation on the diffusion of selected technical-lignin-based innovations: Identification of the relevant decision-makers and their key attributes, behaviors and interactions (several approaches); exploration of how the diffusion of certain lignin-based innovations on the market could look like in different future scenarios, taking into account economic and technological factors (agent-based model).

A systematic literature review identified the most relevant biorefinery approaches from the literature, taking into account the classification approach by Cherubini et al. (2009). To take a broad perspective, 892 abstracts of scientific articles (published between 1999 and 2017) that refer to the search terms “biorefinery” and “feedstock” in their title, abstracts and/or keywords were analyzed. Based on the findings from the first literature review, which indicated a key role of lignocellulosic biomass and the importance of successful valorization of technical lignin, a further literature review was carried out. The aim was to obtain information on applications and markets based on technical lignin and to assess the state of research in this field. By applying a snowball-technique, statements with economic reference to lignin were collected and assigned; the search was finished when the statements were frequently repeated and saturation occurred. To assess the direction of changes in economic and environmental indicators also from a macro level perspective, the potential impacts of utilizing technical lignin were investigated using a multi-regional input-output (MRIO)-based approach, assuming that lignin would replace fossil-based inputs as a chemical feedstock at large. Lignocelluloses and, in particular, lignocellulosic residues are the dominant feedstock mentioned in published biorefinery research. Technical lignin is a relatively large (estimated at 50 million tons per year) and a major underutilized residue stream from the pulp and paper industry (as already stated by Stern et al., 2015), which is now mainly burnt on site for the purpose of gaining energy. Currently, only a limited market for lignin exists, but it is said to play a major role in biorefinery conception in that it is a residue that could be further valorized and replace certain petrochemical products in a more sustainable way. Investigations on technological aspects of lignin for several conceivable applications have been the focus of research for many years, whereas the level of knowledge in the field of markets and innovation diffusion of lignin is rather low.
The results acquired through this research provide the key material for the identification of the relevant decision-makers and their relevant attributes, behaviors and interactions. We expect that this will create the basis for a better understanding of how the diffusion of certain biorefinery innovations on the market could look like in different future scenarios.
Money metric utilities and reference prices

Authors: Bart Capéau, André Decoster (Presenter) and Liebrecht De Sadeleer

In this paper, we show that using different reference prices for different individuals in money metrics of well-being leads to violations of several normative properties of interpersonal welfare comparisons that have become popular in the fairness literature. Money metric utilities measure individual well-being or welfare – both terms will be used interchangeably in this note – by means of the expenditure function evaluated at a given vector of reference prices. They have become a standard tool in (applied) welfare analysis. They serve e.g. as a basis for calculating equivalent and compensating variations (see e.g. King, 1983, Blundell, Preston, and Walker, 1994, or Creedy and Kalb, 2005).

Recently these measures got renewed attention from the fairness approach in social choice theory (Fleurbaey, 2008, 2011, Fleurbaey and Blanchet, 2013, Fleurbaey and Maniquet, 2017, 2018). For practical applications, the question arises which reference prices to use. In the context of labour consumption problems, a common practice is to use actual wages as the reference price for leisure (e.g. Creedy and Kalb, 2005). This choice has recently been advocated also by Chiappori (2015) and Chiappori and Meghir (2016), and is used in many applications of the so-called collective household model (e.g. Chercy et al., 2015, 2018, or Ferrando, 2018). Given individual wage heterogeneity, the consequence is that different reference prices are used for evaluating each person’s welfare.

In this paper, we show that such a practice leads to violation of several normative principles for interpersonal welfare comparisons from fair social choice theory (Fleurbaey and Maniquet, 2011, Decancq, Fleurbaey, and Schokkaert, 2015). More precisely, we show that in such a case the Same Preference Principle and the Nested Contour Criterion are violated. Moreover, in such a case, these measures lose the Nested Opportunity Set Property, which was one of the reasons why these measures got renewed attention from the fairness approach to social choice (Fleurbaey, 2011). Our contribution does not help to choose the appropriate vector of reference prices. It is well known that this choice does matter for making interpersonal welfare comparisons (see Chiappori and Meghir, 2016 for an example). In order to try to circumvent this problem, one strand in the literature has therefore focussed on investigating which class of preferences allows money metric utilities that are reference price independent, i.e. the choice of reference prices does not affect welfare rankings of individuals (see e.g. Blackorby et al. 1994). This turns out to be overly restrictive (homotheticity of preferences). We think however that the choice of reference prices should follow from normative principles guiding interpersonal welfare comparisons, deemed to prevail irrespective of the particular shape of individual preferences to which they are applied, and therefore reference price independence is not necessarily an attractive property.

Our contribution is related to Pauwels (1978, 1986), who alerts for potential incoherences when using the compensating variation, which is essentially the result of applying a money metric utility for making intra-individual welfare comparisons. Pauwels (1978, 1986) shows that if the welfare cost according to the compensating variation for an individual switching from the baseline to situation 1 is higher than that of switching to situation 2, it does not necessarily follow that situation 2 is better than situation 1. The reason is that with the compensating variation, the welfare change of the switch to situation 1 is measured at prices of situation 1, while that of a switch to situation 2 is measured at prices in situation 2. If we would apply the common practice of using market wages to construct money metric utilities, and we would compare an individual in two situations in which she obtains different wages, a similar problem arises. We will show that in such a case the money metric well-being measure is not consistent.
with a person’s own ranking of these situations according to her preferences. In the jargon of
the fairness literature on well-being measurement this is called a violation of the principle of
Respect of Individual Preferences. We extend that critique to the case of interpersonal
comparisons. If two individuals with the same preferences face e.g. different wages, the well-
being ranking of those persons resulting from using the wage of each as a reference price for
evaluating the money metric would not necessarily follow these person’s own ranking
according to their identical preferences. The measure would violate the Same Preference
Principle, in the terminology of the fairness literature.
Section 1 sets out the model and contains some definitions of well-being measures (Subsection
1.1) and some normative principles of well-being measurement (Subsection 1.2). Section 2
shows that money metrics with different reference prices across individuals fail to satisfy all
of the principles from Subsection 1.2. Section 3 gives the model in the specific case of labour
and consumption as the only determinants of well-being. Section 4 contains the empirical
application for Belgian single adults available for the labour market in 2015 and shows that the
violation of these principals in the labour consumption context, is all but exceptional. Section
5 concludes.
Consumption pattern and subsistence level: Effects of changing social assistance regulations in Germany

Authors: Maximilian Sommer (Presenter)

The German welfare state is centered around the concept of a subsistence level. This level is expressed as a monetary value that should ensure a life in dignity. Hence, it includes not only costs for food, housing, clothing, and acute medical care but also allows for an individual’s active participation in society. Until 1990 this value was based on a basket of goods model. However, this was replaced – due to various reasons - by a statistical model that relies on the representative income and expenditure survey. This official household survey is conducted every five years and is adjusted in between. The new approach uses the consumption pattern of a fixed percentage of certain household types to derive mean expenses for different consumption categories. The sum of these values determines the welfare payments in Germany as well as part of the income tax threshold. Subsistence levels are separately calculated for adults and children of three age groups.

In our paper we analyze the two latest waves of the German income and expenditure survey (2008/2013) to study the composition of the subsistence level. We use microsimulation techniques to analyze the effects of changing regulations concerning the statistical methods to calculate the subsistence level. Of main interest are the direct normative interventions of the government in different consumption categories that are then excluded from the calculations as well as the choice of subsets of the population. We also look at the statistical properties of the sample of both waves and the way this affects the robustness of the overall outcome. Furthermore, we simulate the effects of a changing subsistence level on the financial burden of the government.

First indications show, that the subsistence level is quite sensitive to changes in the social assistance regulations. Especially the usage of only certain subsets of the population has to be discussed further. The values for children are affected to a higher degree as the sample size that is used for the calculations is very low.
Economic costs of lost productive life years due to chronic disease: results from a microsimulation model Health&WealthMOD2030 for Australians aged 45 to 64 years old

Authors: Rupendra Shrestha (Presenter), Deborah Schofield, Michelle Cunich, Robert Tanton, Lennert Veerman, Simon Kelly, Owen Tan and, Megan Passey

There has been growing concern about the impact of chronic diseases on individuals’ capacity to remain in the labour force and the loss of productive life years (PLY) to chronic illness. The loss of PLYs as a result of chronic diseases can result in significant economic costs, in some cases greater than the direct healthcare costs. Individuals are affected through reduced income and savings; and governments through decreased taxation revenue and increased expenditure on income support payments. These economic costs are likely to increase in future because of the ageing workforce and increasing prevalence of some diseases.

We have developed a microsimulation model, Health&WealthMOD2030, to project the economic costs of lost PLYs due to ill health for Australians aged 45 to 64 years old from 2015 to 2030. The model captures the long term projections of demographic change, changing labour force participation patterns, real wages growth and trends in chronic diseases. The base population of Health&WealthMOD2030 is based on the Australian Bureau of Statistics 2003 and 2009 Surveys of Disability, Ageing and Carers. Data were reweighted to benchmark against the 2015 Australian Intergenerational Report’s population projection and labour force participation projections; other socio-economic trends such as home ownership from a dynamic microsimulation model APPSIM and the trends in chronic diseases from the 2003 Australian Burden of Diseases and Injury Study. Estimates of income, taxation, income support payments, savings and superannuation from a microsimulation model STINMOD were synthetically matched with the base population and were indexed to reflect economic growth projections to 2030.

We used the output datasets of Health&WealthMOD2030 to estimate the lost PLYs to chronic illness and the associated economic costs for every five years from 2015 to 2030 and to identify the chronic diseases that are associated with the highest economic impacts in future. For Australians aged 45 to 64 years old, there was an estimated PLY loss of 380,000 in 2015, which was projected to increase to 462,000 by 2030. The total costs due to lost PLYs was estimated at A$12.6 billion in 2015 increasing to A$20.5 billion in 2030 in lost income and A$9.3 billion in 2015 increasing to A$11 billion in 2030 in increased welfare payments and lost income tax revenue.

These results provide novel insights into the interdependency of chronic disease, labour force participation and economic outcomes and fill substantial gaps in the current Australian evidence about the health conditions that will keep older working age Australians out of the labour force over the long term. This has potential implications for future health policies that support preventive health interventions that improve health outcomes and enable people continue working instead of retiring prematurely because of chronic diseases.
Optimal Policy Modelling for the Australian Welfare System

Authors: Ben Phillips (Presenter), Matthew Gray and Richard Webster

The Australian Social Security system has largely remained unchanged over recent decades. While there has been some modest changes by and large the system has grown in line with standard indexation measures. This paper considers most Australian pensions, allowances, family payments and rent assistance and attempts to estimate maximum payment rates that minimise the poverty gap for all Australian households. To do this we use the ANU PolicyMod microsimulation model of the Australia tax and social security system. Using a sample of around 20,000 simulations of alternative levels of these payments we establish a statistical relationship between these payment levels and the poverty gap. Using a non-linear optimisation routine we minimise the poverty gap subject to a range of constraints including a budget constraint and several other constraints on payment level movements. Under a budget neutral constraint we find that the Newstart payment is increased substantially while some other payments require offsetting modest reductions. We undertake the analysis at both the household and income unit level and for a range of poverty gap measures with and without housing costs deducted from income. We find that the statistical relationship between the poverty gap and payment levels achieves a very close statistical fit and can be relied upon for modelling the poverty gap in comparison to only using the data in PolicyMod.
A Better Measure of Poverty and Optimal Policy Modelling for Australia’s Social Security System

Authors: Ben Phillips (Presenter)

Poverty measurement in Australia typically uses a variety of measures but the most commonly used measure is the ‘half-median’ income measure where households are defined as being in poverty where their equivalised income is less than 50 per cent of the median household income of all households. There are a number of problems with such a simplistic measure. Typically some fraction of the households defined as in poverty are not in financial stress and often have either significant wealth or their income is not typical of their true living standards. In this paper an attempt is made to develop a broader concept of income including wealth and also to account for different living costs through the lifecycle using an econometric link to financial stress. Finally the paper will consider how an alternative, and hopefully more complete poverty measure impacts on the results of Optimal Policy Modelling to minimise the related poverty gap by varying maximum payment rates in the Australian social security system.
Long-term dynamic microsimulation modelling of labor market careers: a new approach using profiles and matching

Authors: Karel Van den Bosch (Presenter), Gijs Dekkers and Raphael Desmet

Long-term dynamic microsimulation models mostly rely on behavioral models or on Markov transition tables, which are applied consecutively in subsequent years, to project demographic and labor-market variables. When the projection horizon is far into the future, even small misspecification errors can result in large deviations. Partly for this reason, dynamic microsimulation models have the reputation of being like a ‘black-box’ and the potential to run ‘out-of-spin’. Another problem for these models is that it is often necessary to make simplifications to the data to make the model manageable, e.g. to assume that individuals have only one labor-market status and/or only one type of income during a calendar year. This can be a serious drawback in the simulation of distributional outputs, such as inequality and poverty. Both problems are compounded when the focus of the model is on pensions in a Bismarckian system, where the pension depends on the former career, so results should be valid not only for each year cross-sectionally, but also longitudinally for each individual. In particular, there is a danger that spells of unemployment or inactivity are insufficiently concentrated within particular individuals. Finally, it is generally recognized that validation of the results of long-term dynamic microsimulation models, though important, is very difficult as there are no future data available for this purpose.

We propose an alternative approach to long-term dynamic microsimulation modelling that relies much less than current models on behavioral equations. Instead, use is made of observed profiles and matching. A profile is a range of characteristics of one individual, at one time or over several years. Careers are a specific type of profiles. The basic idea is that profiles that are observed in the starting data are matched to the projected individuals. More concretely, we use observed individual labor market episodes of eight-year length, containing all relevant data, and characterized by the age, gender, education, region and migration-status of the person. These episodes are matched to each other and to incomplete careers of projected individuals to create complete careers until retirement, using similarities in overlapping ages as matching criteria. E.g. a career episode of a woman at ages 35-42 is matched to another career episode of a woman at ages 40-47, with the same education, region and migration status. The resulting ‘initial’ careers are adjusted for future aggregate labor market changes projected by a meso-economic model (e.g. less unemployment, higher labor market participation between ages 55 and 66), using behavioral equations and alignment tables, in order to project the ‘effective’ careers. Also, earnings and benefits are updated. Because the original profiles contain all the details of the observed starting data, the projected data have those detail as well. We argue that the results are demonstrably valid, because they are similar to the observed data, except in so far as characteristics are known or assumed to change.

The paper has more details on the new approach, and presents projected results for Belgium up to 2060, comparing these with those of the well-established dynamic microsimulation model MIDAS.
The research project Regional Microsimulations and Indicator Systems (REMIKIS) aims at developing the methodology for the statistical measurement of essential social indicators on regional levels and applying this regionalized microsimulation model for the city of Trier and its environs. The core of the project is to construct a dynamic microsimulation model with the purpose of comprehensive analyses of social indicators at the micro level. Therefore, two components are crucial for the REMIKIS model: a regionalized microdata set as the base population and an appropriate method for estimating the transitions. The base dataset is a semi-synthetic population of the city of Trier that was created using statistical models and heuristic optimization methods. Additionally, the generated households are geographically located at real addresses within census grid cells and maps from the OpenStreetMap-foundation. This enables the calculation of distances and travel times between addresses and institutions such as hospitals, schools and kindergartens.

Taking into account individual and family relationships, the population is updated as a time-discrete dynamic microsimulation at annual intervals. Various administrative data sets and different statistical surveys, such as the German microcensus and the socio-economic panel, serve as the information basis for the development of the population. Model-based transition probabilities regulate the occurrence of certain events, such as births, partnerships, and regional mobility. Generalized linear models, e.g. logit regressions, are used to estimate transition probabilities.

A major challenge is the estimation of transition probabilities on data that lack in regional detail. For these purposes, typically alignment methods are used to adjust the model-based probabilities. We propose an advanced alignment method that allows for the estimation of regional regression coefficients using nonlinear optimization methods with external benchmark constraints on the base population.

This presentation provides an overview of the creation, the structure and the procedure of the REMIKIS microsimulation model and gives an outlook to future developments. Furthermore, the first analysis results for planning regional elderly care requirements in the region of Trier is presented.
The analysis of social effects of elderly care and the integration of migrants into the labour market are the substantial research topics within the research unit (FOR2559, German Research Foundation) Multi-Sectoral regional microsimulation model (MikroSim). This project is dedicated to set the basis for a small-scale microsimulation model for further more general applications. Hence, we require a suitable dataset on a regional level. Since such a dataset is not available in Germany, we generate a synthetic close-to-reality base population meeting marginal distributions on a small-scale level using methods of spatial microsimulation. The aim of this base population is to simulate all the 82 million citizens in each German city and municipality regarding regional sociodemographic characteristics.

At first, we start with a set of basic variables within each city and municipality considering distributions of age, gender, marital status and nationality. The expansion of the dataset is conducted using (multinomial) logit regression models based on the German Microcensus whereas editing is taken into account. Editing is a necessary step to avoid implausible individuals such as young working children. After the expansion, we use the results of the German census to align the population within each city and municipality to known margins. We use simulated annealing in this step to alter the population. Since this is a highly computer-intensive task, especially if we consider all of the around 11,000 cities and municipalities and more than 300,000 benchmarks overall, a high performance computer cluster for parallel computations is used.

In this paper, we show the methods in detail and present results of the generation process as well as the structure of the synthetic population. We also would like to discuss potential improvements, issues and quality measures for synthetic populations.
Modelling foreign labour inflows using a microsimulation model of an ageing country - Slovakia

Authors: Miroslav Stefanik (Presenter) and Tomas Miklosovic

In this submission, we plan to introduce the most recent application of VZAM_microsim; a model developed to forecast labour supply and analyse skills mismatch at the Slovak labour market. The model employs the European Union Labour Force Survey (EU-LFS) microdata published by EUROSTAT. VZAM_microsim was updated from a previous version of VZAM (Workie et al., 2012; Stefanik, M., Miklosovic, T., 2016), which was based on semi-aggregated EU-LFS data, following the concept of manpower requirement model, adopted in the methodology of CEDEFOP’s forecasts of Skills Supply and Demand in Europe (CEDEFOP, 2009).

In the paper, we focus on exploring the potential of the microsimulation approach in simulating foreign labour inflows into the country, driven by the aggregate demand for labour predicted by a macroeconomic model. Our predictions are produced jointly by a combination of a microsimulation model (supply side) and two macroeconomic models (demand side) assuming an equilibrium on the labour market. The deficit of labour, driven mainly by the demographic change is balanced with the labour immigration.

Point of departure

Recent development in the Slovak labour market has presented an unprecedented situation dominated by several interconnected factors, mainly a sharp decline in the unemployment rate, including long-term unemployment, followed by an increase in the share of foreign-born workers. Since 2013, the number of foreign workers in the Slovak labour market had more than quadrupled, reaching almost 60 thousand by mid-2018. Recent development has shown that the ability to fill in vacancies with Slovak workers is declining. While in 2015, only 10% of new jobs were filled by foreign workers, in the first half of 2018 the percentage of foreign workers in total placements was 54%. At this point, it is important to stress that foreign workers are mainly concentrated in occupations that were stable, or even decreasing in the past. We address the question of the extent of labour immigration expected in Slovakia during the period up to 2030?

Modelling approach

The results of our work are based on a unique combination of a set of macroeconomic and microsimulation models. The macroeconomic model is a CGE model predicting the development on the demand side of the labour market (Radvanský and Miklošovič 2016). The supply side of the labour market was modelled using microsimulation model VZAM_microsim, which was created at the Institute of Economic Research of the Slovak Academy of Sciences (IER SAS) and is, in fair detail, described in Štefnik and Miklošovič (2016). The current version of the model is based on the Labour Force Survey microdata for Slovakia in 2017. The initial population is in the following periods updated using a set of deterministic and probability functions covering the following processes: ageing, fertility, mortality, migration, educational achievement, status, economic activity, employment, and unemployment. The main process in the model is employment, where this process bridges the
information from the macroeconomic model on labour demand with the available labour supply. Economically active persons working in certain positions in the previous year remain in their positions. If the total demand (expansion and replacement) for labour in the sector is shrinking, persons with the lowest sector-specific logit score are assigned to unemployment. These individuals are further used in the matching process as vacancies in other sectors are being filled. Matching takes into account the acquired education of individuals and the educational structure of the employed in the sector. If there are some vacant positions after the pool of the unemployed has been utilised, migrants are cloned until the demand for labour is met.

We propose scenarios adopting different assumptions on the growth and structure of labour demand. Results of the microsimulation model show the extent, as well as educational structure of expected labour immigration.

First results

Results of the mid-term projection expect that the total employment in Slovakia will reach almost 2.7 million persons in 2025. Over the coming years, year-by-year expansion demand is going to be decreasing from its expected top level in 2018 (26 thousand) to around 13 thousand in 2024 and 2025. Future demand for labour is going to be driven dominantly by replacement demand for labour, related to the need to fill in jobs after individuals leaving to retirement or other forms of inactivity. At the same time, cohorts of fresh graduates are going to remain significantly lower than the retiring cohorts. The most of this demand will, thus, need to be covered by inflowing foreign labour.
MikroSim – A dynamic spatial microsimulation model for Germany

Authors: Ralf Münich (Presenter), Rainer Schnell, Johannes Kopp, Petra Stein and Markus Zwick

Within the research project MikroSim, funded by the German Research Foundation (DFG FOR 2559), we are setting up a nationwide, multi-sectoral dynamic spatial microsimulation model at the level of households and individuals for Germany. The challenge of the project is to simulate consistently the approx. 82 million citizens that are living in about 40 million households considering their regional distributions in order to enable the analysis of social developments and their effects at a small-scale level. For this purpose, a base dataset is generated using anonymized distributions of the German register and micro-level survey data. In addition, persons and households are geographically located within 100 × 100 meter units using census grid cells. During the project this database will be regularly updated and extended by further variables in collaboration with the German Federal Statistical Office. With this statistically enriched dataset, socio-demographic changes of the underlying population are simulated by estimating transition probabilities on the basis of empirical data. This approach leads to the development of analysis models for social science issues and empirically-based, long-term planning. The simulation model is designed to cover a wide range of substantial areas (sectors).

Concerning the application, the first research focus considers primarily the topics of family processes and elderly care and the integration of migrants into the labor market. An extension to other topics like health, traffic and spatial planning should follow in later work stages. The aim of this poster is to introduce MikroSim to the research community on microsimulation, presenting the objectives, research questions, methodology and current status of the project.
An intelligent system based agriculture microsimulation model with bootstrapping validation

Authors: Azizur Rahman (Presenter)

Advanced level models are essential in dealing with big data environments. Recent developments in smart technologies now allow environmental characteristics like climate, land cover and topography to be measured at fine spatial resolutions. But, reliable small area level data with enough comprehensive information for measuring human socioeconomic activities is often unavailable because they contain confidential or proprietary information. For examples, spatially-disaggregated and explicit data depicting the distribution of livestock, crops, and invasive animals is needed to inform potential agricultural production increases and to manage the risks to food safety and biosecurity. The lack of a small area datasets often negatively impacts the ability of agencies to manage serious health risks. The attributes of individual farms, e.g. their distances to other farms, the size of the population, and invasive animals data is needed to parameterize spatial epidemiological models. Spatial microsimulation models are powerful tools to simulate the characteristics of populations, and model the complex interactions of individuals’ activities at the finest spatial resolutions. This paper provides a new intelligent system based algorithmic methodology for a tractable class of spatial microsimulation models for agricultural industries. It also demonstrates bootstrapping reliability measures for the small area agriculture estimates. Empirical findings reveal that the proposed intelligent system based modelling technique is performing better than the traditional approaches to spatial microsimulation modelling. The bootstrapping validation results show an enhanced reliability to the small area agricultural estimates for regions with smaller populations.
The year 2009 marks the start of a period of tremendous transformations in the Greek economy. After a decade of fast growth, the country faced the worst financial crisis in living memory. In 2009-2013 the economy shrank by an astonishing 29.4 percent. The recovery that followed was sluggish, with the number of employed workers in 2017 still lagging 17.6% behind its 2009 level (Eurostat, 2019).

During the period in question, the Greek personal income tax (PIT) system underwent four major structural reforms (in April 2010, October 2011, December 2012 and April 2016). This is in stark contrast to the previous years of robust economic growth (1995-2008), during which the tax system of the country had remained impressively stable (Ioannidis, 2015). These reforms completely transformed the Greek PIT system and sometimes went against the general taxation trends of its European counterparts. According to a recent OECD report, after the initial phase of the global financial crisis and the tendency to raise taxes and reduce public spending, the majority of OECD countries introduced growth-driven tax reforms. Greece may be among the several EU countries that have introduced radical tax reforms, but it is the only one among them that continued to increase taxes on labour in the aftermath of the economic crisis (OECD, 2017). What was the distributional effect of these policy changes? Who have been the main gainers and losers of the PIT reforms of this period? What has been their impact in terms of income inequality and poverty? How have they affected work incentives, as measured by marginal effective and participation tax rates? The aim of this paper is to provide some first answers to these policy-relevant questions.

The impact of each PIT reform is measured using the Greek component of the EU wide tax-benefit microsimulation model EUROMOD. Drawing on the decomposition approach developed by Bargain and Callan (2010), we approximate the first-order distributional effects of policy changes by simulating a series of hypothetical scenarios. More formally, the counterfactual scenario used to assess the distributional impact of a PIT reform between two consecutive years, t and t-1, is constructed on the basis of: (i) market incomes as in year t; (ii) PIT policies as in year t-1; (iii) all other tax-benefit policies as in year t. This is compared to a situation where all variables are set as in year t. The choice of the underlying microdata is crucial for the distributional assessment of policy reforms. In this research several SILC data waves were used to best capture the actual impact of PIT changes over this long time period. The impact of the 2010 reform is assessed using EUROMOD input data based on SILC 2010; the 2011 and 2012 reforms using microdata based on SILC 2012; and the 2016 reform using data based on SILC 2016. Moreover, in order to capture the intended effect of policy changes we make use of EUROMOD’s state-of-the-art Hypothetical Household Tool (HHoT) and generate several ‘model families’ (Gasior and Recchia, 2018). These allow us to abstract from the complexity of the whole population structure and illustrate the intended effect of policy changes for individuals and households with specific characteristics of interest.

Our preliminary results confirm that all four tax reforms had a revenue-increasing rational. They also suggest that the redistributive impact of all but the 2012 reform had been inequality-reducing. The 2012 reform, which affected incomes earned from 2013 onwards, abolished the zero-tax bracket and introduced a tax credit for employment and pension incomes. This caused a more than 3% decrease in the disposable income of the poorest decile. The 2016 reform slightly mitigated this result, by increasing the disposable income of the first decile by a mere 0.5%.
According to our estimates, the most inequality-reducing tax reform had been the one of 2011; the decrease in the zero-tax bracket, the abolishment of several tax credits and the introduction of new levies on high pensions caused a more than 4% drop in the disposable income of the richest 40% of the population, much more than the corresponding fall in the income of the poorest decile. While the impact of this reform can be described as progressive, this is far from saying that all went well with it. The downward compression of the income distribution caused child and working age poverty to rise by almost half a percentage point. The poverty impact of the 2012 reform was found to be even stronger, with most of the burden falling on the working age population. These initial results highlight the need for a more cautious and socially sensitive design of tax reforms aiming at fiscal consolidation.
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Intensity of poverty among young adults in Europe: how are the strategies of European countries?

Authors: Vincent VERGNAT (Presenter)

Objectives
Young adults in Europe generally do not have access to unemployment benefits due to a lack of contribution periods; in some countries they do not even have access to minimum income. In times of high unemployment in Europe, is it possible for young people to access autonomy without family resources? Do European states offer social assistance to young adults? This paper aims to compare the budgetary constraints of young adults in Europe and to understand the various strategies implemented by different European countries. To do this, the paper is based on the microsimulation model EUROMOD and hypothetical data. I compare the budgetary constraints of identical individuals in all European countries in order to isolate the effect of different tax-benefits systems. This will allow us to study how European countries protect young adults against poverty and social exclusion and how effective are these systems in reducing the intensity of poverty. It will also show which countries promote family-based social assistance and which provide support to young adults on an individual basis.

Research questions
With the phenomenon of destandardization of the transition to adulthood in European countries (Elzinga and Liefbroer 2007), youth poverty has become a major concern for public policymakers. The greater participation of young people in higher education and the worsening situation on the youth labor market create a situation of greater financial dependence of this group. Young people are then dependent on family resources and state support to achieve economic self-sufficiency. There is a rather small body of the literature that is concerned about youth poverty and youth autonomy. Most studies in this area have shown that young adults are one of the most vulnerable groups when it comes to poverty. Smeeding and Ross Phillips (2002) also show that welfare states contribute to reduce the poverty rate of young adults. Comparative studies have also shown that youth poverty varies greatly between European countries and that it is countries with generous social protection systems that, surprisingly, have a highest poverty rate among youth (Aasseve et al. 2006, Mendola et al. 2009). Poverty rates, while an interesting indicator, do not reflect the generosity of welfare states. A high poverty rate may reflect a larger proportion of youth in a state of financial dependence without reflecting a low level of public support. This paper seeks to answer the following questions. What are the different safety net strategies put in place by European countries? Is public support encouraging independence or family cohabitation? Which policies could create inactivity trap phenomena? Nowadays, is Europe always in a Bismackian/Beveridgian duality?

Methodology
My study is based on the EUROMOD microsimulation model. This model makes it possible to simulate the effect of socio-fiscal policies on representative samples of each European country or on reference cases. As in Gasior and Recchia (2018), we used in this paper the Hypothetical Household Tool (HHoT) from EUROMOD to create unique and similar individual on whom we simulate the effect of socio-fiscal system of each European country. Using Hypothetical household makes it possible to study only the impact of socio-fiscal system while ignoring the socio-demographic structure of the entire population. I decided to focus on reference cases which allow me to compare:
1. Minimum income schemes in Europe: youth vs middle age.
2. Minimum income schemes in Europe: free tenant vs tenant with rent.
3. Public support: living with parents vs living alone.
4. Incentives to work: minimum income vs minimum wage.

The paper is to make a European comparison but the countries studied have very different costs of living, it is then logical to observe differences in the amounts of public support. That is why I measure a poverty gap index to assess how social assistance systems reduce poverty intensity in each country as well as a marginal tax rate indicator to assess work incentives. The final objective is to propose a typology of countries according to the care of young adults in Europe.

Results
First, the paper shows that the level of minimum income is often but not always correlated with the poverty line. For example, the level of social assistance is relatively low in Germany, France or Finland, while the poverty line is relatively high. The poverty gap, for a single middle-age person living with minimum income, is less than 20% in Cyprus, the Netherlands, Ireland, Belgium, Denmark and Luxembourg. In the opposite, Bulgaria, Latvia and Slovakia have poverty intensity rates above 80%. 7 countries in Europe have lower minimum income scheme for young adults, among them, there are 2 types of strategies. On the one hand, countries that propose a reduced minimum income for young adults (United Kingdom, Netherlands and Denmark) and on the other hand, those that completely exclude young adults from the social assistance (France, Luxembourg, Cyprus, Spain). Thus, some countries are able to effectively reduce the poverty gap for middle-aged people, but not for young adults (poverty gap below 20% for middle age and more than 20% for young adults). The United Kingdom, however, compensate his poor public support towards young people by having generous policies to support rent payment. This country promotes individual autonomy but some other countries in Europe promote family based social assistance such as France and Luxembourg, where parents receive family allowances for young adults living with them. Minimum wage policies are also of great interest to young people because many are paid at this rate. In few European countries, minimum wage earners still receive social benefits. The effect of taxes and social assistance leads to weak financial incentives to enter the labour market in some countries such as Slovakia. On the other hand, the lack of a minimum income for young people in France and Spain creates a strong financial incentive to work. This paper is a basis for questioning a European social protection system for young adults; simulation of potential European reforms will be done to extend this paper.
Using synthesis methods to estimate micro-level data with multiple sources – A simulation study

Authors: Kristina M. Neufang (Presenter) and Ralf Münnich

When setting up a microsimulation, it can be necessary to add research-relevant variables to the base dataset. Especially when registers are not available, survey data and other information have to be considered in order to obtain the required data. A possible way of adding a variable to the base dataset is the use of regression methods: Given the variable of interest only observed in an auxiliary dataset (as well as predictor variables observed in the base and the auxiliary dataset), a regression-model can be estimated using the auxiliary data in order to obtain fitted values for the base dataset. When multiple sources of auxiliary data are available, each source can be used to estimate a specific regression model. Hence, it would be desirable to combine the single models in an overall model.

Addressing this problem, the current study applies methods originally used in the field of meta-analysis: Meta-analysis describes techniques to combine related study results by synthesizing effect sizes. In regression models, the effect sizes to be synthesized are represented by the regression coefficients. The current study focuses on selected synthesis methods to synthesize coefficients in a linear regression context: Becker & Wu (2007) introduced a multivariate generalized least squares approach (GLS-Approach) to synthesize coefficients in case of identical models. Wu & Becker (2013) proposed a factored likelihood method (FL-Method) to also synthesize models with a nested predictor structure.

To obtain informative findings by running a microsimulation, detailed micro-level data is required. By synthesizing regression models based on multiple auxiliary datasets, the micro-level data resulting from the synthesized model should be more precise than only using a single source of auxiliary data. Hence, the aim of the current study is to evaluate both methods concerning their ability to increase the predictive power through the synthesis of:

a) identical models (M1 = M2 = M3: y ~ x1 + x2 + x3) using GLS-Approach or FL-Method
b) nested models (M1: y ~ x1, M2: y ~ x1 + x2, M3: y ~ x1 + x2 + x3) using the FL-Method under different conditions (predictor structure, correlation among the variables, sample size) within a Monte-Carlo Simulation.

The findings indicate that GLS-Approach and FL-Method both increase the predictive power when synthesizing identical models. In case of synthesizing nested models, the performance of the FL-Method depends on the sample size of the full model. Since regression methods take an important part in the context of microsimulation modelling, the use of synthesis methods may not only be advantageous in the described case. Additional fields of application are conceivable, like the estimation of transition probabilities with multiple sources.
Adjusting the welfare system to new labour market risks: Integrating an in-work benefit into the German basic income system

Authors: Kerstin Bruckmeier (Presenter), Jannek Muhlhan and Jurgen Wiemers

Germany has seen major changes in its labour market institutions over the last 25 years. A number of demand side policy measures implemented from the mid-1990s have facilitated the expansion of non-standard, flexible employment (Eichhorst and Marx, 2011). Additionally, standard employment has increased its competitiveness as a result of greater internal flexibility in wage setting and wage moderation (Dustmann et al., 2014). Between 2002 and 2005 reforms of the unemployment benefit system came into force (the so-called Hartz reforms, see Jacobi and Kluve (2007). The reforms were in line with a general move towards an activating welfare state in Europe and led to increased pressure on labour supply. There is a consensus that the past reform processes and changes in the wage structure since the 1990s have contributed to the recently observed decline in unemployment rates (Hartung et al., 2018; Klinger and Weber, 2016; Dustmann et al., 2014; Klinger and Rothe, 2012; Krause and Uhlig, 2012). Meanwhile, unemployment has reached its lowest level since the German reunification and the focus of policy has shifted towards distributional objectives. This policy shift is mainly driven by the lack of progress in reducing poverty. Over the last twenty years, the risk of relative income poverty has slightly increased for working and non-working individuals (Bruelle et al., 2018).

Additionally, concerns emerge about segmented labour markets with disadvantaged groups trapped in low-wage, part-time and short-term jobs (Garz, 2013). With the perceptions that a high level of employment alone does not necessarily eliminate inequalities and poverty (Marx et al., 2012), the quality of employment has increasingly come to the fore of labour market and social policy. A prominent example of this policy shift is the introduction of a general minimum wage in Germany in 2015.

One policy instrument that has become widespread in many modern welfare states to compensate individuals for working in low-paid and unstable jobs are in-work benefits (IWB)(Brewer et al., 2009; Immervoll and Pearson, 2009). Conditional on employment, these policies are designed to redistribute income to low-paid individuals or low-income households. At the same time, in-work benefits should create work incentives for those with a low work capacity. A large number of studies have analysed the effects of in-work benefits on employment and poverty in several countries. While in-work benefits, such as the Earned Income Tax Credit (EITC) in the US or the former Working Tax Credit (WTC) in the UK, can indeed have positive overall employment and poverty reducing effects, also no or even adverse effects for some groups can occur, e.g. for second earners in couple households, (Brewer et al., 2006; Hotz and Scholz, 2003; Blundell, 2000). Simulation studies emphasize the relevance of the particular design of the in-work benefit as well as the interaction with the national tax benefit system for the effects on different households (Vandelannoote and Verbist, 2017; Haan and Myck, 2007; Bargain and Orsini, 2006; Brewer et al., 2006).

In Germany, only for marginal employment with monthly earnings below €450 a lower taxation and subsidized social security contributions are applied. The introduction of this kind of in-work benefit, independent from household income, in the year 2003 was part of a strategy to increase labour market participation among low-skilled people. Distributional objectives have virtually not been taken into account, and there is no evidence pointing to significant positive employment effects of this subsidy (Steiner and Wrohlich, 2005). Instead of an in-work benefit for poor households, several means-tested benefits are available for low-paid or low-income workers to top up low household incomes. Although none of these benefits was designed to
support working individuals in particular, they have a high coverage among low-wage workers and the working-age population in general. Bruckmeier and Wiemers (2018) show, among others, that the means-tested benefits available for working low-income households are characterized by a complex benefit structure, a distinct overlap and interdependencies between benefits, high implicit marginal tax rates as well as high rates of benefit non-take-up.

In this analysis, we examine the potential of an in-work benefit to reduce the complexity of the benefit system and to increase work-incentives and benefit take-up. In contrast to many existing in-work benefits, we do not simulate the introduction of in-work tax credits, but instead implement a subsidy for the employed that is integrated into the social assistance system. We present an empirical analysis of implementing an alternative benefit that closely follows the existing benefit system, is targeted on social benefit recipients and replaces several other benefits relevant for working individuals. Our analysis is based on the tax-benefit microsimulation model of the Institute for Employment Research (IAB-MSM) which includes a sophisticated joint econometric model of labour supply and benefit take-up. The model is based on the Socio-Economic Panel (GSOEP), a representative survey for Germany. We simulate the fiscal, distributional, and labour supply effects of the proposed reform. For households which are eligible to the proposed in-work benefit, we expect substantially reduced (non-monetary) costs of claiming the benefit compared to the status quo, which should lead to a comparatively high take-up rate for the in-work benefit. Our methodology allows us to account for this expected lower take-up cost in our simulations. To further investigate the importance of benefit non-take-up, we assume two different scenarios for the in-work benefit in terms of the assumed take-up costs. As a benchmark for our findings, we compare our results with the simulated effects of several reforms of existing benefits for low-income earners and their families recently adopted by the federal government. This comparison allows us to assess the reforms with regard to the effects achieved and the resources spent on each reform proposal under realistic budget assumptions.

The results show that the integration of an in-work benefit into the social assistance system can achieve stronger effects on labour supply and poverty reduction compared to recently implemented reforms of the government at relatively lower financial expenditures. The main difference between both analysed policies is that the suggested IWB is strictly limited to the low-income households, which is implemented by a strict means-test. The policy measures of the government favour different groups - mainly families and (low-wage) workers from the entire income distribution. Furthermore, the results show that adjustments of the benefit reduction rate motivates recipients to work full-time jobs. However, improvements in earning opportunities for IWB recipients in favour of full-time jobs tend to be associated with an expansion of the benefit’s phase-out range, i.e., an increase in the gross income threshold at which the benefit expires. This can increase the number of benefit recipients distinctly. The sensitivity analysis concerning the take-up of IWB shows that there is a large proportion of households in the IWB phase-out range. Hence, the distribution of wages and net incomes are crucial issues IWB-policies have to consider. A negative result is that the IWB creates incentives for second earners in couple households to withdraw from the labour market. This result suggests that the benefit should be limited to a specific target group. The inclusion of IWB-recipients in active labour market policies, as suggested by the IWB reform, could mitigate this negative effect. On the one hand, non-active partners could still be subject to the activation regime. On the other hand, they could receive support, for example, in finding suitable childcare. In general, the integration of the IWB recipients into the existing social assistance system offers the opportunity of defining employed persons from poor households as new target group of labour market policies. For this group, in addition to monetary incentives, active labour market policy measures and social services could be helpful to stabilise employment and increase upward mobility.
Drivers of Income Inequality in Luxembourg: Isolating the Roles of Policy, Demography, Market Returns and Labour Market Structure

Authors: Denisa Sologon, Emilia Toczydlowska (Presenter) and Philippe Van Kerm

The objective of the paper is to investigate within country differences in income inequality in Luxembourg by exploring several drivers of distributional changes through the Great Recession. Specifically, by integrating micro-econometric and micro-simulation approaches in the way of combining a flexible parametric modeling of the market income distribution with the EUROMOD microsimulation model at multiple points in time, we quantify the role of tax-benefit systems, labour market structures, returns, and demographic composition in accounting for differences in income inequality in the country between 2007 and 2014.

The paper will answer questions such as: Has the tax-benefit system in Luxembourg cushioned the income shocks faced by households since the Great Recession? Or what was the impact of demographic changes on income inequality in the country over time? Which of the drivers of income inequality in Luxembourg is the most prominent over time? Acknowledging that tax-benefit system, labour market structure, earnings returns and demographics in Luxembourg change over time, we built upon a micro-simulation micro-econometric approach by developing a household income distribution model and adapt it over time in order to explore how the changes in each factor impact on disposable income inequality since the GR in Luxembourg.

Our micro-simulation and micro-econometric approach with a household income distribution model extends the approach by Sologon et al. (2018), firstly presented in Bourguignon et al. (2008). As in Sologon et al (2018) and Bourguignon et al. (2008), our income generation model is a system of equations for multiple household income sources with a parametric representation of the link between different components of household income and socio-economic characteristics of households and individuals, completed by non-parametric re-weighting technique to account for demographic characteristics.

The analysis of the distributional differences in Luxembourg since GR revealed that whereas inequality in market incomes has increased, the inequality in household disposable income has remained relatively stable (decreased only slightly). The distributions of income in Luxembourg appear relatively similar in the middle of the income distribution for 2007 and 2014 while the noticeable differences are observed in the bottom and in the top of the income distributions. The incomes of the poorest were lower in 2007 than in 2014 and the incomes of the richest decile were relatively higher in 2007 than in 2014.

By integrating micro-econometric and micro-simulation approaches in a decomposition analysis, we quantified the role of tax-benefit systems, employment and occupational structures, labour prices and market returns, and demographic composition in accounting for differences in income inequality in Luxembourg between 2007 and 2014. Using a decomposition framework, we identified that the inequality decreasing effect was provided by the changes in the benefit and tax policy. The design of the tax-benefit policies has become more redistributive after the crisis due to an increase in the generosity of benefits, benefit regressivity and an increase in tax redistribution. Hence, more poor people benefited from social transfers, the average amount of the transfer increased, and a larger percentage of tax contributions came from high-income earners. Further decompositions revealed that market income inequality increased due to a change in demographic profile of the country with more people improving their education level (getting university degree), due to higher percentage of working age population and higher share of foreigners.
OncoSim cancer microsimulation model: Assessing cancer burden attributable to modifiable risk factors in Canada

Authors: Keiko Asakawa (Presenter), Bill Flanagan, Claude Nadeau, Chaohui Lu, Natalie Fitzgerald, Saima Memon, Jean H.E.Yong, Darren R. Brenner and the OncoSim Technical Working Group

Background: OncoSim is a discrete-event, continuous-time, web-based microsimulation model that projects population-based health and economic outcomes associated with various cancer control strategies. The overarching goal is to provide evidence-based policy evaluations to decision makers through the assessment of user-specific policy questions. To date, OncoSim consists of a series in-depth modules (lung, colorectal, cervical and breast cancers) that simulate risk factors, natural history, screening and treatment associated with these cancers. The model is widely used by decision makers and researchers across Canada as a decision-making and evaluation tool. In a recent release, a new module was developed to expand its projections to 32 cancers and attribute cancer burden to 27 risk factors. The new module also allows users to assess future impacts of modifiable risk factor interventions (e.g., alcohol, physical inactivity) on cancer outcomes using the population attributable fraction (PAF) framework. Objective: To provide an overview of the OncoSim’s new feature on assessing cancer burden and risk. We will explain methodology and demonstrate the model functionality to explore impacts of risk factor interventions on PAFs through a series of scenario evaluations.

Method: The module was built on an existing simulation of demography in OncoSim that reflects historical and projected Canadian population dynamics (births, deaths, migration). Incidence and cause-specific mortality of 32 cancers were modelled based on analyses of the Canadian Cancer Registry. Deaths for other causes were considered as competing events. Direct healthcare costs were taken from the Canadian retrospective administrative data analyses. The methodological framework and data source for modeling PAF were based primarily on the ComPARe study that estimates the cancer population attributable risks in Canada. To estimate PAFs, data on risk factor exposure prevalence and relative risks were used. Cancer cases, deaths and costs attributable to each risk factor were estimated by multiplying model projections of incidence, deaths and costs with PAF estimates. Users can alter exposure prevalence distributions to evaluate impacts of risk factor interventions on outcomes attributed to specific risk factors.

Results: OncoSim estimated that 210,000 new cancer cases would be diagnosed in Canada in 2018. Active smoking would be the largest cancer risk factor, accountable for 38,000 new cancer cases, 25,000 cancer-deaths and $2.5 billion (in Canadian dollars) cancer-related direct healthcare costs. The next largest contributors to cancer burden would be physical inactivity and excess body weight (26,000 new cancer cases and 11,000 cancer-deaths, combined). Preliminary results of the evaluation of risk factor intervention scenarios will be also presented.

Conclusions: The new OncoSim module is a useful tool to explore policy-relevant scenarios associated with risk reduction and cancer burden (incidence, mortality, and direct healthcare costs).
Acknowledgment: OncoSim is led and supported by the Canadian Partnership Against Cancer, with model development by Statistics Canada, and is made possible through funding by Health Canada.
The Distribution of Pension Wealth in Norway

Authors: Dennis Fredriksen and Elin Halvorsen (Presenter)

The concept of pension wealth has been extensively used by economists in theoretical and applied research since Feldstein's seminal paper (1974)1, but in recent decades, due to population ageing, it has attracted the attention from a wider scientific community and from policy makers. Pension wealth constitutes a significant proportion of total household wealth, but few countries have a comprehensive measure of pension wealth at the individual level. There is no simple and unique way of measuring or defining pension wealth. Because this type of wealth may include several different pension benefits and social security provisions, it could be defined in different ways, on a gross or a net basis for instance. In short, pension wealth estimates can be constructed either from calculating the present discounted value of a stream of future benefits, or from a reported current account balance. The definition will also depend on the end use of the wealth measure. If the main goal is to evaluate the sustainability of PAYG pension system, then one would opt for a measure that takes account of all future flows of benefits and contributions to be paid or received by the pension system. At the end of 2019, Statistics Norway plans to present statistics over pension wealth as part of their official wealth statistic for the first time. Thus, since the end use is wealth statistics at the individual or household level, we choose the so-called “accrued-to date” approach.

This study presents these new and unique individual pension wealth data that covers the entire Norwegian population. Wealth data has been collected that covers all three pillars; national insurance scheme, occupational pensions (both public and private) and personal pension saving. For members of defined contribution (DC) plans the accrued value is used, but for defined benefit plans (DB) a sophisticated simulation model, the Norwegian micro-simulation model MOSART is used. With this model we can calculate the present value of future pension wealth under realistic and detailed assumptions about job market behavior, choices of retirement age and individual expected longevity (based on socio-demographic characteristics). The data is used to analyze the distribution of individual pension wealth data and how it relates to the distribution of other personal wealth (both financial and real wealth). In most cases pension wealth becomes liquid at the time of retirement. The present value of future benefits will therefore depend on the timing of retirement. Furthermore, in calculating the present discounted value of a stream of future benefits, the expected longevity and choice of discount rate will obviously be important determinants. Therefore, we analyze the sensitivity of the calculations to choices about discount rates, the timing of retirement, and the stochastic assumptions used in projections of individual longevity.

Finally, we present an analysis of the distribution of pension wealth for all Norwegian persons and households. We consider ownership and the distribution of wealth held in different types of pensions (state, occupational, personal) overall, and by individual characteristics such as age, gender, educational attainment, and industry. Furthermore, we can answer questions such as: How many have zero or very low private pension wealth? How much does pensions contribute to levelling out the wealth distribution? Is occupational pension wealth as unequally distributed as other personal wealth? Do public pensions crowd out private saving for retirement?
Microsimulation models are increasingly used to evaluate the effects of policy changes on the public finance or on the income distribution, thus contributing to policy debates and to academic literature as well (Figari et al., 2015). However, policy makers must rely on the analysis conducted by the academics or analytics of government institutions and wait for their results. Hence, we brought microsimulations closer to policy makers and the public and created a web-based user interface allowing to run a simplified version of the Slovak static microsimulation model, SIMTASK, by themselves. SIMTASK is a microsimulation model of the Slovak tax and transfer system (Siebertova et al., 2015). It calculates all the individual’s personal income tax, the social and health insurance contributions paid by employees and employers. The model also simulates family transfers like child birth grant, child benefit, parental allowance and material need benefit. Simulations also include VAT paid by households.

The underlying database is the Statistics on Income and Living Conditions (SILC) with income reference period 2016. Adjustments to data and weights were made so that the database corresponds to the distribution of labour income, the demography and the economic status in 2019 (Siebertova et al., 2016). Users are allowed to propose and evaluate parametric changes in the Slovak tax and transfer system. There are 63 parameters of the system users can change. The input parameters are sent to STATA program operating on a virtual server which invokes SIMTASK (see Fig. 1). The results simulated by SIMTASK are saved in xml files, they are sent back to users and graphically depicted. Users are able to get their results in 15 seconds.

The static effects of the users’ proposed changes are presented in five tables: aggregated fiscal effects, impact on individuals’ income distribution, impact on households’ income distribution, impact on typical households’ income and impact on income inequalities. Validating the baseline variables against governments forecast for 2019 we found out that the personal income tax is underestimated by 23%, health insurance contributions are underestimated by 12%, social insurance contributions are simulated in line with official forecast and selected transfers
are underestimated by 2%. Therefore, to get relevant numbers, the model’s results are accordingly rescaled when interpreting the aggregated fiscal effects.
This paper examines a novel administrative data source for microsimulations: Income modules for microsimulation models are usually based on survey samples. This is associated with various methodological challenges and requires extensive adjustments. For the first time, the German taxpayer panel – an income register recording the total population of more than 54 million taxpayers in Germany from 2001 to 2014 – is used for dynamic, spatial microsimulations. The data set reveals the full income distribution in Germany and therefore provides an ideal basis to analyse income and its development over time.

The aim is to develop an income module for a large German microsimulation model called MikroSim that is currently being built jointly by the universities of Trier and Duisburg-Essen in cooperation with the Federal Statistical Office. This will provide necessary information to enable a variety of microsimulations in general and particularly for income-related policy analysis, such as tax or family policy reforms. Moreover, income also serves as an important explanatory variable for other modules, such as fertility decisions, internal migration or education opportunities of children.

The strategy pursued to construct the income module is tripartite: First, regional income disparities between family types are examined at the cross-sectional level. Second, the variation of income over time is analysed for employees, self-employed, freelancers and pensioners taking into account some demographic variables as well as regional disparities on municipality level. Due to the purpose of the administrative data, important covariates like education are not available. Yet, detailed income information is provided and data confidentiality is ensured by estimating the models on the highly sensitive micro data inside the statistical office. Third, the synthetic data set is generated and the results are validated.

Mixed model approaches are employed to estimate individual income and the difference in incomes over time. Precisely speaking, different generalized additive models with structured and unstructured spatial effects as well as p-splines are estimated. Where necessary, income disparities over time are modeled following a Markov process. As an alternative methodological approach, in a later stage, it shall be compared whether the use of structured additive distributional regression further enhances predictive performance of income estimates for microsimulations by providing estimates of the full income distribution conditional on the included covariates. Exemplary results are presented with a focus on the group of single-parents whose income is compared to other family types on municipality level.

Once the regression results are published, predictions can be performed by the cooperation partners to add the monetary variables to the base population. The feasibility of this endeavour is continuously checked by forecasting the income components and evaluating the required calibration methods based on the German microcensus which has a similar structure as the synthetic data set. Additional to the usual validation techniques, the results are checked by comparing the predicted income to the self-reported classified income records from the microcensus. The validation process is thus expected to offer interesting insights on the advantages and challenges of using register in comparison to survey data for the construction of new variable sets that allow enhancing base data sets.

The research is developed within the research group MikroSim (FOR 2559), funded by the German Research Foundation.
A multi-purpose agent-based model of the healthcare system

Authors: Florian Chávez-Juárez, Alejandro Blasco (Presenter), Lucy Hackett and Georgina Trujillo

Healthcare, as a whole, can be conceived as a complex system, where more or less direct interactions take place between different agents such as health care providers, insurance companies, regulators and patients. The complex nature of healthcare systems implies significant challenges to policy makers aiming to design far-reaching policy proposals, as happens in many countries that face rising costs and inequalities in care. In order to better inform healthcare debates, we have developed a multi-purpose agent-based model of the health system. The objective of the model is to create a flexible framework for simulating the healthcare systems of different countries in order to analyze public policy proposals ex-ante and to study their impact on a wide range of outcome variables. In its current version, the model can simulate several policy proposals inspired by ongoing policy debates, such as mandatory insurance (US), increases in minimum deductible rates (CH), free provider selection by insurance company versus mandatory contracts (CH), universal free health care insurance (MEX), among others.

Though our model incorporates a wide array of health literature in the determination of different processes and bases its methods and logic on theoretical and empirical research in the areas of health and behavioral economics, this is the first agent-based model of an entire health system that we are aware of. The model is easily adaptable to real-world scenarios and is flexible with respect to the legal and economic environment. It allows for calibration with real-world data, and is value-neutral in the sense that we acknowledge that many political discussions depend on crucial hypotheses on certain behaviours. Our model is designed to achieve maximal flexibility, allowing the user to run simulations under different hypotheses. For example, the user can choose whether providers will care more about the health outcome of their patients (altruistic view) or their financial situation (economic view). Finally, the model is multi-purpose as it is able to simulate various public policies and contexts fairly easily. This model will allow researchers to focus on a wide range of outcomes of potential interest.

The model uses the methodology of agent-based modelling, and is built around three key agents in the healthcare sector: providers, health insurance companies and patients, all of whom can interact and adapt to their context and to other agents’ decisions. The most noteworthy elements included in this first version are (1) endogenous learning of all agents to best adapt to the system’s current state, (2) the possibility of importing data on medical conditions, such as incidence and severity of medical conditions, and (3) heterogeneity between agents, both in terms of characteristics and behaviour. In order to allow for analysing the effect of policy measures on diverse outcomes, the model provides indicators and data on different variables of interest. For instance, the model provides detailed information on healthcare expenditures, the financial burden on families, the health status of each individual, as well as on access and quality of care.

In this study, we mainly focus on the presentation of this multi-purpose model, but we also include some illustrative examples on how public policies can be analysed with the model. These examples have not yet been simulated because we are currently validating the model. We expect to have the full results by late March 2019.
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Tax simulation in an economy with a large informal sector and inequality: the case of Mexico

Authors: Florian Chávez-Juárez, Alejandro Blasco (Presenter), Lucy Hackett and Georgina Trujillo

Tax systems are important structures for financing government functioning and services. They also play important roles in redistributing wealth, altering consumption patterns, and providing (dis)incentives to certain sectors of the economy. However, tax collection faces many challenges in the developing world, particularly in Mexico, where average rates of tax evasion are as high as 31%, with some individual rates of evasion estimated to be above 70% for specific tax schemes. Additionally, Mexico faces high rates of inequality, which distort who comprises the effective tax base both for income and consumption taxes on non-essential goods.

This unique context and the challenges it presents to achieving the goals of tax reform form the basis for our motivation in developing a comprehensive microsimulation model of the Mexican tax system. We seek to reproduce official aggregate statistics of tax collection, evasion and inequality from microdata, and to compare the impact of detailed reforms to the tax structure. Unlike theoretical economic models which are only capable of analyzing abstract changes that may or may not map to real tax structures, our simulator is highly flexible, and permits changes not only to individual rates, but also to subsidies of social programs and exemptions and cuotas for corporate, income and consumption taxes. Important to the design of the simulator is a user-friendly interface which does not require any prior statistical or programming knowledge; this permits the tool to be easily used by policy makers for analyzing the impact of potential reforms. We follow in the footsteps of traditional microsimulation models, applying the tax structure to individual-level data. However, we also incorporate empirical evidence about tax evasion and informal employment in Mexico in order to more accurately reflect the fiscal realities observed. We also incorporate an ad-hoc model of consumption in order to endogenize consumption patterns. This model combines a standard economic model of utility with the recognition that households, particularly those near or below the poverty line, must first meet basic survival and hygienic needs before spending on non-essential items. For the simulation, we utilize a diverse array of data sources, including household expenditure surveys, income and work data, tax records, and economic census data to create a simulator which compares the effect of detailed tax changes on inequality, tax collection, and the distribution tax payments by decile.

We are able to qualitatively reproduce aggregate income tax collection, national inequality measures, and rates of work income that is not taxed. The model overestimates consumption tax collection, a result most likely due to the fact that this first version of the model does not account for the highly informal nature of rural consumption. Simulations comparing the current income tax structure to hypothetical alternatives that are dramatically more progressive reveal that even dramatic changes have little to no impact on inequality measures. This results suggest that the current way to defining marginal tax rates by relatively large income brackets is not well suited to use the tax system as a inequality reducer. The main reason of this result is that due to the extreme inequality, almost all households are within one or two brackets.
Accounting for the distributional effects of the 2007-2008 crisis and the Economic Adjustment Program in Portugal

Authors: Denisa M. Sologon (Presenter), Vanda Almeida and Philippe Van Kerm

Understanding what drives changes in income distributions over time is a central issue in economic research and policy analysis. Various strategies have been used to investigate this important topic. Traditional approaches compute a particular inequality summary index in two different moments in time and then use decomposition methods to break down the observed changes into the contribution of a number of components. Other approaches focus on modelling the market income distribution using parametric and semi-parametric econometric techniques and building counterfactual scenarios that allow for an assessment of the contributions of various factors to the overall evolution of the distribution. Finally, there is a sizeable literature that departs from an observed market income distribution and focuses on assessing the contribution of the tax-benefit system to changes in the disposable income distribution, through the use of microsimulation models. These strategies, while interesting and useful in their own right, have a limited scope, as they refer to the analysis of either a summary measure or only one part of the income distribution.

In this paper we propose a new method that tackles the above mentioned limitations, allowing for the modelling of the whole household disposable income distribution and an assessment of the main drivers of changes in this distribution (or functionals such as inequality measures) between any two moments in time. We build on the approach developed in Sologon et al. (2018), adapting it to study changes in income distributions over time for one single country instead of differences in income distributions across countries in a given moment. The method integrates both a micro-econometric and microsimulation approaches, combining a flexible parametric modelling of the distribution of household market income with the EUROMOD model to simulate the value of taxes and benefits. We generate a multitude of counterfactual income distributions, obtained by “swapping” the characteristics of the country in two different moments in time along four main dimensions: (i) labour market structure; (ii) returns; (iii) demographic composition; and (iv) tax-benefit system. The comparison of these counterfactual distributions then allows us to quantify the contribution of each dimension to the changes in the income distribution (or functionals). The model is constructed on the basis of the European Union Statistics on Income and Living Conditions (EU-SILC) survey, which is available in a harmonised form for all European Union (EU) countries. The fact that the model relies on EU-SILC and uses EUROMOD is a particularly useful feature, as it gives the model the potential to be easily adapted to examine changes in income distributions in any EU country.

We apply this new framework to the study of changes in the Portuguese income distribution between 2007 and 2013. This was a particularly intense period for the Portugal, comprising: (i) the “direct” impacts of the 2007-2008 crisis; (ii) the effects of fiscal stimulus measures adopted in 2008 and 2009; and (iii) the effects of fiscal consolidation measures taken from 2010 onwards, particularly in the context of the Economic Adjustment Program (EAP). The richness of the post 2007-2008 crisis Portuguese experience makes it a particularly suitable choice for an application of our framework. By studying the changes in the disposable income distribution that occurred during this period and decomposing them into the contributions of several key factors we are able to shed light on the distributional consequences of the crisis and aftermath policies, giving useful information for the design of crisis-coping policies and fiscal consolidation programs.
Results illustrate the complexity of the Portuguese post 2007-2008 crisis story and show that it embodies very contrasting developments over two sub-periods: 2007 to 2009, when the crisis had not yet hit in full force and stimulus measures were adopted; 2010 to 2013, when the crisis had its most profound recessive effects and the country was subject to severe austerity measures, particularly in the context of the EAP signed by the government and the Troika in 2011. The fiscal stimulus measures adopted in the immediate aftermath of the crisis determined significant income gains, and were particularly beneficial for households at the bottom of the income distribution. They had an equalizing effect, implying a slight decrease in market income inequality and a significant decrease in disposable income inequality. Automatic stabilisers also played a role, by preventing (the yet small) employment losses from translating into significant decreases in disposable income. The effects of the crisis felt from 2009 onwards together with the austerity measures that began in 2010 took a toll on the incomes of households across the entire income distribution, particularly those at the bottom and at the top. Furthermore, they had a disequalising effect, implying a significant increase in market income inequality and a mild increase in disposable income inequality. Taking the period between 2007 and 2013 as a whole, the income losses between 2010 and 2013 were stronger than the gains between 2007 and 2009 for households at the very bottom and top of the income distribution. For those in the middle, losses and gains more or less cancelled out such that they did not experience significant income changes. Market income inequality increased significantly, but disposable income inequality decreased, as the noteworthy fall between 2007 and 2009 more than compensated the rise between 2010 and 2013.

Several lessons can be drawn from the post 2007-2008 crisis Portuguese experience. First, aggregate crises are likely to have important distributional consequences, beyond their effects on the aggregate economy. Second, implementing fiscal stimulus packages following a crisis can be effective not only at stabilising aggregate outcomes but also at rendering the income distribution more equal. Conversely, the implementation of austerity measures may reinforce income losses induced by the contractionary effects of the crisis and reduce protection of the poorest. Third, beyond the effect of discretionary changes in tax-benefit rules, automatic stabilisers may be crucial at minimising income losses and preventing a rise in income inequality following a crisis. The bottom line is that government policies may significantly impact the heterogeneity of the effects of a crisis on households’ incomes, determining important income gains or losses for different income groups. When facing rising unemployment, decreasing aggregate activity and growing budget deficits, following a crisis, governments need to take into careful consideration the distributional impacts of their policy choices, searching for a balance between stabilising aggregate outcomes and shielding households from extreme and unequal income changes.
Two of the biggest challenges for the German transport sector appear to be reaching their peak these days: On the one hand, the advancing global warming requires stronger CO2 reduction goals while on the other hand health hazards due to air pollution lead to bans on older diesel cars from more and more German cities. Therefore, policy instruments like environmental taxes gain in importance. A first step in this direction had already been taken some years ago by the European Commission (2011), proposing an amendment of the EU Energy Taxation Directive. The amendment defined the ratio of the tax rates for transport fuels according to their CO2 content. In several European countries, including Germany, this would have led to an inversed tax rate ratio of diesel and petrol and therefore to the abolishment of the diesel tax privilege. Although national governments had blocked the initiative, calls to reassess the diesel privilege reappeared in the aftermath of the Dieselgate scandal. However, conflicting priorities of economic interests and social acceptance hampered political action so far. The recent international protests against rising energy and fuel costs demonstrate the potential risk for governments to raise excise duties, such as the energy tax, without adequately addressing their sensitive distribution issues. Despite the extensive scientific literature on the distributional effects of fuel taxes, detailed insight into the social, ecological and economic consequences on private households in present-day Germany is still lacking. This study examines the social ramifications of the proposed amendment of the EU Energy Taxation Directive for Germany. The morning-after effects of two revenue neutral tax reforms are analysed. In the first scenario, the energy tax rates for different types of fuels are adjusted to the ratio of their CO2 content. Hence, the tax rate for petrol decreases and the tax rate for diesel rises, resulting in a considerably higher market price for diesel compared to petrol. The second scenario abolishes the vehicle tax, while maintaining the energy tax ratio of the first scenario. Compared to the current tax levels, this results in higher energy tax rates for all fuel types. The household expenditures on taxes induced by these two scenarios are compared to the status quo.

To simulate the energy and vehicle tax for the stock of passenger cars of private households in Germany the microsimulation model CARMOD is currently developed at the Fraunhofer Institute for Applied Sciences FIT. The model is based on the microdata Mobility in Germany 2017, the world’s largest survey on private mobility. This extensive database provides a broad variety of socio-economic household characteristics with spatial details and information on mobility patterns. The data has been enhanced with car specific information on fuel consumption as well as CO2 and NOx emissions, allowing for a precise estimation of the households’ tax burden. Missing data is thoroughly imputed applying statistical methods. Previous findings are reviewed in this study using a more comprehensive and most up-to-date database. With the substantially larger sample size, it is now possible to measure distributional effects by indicators of progressivity and redistribution. For the first scenario, previous findings give reason to expect a financial relief for more than two-thirds of the car-using households, with particularly low-income households benefiting. The extent to which these results have changed will be subject to the pending simulations. While the fuel type almost entirely defines the winners and losers in the first scenario, there will be more complex effects in the second scenario. By precisely modeling the shift of the households’ tax burdens the results not only
add to the scientific discourse but can serve as a foundation for evidence-based policy decisions.
The possibility of becoming severely cognitively impaired is among the most important risks facing older adults and their families. In addition to the emotional and physical toll associated with dementia, the financial consequences can be overwhelming, as many patients require expensive paid care. In the United States, these costs are often borne out of pocket. Public help is primarily available through the Medicaid program, which has stringent income and asset tests; a patchwork of smaller programs serve veterans and residents of local communities. Although proposals to expand access to long-term services and supports have languished at the federal level, many US states are now considering developing their own programs to fill these gaps. These state efforts are generating a need for models that project the potential cost and distributional effects of alternative proposals.

Projections of future care needs and costs are difficult because the older population is changing in ways that will likely shape the course of cognitive impairment. Such changes include evolving population educational and health profiles. This study uses the Dynamic Simulation of Income Model (DYNASIM) to project the risk and costs of severe cognitive impairment at older ages in the United States over the coming decades. Using multiple data sources and sophisticated econometric techniques, DYNASIM simulates the future population and its characteristics, projecting financial resources, disability status, medical conditions, cognitive status, and use of long-term services and supports. Unlike most past research, this study shows how severe cognitive impairment and associated costs vary across the population, with a focus on differences by education and income.

Our paper and presentation will highlight some of the challenges that we have faced that are common for those building dynamic microsimulation models. For example, data are limited and measurement is very challenging. Estimates from high-quality studies can differ greatly depending on the measurement approach and sample population; many of the studies with the most sophisticated diagnostic information are community-based and not nationally representative. These data limitations and inconsistencies create spillovers into model specification, as analysts must try to capture the dynamics of cognitive decline in a context with vulnerable respondents who have high death rates. Survivors may be difficult to follow, so compliance by proxies/surrogates is critical. Learning effects may affect results from cognitive tests for those followed over time. Data from health care provider payment records may offer important supplemental information, but those with dementia are often being treated for other chronic conditions, and some of the most important payment information is not tracked. Moreover, developers must decide how to integrate trends observed in recent years in nationally-representative data but not all community-based studies.

We describe how we are approaching these challenges and welcome a discussion with others engaged in this research space.
Design Options for a New Microsimulation Model for Retirement Income in Canada

Authors: Chantal Hicks (Presenter), Kevin Moore, Martin Spielauer

The government of Canada has proposed building a new large-scale microsimulation model which would allow for analysis of retirement income outcomes, with an early focus on the Canadian Pension Plan (CPP). Two previous dynamic microsimulation models existed in the government of Canada addressing these issues: DYNACAN and LifePaths. The termination of both projects has left a gap for policy analysis in government. SIMUL, a model developed by academics, started with a Quebec focus and is still being maintained. Concerning model design, SIMUL, DYNACAN and LifePaths followed very different approaches, a diversity also observed in existing pension microsimulation models internationally. This variety reflects differing priorities, data availability and restrictions, as well as current or past technical choices and limitations.

Some of the design options relate to model architecture. How should a population be created? When should a simulation start? How does time evolve in the simulation? Should families be modelled one at a time, or should the entire population be run at the same time? Does the model allow for alignment? Should spouses be found within a closed population? Other design options relate to what data should be used. Administrative data which would restrict the accessibility of the model due to confidentiality? Public-use data which would restrict the level of detail that is available and are of limited sample size, but increase accessibility? Synthetic data which might overcome sample size and confidentiality issues, but requires additional modeling efforts and might be difficult to communicate?

The aim of this paper is to develop some concrete design options, identify their trade-offs, and compare them applying a set of criteria being considered. As some design goals cannot be achieved simultaneously, we also explore some hybrid models, which can be run in alternative modes.
Objective: The term dementia is used to describe a set of symptoms associated with a decline in mental functioning. While dementia primarily affects older individuals, it is not part of healthy aging. It has a variety of causes, including Alzheimer’s disease, which is the most common cause of dementia. Globally, the prevalence of dementia is expected to double in 20 years. Increases in the prevalence of dementia will likely result in large demands for caregivers and supportive services, which will be challenging to address. Population-based dementia models have been created to support planning by projecting the number of people living with dementia and by allowing the examination of counterfactual scenarios that may ameliorate or exacerbate dementia’s societal burden. However, current dementia models have been criticized as being overly simplistic. The objective of this research project was to create a dynamic microsimulation model to project dementia burden in Canada from a societal perspective that included the health impacts as well as direct and indirect health care (out-of-pocket costs and informal caregiving) costs.

Research questions: n/a

Theoretical framework: n/a

Methodology: We sought to project the prevalence of dementia and its related health and health care burden in Canada from 2011 to 2031. To do so, a new microsimulation model – POHEM (Population Health Model) Neurological – was developed at Statistics Canada in collaboration with the Public Health Agency of Canada. Within POHEM-Neurological was created a population-based microsimulation model of Alzheimer’s and related dementias (POHEM:Neurological) using Canadian demographic data, estimates of dementia incidence, health status (health-related quality of life and mortality risk), health care costs and informal caregiving use. Dementia prevalence and 12 other measures were projected to 2031.

Results: Between 2011 and 2031, there was a projected two-fold increase in the number of people living with dementia in Canada. The projected number of deaths among people with dementia also increased from 2011 to 2031. By 2031, the projected informal (unpaid) caregiving for dementia in Canada was two billion hours per year, or 100 h per year per Canadian of working age. The direct health care cost for people with dementia was $9.2 billion CDN in 2011 ($27,000 per-person cost), which was projected to increase to $18.2 billion in 2031. The highest cost sectors were long-term care (46 % of total cost) and hospitalization (27 % of total cost). Future developments for the dementia model will include updating the incidence calculation to include modifiable risk factors like smoking and alcohol intake.
Microsimulation models are commonly used to predict future developments in several societal areas (health, traffic, finances, demographic transition etc.). The quality of such predictions strongly depends on the quality of the empirical input. In addition to the need of high-quality empirical starting data, the rules for updating this data during a microsimulation can also be derived from empirical data.

This brings up two main challenges. Firstly, developments on the individual level have to be estimated accurately. This can be done by dynamic panel models in which state dependence (effects of lagged dependent variables) is separated from time-invariant unobserved heterogeneity (modeled by a random intercept). It is desirable to distinguish between these two aspects in microsimulation models. This is so, as for updating a life course of an individual person, one needs to know whether future values of a dependent variable are influenced by the past (state dependence), or if the level of the values of the dependent variable just results from unmeasured time-invariant characteristics of this individual (unobserved heterogeneity). However, it is difficult to obtain unbiased estimates in models that are designed to answer this question. For example, the inclusion of a lagged dependent variable (LDV) as an explanatory variable – which is a popular approach in panel data modelling to detect true state dependence or reverse causality – introduces an endogeneity bias, because the LDV is associated with the error term. Some approaches, which try to overcome these problems, will be presented. These include models that use internal instruments (lags of already involved variables, e.g. longer lags of the LDV) for handling endogeneity (e.g. Arellano-Bond estimator using Generalized Method of Moments – Arellano, Bond 1991). Another method to solve endogeneity problems that will be discussed is a structural equation modeling approach based on Maximum Likelihood (ML-SEM – Williams, Allison, Moral-Benito 2018).

Secondly, it is challenging to transfer the results from these models into a microsimulation model when the starting data (simulation sample) does not coincide with the estimation sample, which is typically the case. The biggest difficulty arises from the fact that random intercepts are unknown for persons in the simulation sample. These values have to be imputed. Some simple approaches exist. Unfortunately, these methods often lead to substantial forecasting errors in microsimulation models (due to a large difference between true and imputed random intercepts). However, Richiardi (2014) developed a method to impute random intercepts by exploiting empirical information from the simulation sample (Rank Method). This method can reduce the forecasting error dramatically. It is already useful for panel models without endogenous dynamics like standard fixed or random effects models. We will present this method and strategies to extend it to dynamic panel models. This extension to dynamic panel models is especially challenging, because additional empirical information is needed (e.g. subsequent values of a variable from more than one point in time) when an effect of a lagged dependent variable is included in a model that also contains a random intercept.

For several models, these implementation strategies have been tested with empirical and synthetic data. The results will be presented, focusing on the short-term forecasting quality of these strategies for dynamic microsimulation models.
Building a microsimulation model to predict future health of Canadian population: developing a framework and prototype model

Authors: Olga Krylova, Koffi Kpelitse (Presenter), Byron Cotnam, Jeff Hatcher, Yvonne Rosehart, Petros Pechlivanoglou, Hawre Jalal and Fernando Alarid-Escudero

The Canadian Institute for Health Information (CIHI) is developing a multi-disease microsimulation model to predict the future health of the Canadian population and the burden of common chronic health conditions. Building a comprehensive model that would be used for policy decision making is a challenging and time-consuming endeavour. Therefore, we started by building a prototype model with a subset of common chronic conditions. This paper describes the steps taken to develop the conceptual framework of the comprehensive model and the implementation of a prototype microsimulation model, which forms the basis for the future multi-disease model.

We conducted a systematic literature review of existing microsimulation models and techniques. We then engaged with Canadian and international experts to understand the opportunities and challenges with building and using such models for policy decisions. We also performed extensive consultations with our provincial stakeholders regarding their needs and requirements for the model so that it is useful and applicable in their decision making process. Our study draws on unique complete population administrative data linked across multiple sectors of health care. It includes demographic, financial and clinical information from patient interactions with hospitals, emergency departments, primary care and long-term care over a period of five years. The CIHI’s population grouping methodology is then applied to this data to create a health profile for each person in the population, which provides a comprehensive picture of the population health status.

To identify the appropriate methodology for the multi-disease model, we built a prototype model with two health conditions: Chronic Obstructive Pulmonary Disease (COPD) and Congestive Heart Failure (CHF). We chose these health conditions based on the interest from our stakeholders. Each disease is implicated in exacerbations of the other condition, greatly increasing hospitalizations and associated health care costs. The prototype model will help to understand future impact of this interaction and develop better health care plans. For our prototype model, we used a closed population with no births and migration. We developed a dynamic discrete-time microsimulation model, where individuals can transition between five health states, based on annual transition probabilities that are function of demographic characteristics and health profile. The health-related risk-factors do not change with time and the model focuses on short-term (5- to 10-years) projections. We estimated the transition probabilities of this model with multinomial logistic regressions. As a structural sensitivity analysis, we also estimated the transition probabilities with other statistical methods, such as survival multi-state models. Summary statistics for the population are computed by aggregating individual results.

With the model, we predict the prevalence of COPD and CHF and number of deaths over ten years. We also examine how healthcare resource utilization (number of primary care visits and ED visits) varies between people who have both COPD and CHF and those who have only one condition. Our next step is to expand the prototype model to include a broader number of diseases. The multi-disease model will provide a full picture of the morbidity and mortality of the population and future healthcare needs, with key applications for health policy makers, planners and funders. Building a conceptual framework and a prototype model are the first key steps in the model development, which will be presented at this talk.
Creating a synthetic database for use in microsimulation models to investigate alternative pharma-care programs in Canada

Authors: Deirdre Hennessy (Presenter), Carleigh Busby, Jackson Chung, Laurie Plager, Jennifer Jones and Chantal Hicks

Objectives: In recent years government spending on prescription drugs has grown in Canada. At the same time, a proportion of Canadians are still unable to access prescription medicines because of their cost and/or find it necessary to cover prescription medications through out-of-pocket spending. The objective of this study was to develop a synthetic database which would be used with a microsimulation model to investigate alternative pharmaceutical (pharma)-care programs in Canada. The Social Policy Simulation Database (SPSD), developed by Statistics Canada was augmented with a variety of prescription drug use/costs and health related information from drug expenditure data and national health surveys. The Social Policy Simulation Model (SPSM) is a microsimulation tool that has been used to investigate financial interactions between governments and individuals in Canada. Combined, the augmented SPSD and SPSM will be used to investigate alternative pharma-care programs in Canada.

Research questions: N/A

Theoretical framework: N/A

Methodology: Data on health status, disease status, drug use, insurance status (drug and dental), out-of-pocket spending on prescription drugs and dental care, and aggregated drug expenditure data were drawn together from population-based surveys (including the Canadian Community Health Survey (CCHS), the Canadian Health Measures Survey (CHMS), Survey of Household Spending (SHS) and IQVIA Canada Inc.). These data were assigned to individuals in the CCHS 2013/2014 (host health dataset) through statistical matching and imputation techniques. The resulting health dataset was merged with the SPSD using categorically constrained matching.

Results: The SPSD health database was validated and generally showed good agreement with the datasets used to construct it. The distributions of statistically matched variables were investigated by important sociodemographic and health variables and will be presented. The SPSD health database represents the integration of a wide range of high quality health data sources, including national health and expenditure surveys and data for drug costs. Using the augmented SPSD with SPSM, policy makers will be able to investigate alternative pharma-care programs and their monetary impacts on individuals and families in Canada.
The Development of Reporting Guidelines for Public Health Non-Communicable Diseases Modelling Studies

Authors: Doug Manuel (Presenter), Adam Briggs, Laura Webber, Oliver Mytton and the Expert Advisory Group

Background
Public health non-communicable diseases (NCD) modelling studies quantify the health impact of changes in risk factors for NCDs without directly measuring health impact. As in other areas of science, there are concerns that NCD modelling studies lack transparency. There are also concerns about the quality of published studies, with judgements on quality being hindered, in part, by incomplete or inadequate reporting. These concerns potentially undermine and reduce the use of models to support public health planning. The development of reporting guideline in health research is a well-established field with over 400 published guidelines that are endorsed by dozens of journals and organizations. The EQUATOR Network (Enhancing the QUAlity and Transparency Of health Research) supports the development and dissemination of reporting guidelines.

Research aim
To develop, publish and support the uptake of internationally agreed upon guidelines for undertaking and transparently reporting NCD public health modelling studies to improve the quality, validity and transparency of these studies.

Methodology
The development of the reporting guideline uses the methods published by the EQUATOR network. The development will follow the five-step process outlined by EQUATOR: literature review; online consensus Delphi consultation; expert consensus meeting (face-to-face); writing of guidelines by small committee; dissemination.

Results
The development process has begun with the following results. Published literature reviews did not identify existing NCD modelling reporting guidelines, but research teams and background studies were identified. Also identified were related guidelines such as CHEERS for health economic modelling, ODD for agent-based modelling, GATHER for synthetic estimates of descriptive epidemiology, STRESS for strengthening the reporting of empirical simulation studies. The literature review identified studies that were presented at previous International Microsimulation Association meetings. An international online consultation was performed. Included were 61 participants from 10 countries who had broad methodological and topic expertise. Participants included modellers, journal editors as well as those with other expertise, e.g. those who commissioned or used modelling studies to inform practice. There was a very strong consensus (98% support) about the need to develop reporting guidelines for public health modelling studies. In particular, participants commented on inconsistent and, at times, poor reporting that hindered understanding and reproduction. Participants also highlighted the need for guidelines to underpin scientific review, as well as an opportunity for guidelines to support comparative modelling and facilitate methodological development. Based on the online consultation, a scope of the reporting guidelines has been established and registered with the EQUATOR network http://www.equator-network.org. The development team has now established, and are seeking to grow, an international network of public health...
NCD modellers who will collaborate to produce the guidelines. The team is currently seeking funding to develop the guidelines, and if successful work will begin in September 2019 and the guidelines published in summer 2021. Updates to the study will be published at http://www.mrc-epid.cam.ac.uk/ph-modelling-guidelines/
Comparative Analysis of Different Imputation Methods to Impute Expenditures into an Income Dataset

Authors: Elif Cansu Akoğuz (Presenter)

Large and high-quality datasets containing both income and expenditure data hold many promises for micro-simulation purposes. However, such datasets are seldom found. In order to perform simulations that require both data, one needs a reliable imputation procedure to merge the two datasets together. This paper compares three imputation methods - Engel Curves, Hot Deck Matching and Predictive Mean Matching - both theoretically and empirically, benefitting from the 2014 Household Budget Survey of Belgium. We evaluate the methods in terms of their performances in 1) preserving the variance of variables, 2) preserving the correlation between variables and 3) minimizing the distance between observed and imputed values. The conventional Engel Curves imputation performs better in terms of minimizing the distance while it performs worse in terms of preserving the variance & covariance structure. Therefore, we modify the Engel Curve imputations by adding random errors and examine whether its performance can be improved in the latter aspect.
Intergenerational Transmission of Informational Disadvantage: A New Approach to Immobility across Generations

Authors: Elif Cansu Akoğuz (Presenter)

Social networks are known to play an important role in finding job opportunities. Nevertheless, their implications on income distribution or mobility are rarely studied. This paper provides a framework that facilitates theoretical analysis of the implications of ‘social network inheritance’ on mobility. We built an agent-based model where agents use their connections to get job information and parents prioritize their children while transferring information. The model is simulated with different network densities and economic segregation levels. The results suggest that the higher the segregation between economic classes is the more the parental advantage hinders the equality of opportunity. Increasing network density decreases this effect to an extent by diffusing information; however, high levels of economic segregation reduce the compensating effect of high network density by hindering information diffusion. Despite that, a highly segregated network still produces higher levels of mobility compared to no network. Both the marginal effect of an additional connection and the effect of social segregation diminish as the network density increase.
This paper gives an overview of a validation framework for complex simulation models. Errors or bugs in simulation models can be common and hard to detect due to complex internal logic, interactions with large and noisy input data, and unintentional human errors. However, even a minor error may sometimes lead to substantial deviations in the results, misleading the users. This paper proposes a framework of validation, which systematically verifies the implementation of the parameters, policies, computation logic, integrations and the overall design of a microsimulation model. We apply this framework to STINMOD+, a tax and transfer microsimulation model developed at NATSEM, and demonstrate how it is used to reduce the errors in the model. The paper also discusses how the framework can be applied automatically so that the model can be continuously validated against possible errors with no or limited human interventions. Such a framework can potentially be generalised to other simulation models.
Economic Cost of Type II Diabetes in Australia

Authors: Laurie Brown (Presenter), Hai Anh La and Jinjing Li

Type II diabetes is an increasingly prevalent disease in Australia and poses a substantial burden on the economy due to the medical and social cost. Existing research mainly focuses on the direct economic burden of diagnosed diabetes and the cost associated with increased health resource use and lost productivity. The changes in the lifestyle and behaviours due to the disease however, also incur additional cost compared with a healthy individual. Few studies have examined the impact of the disease on the general living standard due to the lifestyle change and its spillover cost to family members, as the indirect cost may be difficult to assess and quantify.

This paper addresses this particular gap in the literature and uses the compensation variation approach to estimate the cost of type II diabetes in Australia as the amount of additional income required by families with diabetes patients to reach an equivalent standard of living as their healthy counterparts. Using the latest Household Income Labour Dynamics Australia (HILDA) survey, we estimate the cost of diseases by non-parametrically matching households with and without diabetes patient based on their common characteristics and their living standards. We further simulate a number of policy options that could reduce or eliminate the gap in the living standards and estimate the poverty and budgetary impact via a microsimulation model.
The Distribution of Private and Fiscal Returns to Higher Education: A Dynamic Microsimulation Approach

Authors: Benjamin Fischer (Presenter) and Dominik Hügle

We quantify the individual and fiscal life-cycle returns to higher education in Germany accounting for the financing of education, redistribution through the tax-and-transfer system, and cohort effects. To this end, we build a dynamic microsimulation model that simulates life cycles of a single cohort in terms of several key variables of interest, such as labor force participation, employment, wages, fertility, marriage, and divorce. To estimate the rates of return to higher education, we link our dynamic microsimulation model with a tax-benefit calculator that allows converting gross wages into disposable incomes, accounting for the various interactions between income tax, social security contributions and social transfers at the individual and household level. At the individual level, we find median returns of 5-7% for men and 10-11% for women. Looking at the distribution of returns, a considerable share of individuals in our simulation has negative returns. Fiscal returns are positive for women and negative for men.

Motivation
In 2016, 52% of German school leavers faced the decision whether to enter higher education or vocational training. At the same time, universities are highly subsidized by taxpayer money in Germany. An important question is therefore whether completing higher education pays off financially both for the individual and for the state and to what extent these returns depend on the design of the tax-and-transfer system. The traditional Mincerian (1974) approach to estimating (internal) rates of return to education has been shown to depend on strong assumptions, such as the absence of tuition costs, (progressive) income taxation, interaction effects between schooling and experience, and working life effects of schooling levels (Heckman et al. 2006, 2008). Long-term household panel data allows to relax these assumptions and to analyze the distribution of returns to education, but is rarely available. A remedy is offered by microsimulation methods which allow to simulate individual trajectories (Li and O'Donoghue, 2013). We follow this approach to estimate the distribution of returns to higher education for the German 1985 birth cohort.

Literature
Courtoux et al. (2014) and Courtoux and Lignon (2016) analyze the distribution of private returns to higher education for France and find that there is a significant risk of low and negative returns for some diploma types. Furthermore they show that that for women, marriage market returns to education play an important role. For Germany, Pfeiffer and Stichnoth (2015) estimate private and fiscal returns by constructing full life cycles from a single cross-section, and find that individual rates of return shrink considerably after accounting for taxes and transfers.

Method
We apply the dynamic microsimulation approach and simulate individual life-cycles of a single cohort in terms of employment, wages, fertility and household formation from young adulthood to retirement, using German household survey data, the Socio-Economic Panel (SOEP). Including the household dimension allows to account for the large number of marriage and
household specific rules in the German tax and transfer system. Moreover, employment behavior depends crucially on partnership status and the presence of children in the household. Transitions probabilities are derived from discrete-choice models and aligned to estimated aggregate targets that account for cohort effects. Finally, using a tax-benefit calculator, we translate the simulated individual gross labor incomes into disposable household incomes.

Simulation Results
At the individual level, we find median returns of 5-7% for men and 10-11% for women, depending on the assumption about the extent of income sharing in couples. Taking into account redistribution by the tax-transfer system shrinks the returns considerably. The share of negative returns is sizeable, with about one fourth for women and one third for men. Fiscal returns are positive for women (9%) and negative for men (-8%), with a large fraction of negative returns.
Predicting long-term population health of sugar-sweetened beverage taxes: A microsimulation approach

Authors: PhuongGiang Nguyen (Presenter), Tadeja Gracner, Irene Vidyanti and Roland Sturm

Background: Taxes on sugar-sweetened beverages (SSB) are commonly proposed as an obesity-prevention policy. Its long-run population effects are hard to estimate: Even if taxes reduce consumption, individual risks for chronic conditions change by small amounts and aggregate to large changes in population prevalence rates only after many years. Health benefits may be unequally distributed as subpopulations differ in purchasing patterns, consumption levels of sugar-sweetened beverages, and current health risks.

Objective: We use microsimulation to predict the potential health and economic consequences of a 10% and 20% SSB tax applied nationwide in the US over a time horizon of 30 years. Of particular interest are differential effects by sex, education, and race/ethnicity.

Methods: We combine a dynamic micro-simulation model for population health, the Future Americans Model, with price elasticities from published literature and current consumption levels from a national dietary survey. We project the prevalence of obesity, related chronic diseases and disability for the next 30 years (through 2050) comparing status quo (no taxes) to 10%, and 20% taxes on SSB.

Results: Implementing a national SSB tax in the U.S. would lead to a decrease in SSB consumption by 16%. By 2050, we estimate a 10% tax would lead to a decrease in 10 million cases of obesity, 2 million cases of diabetes and 476 thousand cases of heart disease. Total quality-of-life-adjusted years is projected to increase by 1 million, and medical care spending projected to decrease by 40 billion USD. Most of the health benefits and cost savings accrue to males, those with lower educational attainment, and Hispanics and blacks.

Conclusions: Over a 30 years prediction horizon, simulations show that a national tax on SSBs would lead to a decrease in SSB consumption, which translates to a decrease in obesity, decrease in chronic disease prevalence, increase in quality-adjusted life-years increase, and net medical cost savings.
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Tax-benefit reforms and the anti-poverty marginal benefit of public funds in Belgium

Authors: Diego Collado (Presenter)

During the last decades in Belgium, tax-benefit reforms that deal with the interrelated challenges of poverty, labour market participation and tighter government budgets have been implemented. At the same time, there have been changes in the environment in which policies operate. It is then relevant to evaluate tax-benefit reforms using a framework that can accommodate all these elements. We do so by estimating the poverty gap index reduction per euro of net revenue that the (cash) tax-benefit reforms implemented between 2005 and 2014 provoked, separating their impact from the environment in which they operated and accounting for reform-driven labour supply reactions. We focus on households at the bottom half of the income distribution and utilise (‘no population change’) counterfactual income decompositions to isolate the effect of reforms. Without taking into account labour supply reactions, reforms reduced the average poverty gap at the bottom half of the income distribution in €3.5 at the cost of a reduction in net revenue of €38 per person. This meant a ratio of €0.09 of poverty gap reduction for each euro of net revenue decline. However, this decreases to €0.05 when including labour supply reactions because policy changes reduced the probability of being in the labour market. This reduction was due to the fact that unemployment benefits grew faster than in-work compensations. These results highlight the importance of looking simultaneously at potential reforms to in- and out-of-work tax-benefits.
The inequality of public pension benefits of the elderly using Estonian data

Authors: Magnus Piirits (Presenter)

Estonia is one example of the World Bank’s three-pillar pension system but with its own characteristics and a peculiar history. Inequality of Estonia’s old-age retirees’ income is one of Europe’s lowest. Although currently in Estonia, the ratio is low compared to other European countries then it will not stay low because the pension reforms start to change it because pension depends on around 70% from the individual wage. The paper tries to answer to the following three questions:

• What is inequality during 2017-2100 of the World Bank recommended three pillar pension system in case of Estonia?
• How the reforms of the first pillar affect pensions inequality?
• How much could the pension system reduce income inequality?

This paper seeks to assess inequalities from the perspective of the generations, in other words, an analysis of the inequalities intergeneration’s and intrageneration. The assessment of inequalities within generations considers horizontal and vertical equality. Horizontal equality must take into account the differences between people: age, size of the family, etc (Barr 2012) and, in view of these, people must be treated in the same way (Atkinson and Stiglitz 1980, Clements, Eich, and Gupta 2014). Vertical equality must take account of people’s incomes and the redistribution of income must be directed at people with lower incomes. (Barr 2012) The distributions between the cohorts are also significantly influenced by reforms that make the pension system more actuarial or vice versa. It is therefore important whether the pension system is completely solidarity-based (everyone gets the same regardless of the contribution), intermediate or totally wage-dependent. If the average productivity of people before and after the transition is the same, the transition from one system to another does not produce direct cohesive distributional effects (Lindbeck, Persson 2003). For example, Davies (2009) found that contribution-based pensions have a lower levelling effect than the previous defined benefit pension system. Olaf van Vliet et al., who had studied pension indicators in 15 European countries between 1995 and 2007, came to the opposite result and found that reforms did not increase the risk of poverty or inequality among the elderly, but add that not yet (van Vliet et al. 2012). However, it can be assumed that reforms are targeted at the following cohorts in the countries, and therefore the effect of the reforms is not yet visible. At the same time, the same authors found in the repeat study involving more countries and expanding the time frame, similar results as previous authors, but the opposite results to their previous research. (Been et al. 2016)

In order to meet the findings of the aim, a population microsimulation model has been developed. The proposed population (1.3 million person) microsimulation model is used to simulate all three pillar (state, mandatory funded and voluntary funded pension) pensions. Registry data is used for microsimulation: 1) Social Insurance Board micro level data about pension rights of already retired and still working people; 2) Estonian Central Register of Securities micro level data about second and third pillar; 3) Estonian Education Information Board micro level education data. Macro level data about mortality, fertility and macroeconomic projection. Replacement rates, Coefficient of Gini and other indicators are used to fulfill the objectives.

Although all three pillars are linked to wage in large scale then the results of the microsimulation model show that inequality of pensions raise slowly. The adopted pension reforms at the end of 2018 (linking retirement age to life expectancy, decrease of wage part in
pay-as-you-go) do not change the inequality significantly and rather increase it. The pension reforms are needed in sustainability point of view because without of the reforms pay-as-you-go scheme would be in deficit, at least until 2050. The pay-as-you-go scheme would be raised from deficit to excess in the future with all adopted pension reform changes.
Comparison of sample free and sample based synthetic populations

Authors: Robert Tanton (Presenter), Nam Huynh, Yogi Vidyattama and Johan Barthelemy

Synthetic populations are used where unit record data are needed for analysis, but there is no unit record data available. This analysis may include modelling that needs unit record data like microsimulation or agent based modelling, or there may be a need to impute characteristics onto a population, like health.

Broadly speaking, synthetic populations can use one of two methods; sample free and sample based. A sample free method uses reliable aggregate cross-tabulations for each small area for which the synthetic population is required, and creates a synthetic population using Iterative Proportional Fit methods from an initial simple population, usually based on an Age/Sex table. A sample based method uses a unit record file from a sample survey to select people into each small area, based on the same reliable aggregate cross-tabulations as used for the sample free method.

This paper compares these two methods, comparing how reliable the results are from each method, the distribution of people in each area, and finally how long each method takes when run on the same computer. The results show that if both person and household benchmarks are required, then the non-sample based synthetic method is the best method to use. The other advantage of this method is that a survey unit record file is not required; however it does not provide all the variables that were in the survey for analysis, which is a significant advantage of the sample based approach.

If only person (or only household) level benchmarks are required, then a sample based synthetic population is the most efficient, flexible (in terms of having all the variables on the survey available in the synthetic dataset), and accurate method.
The Importance of Fiscal measures in Financial Incentives for Land Use Decisions

Authors: Mary Ryan (Presenter) and Cathal O'Donoghue

The question of what motivates decisions to change land use or farm management practices is a complex one which has recently received much attention in the context of designing policies to incentivise change. This paper uses Ireland as a case study to critically analyse aspects of the prevailing policy incentives, with a view to identifying how different financial instruments influence uptake. There is already extensive literature on farm-level modelling which focuses on farm subsidies (see Ahearn et al. 1985, Keeney 2000, Bhaskar and Beghin 2009) and previous quantitative studies in the literature focus only on gross income, which is a combination of market income and subsidies. However net income should also be considered as tax incentives can be quite important in relation to the determination of disposable income in farm-level decision making (Andersen et al. 2002, Hill and Cahill 2007). In reality, when an incentive is offered, the wider household is affected and other income-related instruments may have implications for the farm family. For instance, in Ireland there are means-tested financial instruments for working-age farm families (Farm Assist) and (non-contributory) pensions for retirement-age farmers. To understand the impact of tax incentives on farmer behaviour, a hypothetical microsimulation model of agricultural and forestry taxation was developed, utilising a framework similar to that used in benchmarking studies such as the International Farm Comparison Network (IFCN) (Hemme et al. 2000). This study illustrates the importance of the benefits and income-tax components of disposable income on hypothetical extensive and intensive cattle and dairy farms. From a household welfare perspective, the inclusion of benefits and taxation in the calculation of life-cycle farm income can impact on the long-term financial welfare of the household, particularly at the extremes of the income distribution.
Improving the Localised Environmental Precision of a Spatial Farm Level Microsimulation Model

Authors: Dilovar Haydarov (Presenter), Cathal O’Donoghue, Mary Ryan, Paul Kilgarriff and Chaosheng Zhang

Existing farm level sampling techniques do not consider localised agronomic and environmental context, which vary from one local area to another. In this article, using spatial microsimulation method we demonstrate the importance of heterogeneous environmental and agronomic characteristics. We show output differences with and without inclusion of spatially varying localised factors. Results show that including agronomic variables in the equation improve fitness of model, while it is also found that there is more income inequality when we take into account environmental differences.
Assessing the Anti-Poverty Effects of Social Transfers: Net or Gross? And does it really matter?

Authors: Chrysa Leventi (Presenter), Andrea Papini and Holly Sutherland

The aim of this paper is to explore alternative ways to define social transfers and measure their effects on income poverty reduction in EU-28. Using microsimulation techniques, we attempt to analyse the effects of treating social transfers in net or gross terms, the definition of pensions and their treatment as original income or as social transfers, the role of different types of benefits and the impact of policy interdependencies when constructing hypothetical scenarios where some transfers are set to zero. We find that the average contribution of net transfers to income poverty reduction is smaller than the corresponding contribution of gross transfers. Depending on whether transfers are considered gross or net, the ranking of countries in terms of the anti-poverty effectiveness of their monetary social provision systems also changes substantially. Non-means-tested benefits seem to explain most of the total impact of benefits on income poverty reduction. The countries where means-tested benefits achieve the most significant poverty reduction (both in gross and in net terms) are the UK and Ireland.
The development of urban models has been prompted by the need for informed policy recommendations from urban planners and informed decisions by policymakers. The imperative to develop integrated urban models for developing countries is growing with the need to enhance rational decision-making processes in controlling and directing urban change. The demand for urban models for developing countries is particularly great because of the large number of variables and required policy parameters, the complex relationships among them, and the long-term consequences of public decisions. It is argued however that urban modelling efforts in developing countries has been hampered by both demand and supply constraints. On the demand side, the importance and utility of operational urban models in actual planning and policy-making situations has not been widely accepted. Decision-making has been largely based on sectoral and short-term view of the urban system. On the supply side, the capacity for developing useful urban models for developing countries has been faced with several challenges. Firstly, the kind of modelling work that can be done is severely constrained by limitations in data availability and quality. If available, existing data sets, more often than not, do not possess the desired spatial and temporal coverage to allow detailed and sophisticated analyses of urban phenomenon. Secondly, the lag in urban modelling work is brought about by serious difficulties in capturing the complex inter-relationships among factors in the urban system. The intricacies of the structure of the social organizations and individual behavior, as well as, the presence of many market imperfections, has prompted urban analysts and researchers to express the necessity of dealing with unique issues that needs to be dealt with in making models work for developing countries. Tiglao and Tsutsumi (2001) highlighted key modelling issues that need to be tackled in the development of urban models for developing countries citing Metro Manila in the Philippines as a case in point. A major consideration points to the need to capture the characteristics of households at a more disaggregate level, both in attribute and spatial detail. For example, there is a need to effectively identify informal households ‘on the ground’ by distinguish the various income and socio-demographic household groups. The current modelling practice of defining ‘representative households’ needs to be refined in the context of modelling new urban policies in developing countries. There has been renewed interest in the integrated models of urban land use and transport in the light of environmental debate. Sustainability issues, together with new technological developments and new planning policies, also present new challenges to urban modelling. Existing urban models are too aggregate to respond to modelling challenges. Typical models distinguish only few socio-economic groups and dwelling categories, too fee to take account of new production and distribution technologies and emerging lifestyles and work patterns. Moreover, most urban models get their spatial dimension through a zonal system in which it is assumed that all attributes are uniformly distributed throughout a zone. These 2019 - IMA 7th World Congress, Galway June 19-21 considerations suggest a fundamentally new organization of urban models based on a microscopic view of urban change. The method for this new type of model is Monte Carlo microsimulation (Wegener 2002). Clarke (1996) points out that there are two major methods in spatial analysis. The first involves the creation of a microdata set using conditional probabilities and contingency tables. A method called iterative proportional fitting is also used to create probabilities using data sets which have different spatial scale. The next step involves the creation of a sample of individuals or households based on the set of
probabilities. Microsimulation methods has not received wide application in regional science due to the lack of microdata sets to calibrate or test results of simulation. This situation is changing as survey data are becoming more readily available, even for developing countries. Up to now, a large number of microsimulation models are inherently aspatial. This means that existing microsimulation models does not incorporate sufficient geographic detail so as to allow richer analysis at fine spatial levels. This study argues that spatial microsimulation approach provides a very powerful framework in overcoming the data and modelling problems in the development of integrated urban models for developing countries. One main advantage of the spatial microsimulation approach is that it is capable of building reliable disaggregate data sets at the household level and provide it at an appropriately fine geographic scale for detailed analysis. It is able to utilize existing disparate data sets and it is flexible enough to incorporate new available information. Finally, since household micro data can be developed, appropriate models can be calibrated and tested using the rich database. A spatial microsimulation model called InformalSim has been developed for Metro Manila. The microsimulation model uniquely provides detailed household microdata and allows the identification of the so-called ‘informal households’. InformalSim is the first application of spatial microsimulation approach for modelling the characteristics of households in Metro Manila, particularly those in the informal sector. InformalSim is the first application of spatial microsimulation approach for modelling the characteristics of households in Metro Manila, particularly those in the informal sector. Presently, InformalSim covers the City of Manila. However, the model can be easily extended to cover other cities and municipalities in Metro Manila. This paper presents the development of residential and employment location choice models as extensions to the existing microsimulation model. Also, the paper presents the possible role of such models in the development of spatial planning and decision support tool for developing countries.
Behavioural responses in tax evasion. Could they contribute to the feasibility of Italian Government proposal of a flat tax system?

Authors: Roberto Leombruni (Presenter), Roberto Quaranta, Roberto Zotti and Riccardo Ricciardi

In recent years there has been a growing interest towards flat tax (FT) systems, and many countries – mainly in East Europe – already delivered policy reforms in this direction (EC, 2018). The main idea is to target progressivity by means of exemptions or basic income (BI) measures, and then fix a single tax rate for all income levels. The ratio of a non-increasing rate is to set higher incentives to work and induce a lower propensity to tax avoidance (Friedman, 1967; Atkinson, 1996).

A large literature is using behavioural MSM to investigate the possible welfare effects of FT&BI – recent contributions including Islam and Colombino, 2018a; Schubert, 2018; Browne and Immervoll, 2017 – where the behavioural response is in labour supply. Indeed, this is of central interest to assess their feasibility: the increase in production may be a crucial component to finance both the BI provisions and the tax cut for higher incomes. Very rare instead are the studies trying to assess the role played by a response also in tax avoidance behaviours (an exception is Duncan, 2014).

The objective of this paper is to investigate this second behavioural response to assess the feasibility of a flat tax in Italy, where it is an highly debated theme following the actual proposal by a current government coalition party (the right-wing Lega party) of a flat rate at 15% (or a dual rate at 15% and 20%) – to be compared to current progressive rates going from 23% up to 43% – combined with pretty generous exemptions linked to family’s size and gross income. Indeed, many analysts estimated a huge, negative first-round effect on the public budget, ranging from about 50 to 90 billion euros (roughly 3%-5% of GDP). The main counter arguments have to do with the mentioned behavioural responses: the tax cut will propel the aggregate demand and increase labour supply; the flat and lower tax rate, together with a more severe enforcement of the fiscal system, will decrease tax evasion. As regards the first point, the expectation that a labour supply effect could guarantee the self-financing of the package is not supported by the MSM results of Colombino and Islam (2018). The second point however could be a central one, since Italy has one of the largest shadow economies among the developed countries (Medina and Schneider, 2018) and a change induced in tax avoidance behaviour could reveal to be crucial for the sustainability of a tax reform.

From a theoretical point of view, since the early works on optimal avoidance behaviour (Allingham and Sandmo, 1972; Yitzhaki, 1974) there is a consensus that high tax rates encourage the concealment of activities (Schneider and Enste, 2000; Slemrod, 2001). In the case of income taxes, however, there appear to be only few empirical studies which actually quantified this relation, also because the extent of non-compliance, by its very nature, is hard to measure with accuracy. An exception has to do with the introduction of a flat tax rate at 13% in Russia in the early 2000s, a reform studied by Ivanova et al. (2005) and Gorodnichenko (2009). Compliance does appear to have improved quite substantially after the reform, even though it remains unclear whether this was due to the parametric tax reform or to accompanying changes in enforcement. Using these empirical results, Duncan (2014) builds a MSM with behavioural responses in avoidance behaviour to study the impact of the reform, finding that the switch to a flat tax system did not imply a higher inequality.

We employ EUROMOD to simulate the Lega proposal and another FT proposal made by the Istituto Milton Friedman considering the behavioural response in labour income tax avoidance,
which is presumably the main income component that may react to the reform (for other income sources such as from financial assets and real estate there are options in the current system to opt for a flat rate). In order to implement it, we consider the available estimates of the incidence of informal employment by sector of activity and employment type published by the National Institute of Statistics, assuming that the distribution of income of informal workers is the same as that of formal ones. (We are currently working to use original and more detailed estimates of the incidence of informality).

We use the MSM to estimate an upper bound for the increase in tax revenues assuming that all informal workers reveal their entire incomes after the reforms. In the Lega proposal, our first round estimate is a 51.7% reduction in total tax revenues (about 74 billion euros), while the upper bound for the additional tax revenues due to labour income emersion is of about 6 billion euros. Such a small contribution of emersion to the feasibility of the reform is due to the generous exemptions considered in the package to target progressivity, similar to what is found in Colombino and Islam (2018). Actually, in the other FT scheme considered, the additional tax revenues due to labour income roughly doubles, reaching 12 billion euros.
Adding Historical Earnings to the 2004 and 2008 Survey of Income and Program Participation (SIPP)

Authors: Karen Smith (Presenter)

The Urban Institute’s Dynamic Simulation of Income Model (DYNASIM) is a microsimulation model used to estimate the distributional impact of Social Security, pension, and tax reforms on savings, family income, and government budgets over the next 75-years. Because Social Security, pensions, and savings accrue over workers’ careers, it is critical to have proper representation of lifetime earnings. This paper describes the statistical matching method we used to generate longitudinal earnings from 1951 to the 2004 and 2008 Survey of Income and Program Participation (SIPP) interview dates using longitudinal earnings data from the Panel Study of Income Dynamics, National Longitudinal Survey of Youth, and public use Summary Earnings Record and Master Beneficiary Record data. It then compares the imputed file with actual administrative data linked to the SIPP panels to show that the imputed file has a high degree of similarity to the actual data by cohort, gender, race, education, and marital status.
Basic income and optimal taxes. Efficiency, equity, losers and winners

Authors: Ugo Colombino and Nizamul Islam (Presenter)

We use a behavioural microsimulation model embedded in a numerical optimization procedure in order to identify optimal (social welfare maximizing) tax-transfer rules. The rules consist of a universal basic income and a flexible tax approximated by a 4th degree polynomial. We illustrate the emerging equity-efficiency trade-off, the solutions implied by alternative degrees of inequality aversion and the distribution of winners and losers with respect to the current rules. We also explore the design of optimal policies where the number of losers is constrained to be “sufficiently small” and/or “even” across deciles. We compare the results in three countries, Italy, Luxembourg and Ireland.
Dynamic microsimulation models draw on a database of objects to simulate a path for each object through different states over time. In public policy modelling, these objects are often individuals or family units moving through various decision points such as whether they work, how much they earn, or whether they have children. Movements of objects through different states are, in large part, determined by relevant historical information. For example, many years of work experience would result in a high probability that a person will continue working. This method of simulation is advantageous as it creates sensible (but diverse) paths for these objects over time and also creates detailed cross sectional distributions at each time interval. This makes dynamic microsimulation models well suited for projecting objects over long time horizons. One challenge that dynamic microsimulation models face is striking a balance between capturing the likely paths of objects based on historical evidence and incorporating the future dynamics and changes (either expected or unexpected) that may influence the potential paths that objects evolve within. To incorporate changes to various factors that influence the movement of objects, dynamic models often incorporate ‘alignment’ where the model must conform to pre-determined exogenous benchmarks. This alignment approach ensures that the aggregate results of dynamic microsimulation models produce a reasonable reflection of reality, whilst still allowing the microsimulation to dictate who is most likely to be in a particular state to reach these benchmarks. The Department of Treasury has built MARIA, a dynamic microsimulation Model of Australian Retirement Income and Assets, to estimate retirement income adequacy and the sustainability of policy settings. The model takes a database of the Australian population over the age of 25 and simulates relevant life events to accumulate superannuation assets for retirement (for example whether they work, how much they earn and how much they contribute to superannuation). The incidence of a variety of life events and choices are simulated using historical information from a range of longitudinal data (both administrative and survey data). This simulation places a value on persistence of states of being in people’s lives. Valuing persistence weights decisions towards historical influences over future changes in the economy that may influence peoples’ lives. However, without this approach, it would be difficult to incorporate the stochastic nature and heterogeneity of choices and outcomes in a sensible manner. MARIA balances these competing priorities by aligning to key aggregate benchmarks at a number of points in the model to reflect projections of how the Australian economy will grow over the coming decades. For example, MARIA aligns to Treasury’s long-term demographic and labour force projections (produced by a suite of cohort-based models). These projections are used as benchmarks to ensure that the number of people in various age groups and labour force statuses matches the cohort-based projections. This paper steps through the key decision points in MARIA that incorporate ‘alignment’ to aggregates and the key advantages of doing so. The paper also examines a number of stages of the model that are not currently aligned to aggregates to assess how results of these simulated events develop over the projection period and whether there are any issues with how historical information is driving these results.
Twelve years of the “International Journal of Microsimulation”

Authors: Marc Hannappel (Presenter) and Ardian Canolli

Research question: The International Journal of Microsimulation (IJM) was founded eleven years ago. With a bibliometric network analysis of all articles and contributions of the IJM, we want to get an idea of the current state of microsimulation and its development within the journal. Furthermore, we consider the development within the journal as an indicator of the state of microsimulation within social sciences as a whole. Thus, we focus on the following questions: (1) Who are the key actors within the IJM and (2) which thematic priorities can be identified and how are these topics linked?

Theoretical Framework and Methodology

Bibliometric analyses are primarily analyses of publications or their characteristics. Scientometric bibliometry for example deals with the questions of how authors are connected or integrated within a scientific field, which significance journals have within a subject area or which influence certain publications have. Co-authorship networks are therefore an appropriate way of investigating the embedment of authors in a scientific network. In contrast, co-word analyses can be used to identify the focus of publications or journals. We analyzed all articles as well as the relevant characteristics (author(s), keywords, year of publication) in the IJM. To extract the articles, we chose the online database EconPapers (www.EconPapers.repec.org). This website provides the bibliographic data of all articles of the journal. The data can be downloaded in bibtex format. Subsequently, we evaluated the data file with the statistics software R using the "bibliometrix" package.

Results: The development of the author network within the IJM shows a large increase in the number of contributing authors. As a result, authors who are less involved in larger networks have the opportunity to successfully submit contributions to this journal. However, the formation of clusters or 'cliques' is also evident, i.e. a concentration of many several authors around only a few authors with strong publications.

The co-word analysis for the entire period shows an additional expansion into various contexts of use, an increasing differentiation and at the same time close connections between the keywords. Despite the expansion into various research fields, a central finding from the co-word analyses is: since the first issue, the topics "tax", "pension" and "health" represent the three dominating research foci of the journal.

Discussion: In his vision about the role and function of microsimulation, Guy Orcutt focused on two areas of application. On the one hand, microsimulation models should be used as models “for unconditional forecasting or for predictions of what would happen given specified external conditions and governmental actions“ (Orcutt 1957: 122) within the framework of socio-political issues. On the other hand, they should be used as a research method in social sciences. His first vision has certainly come true, but work must continue regarding his second vision. Of course, this also includes the establishment of this method in the repertoire of the methods of social science method training. In our view, this would be an important step towards an initiation of the establishment of microsimulation in the scientific field.
In recent years plenty of evidence were provided to understand what determines the redistributive power of the Italian tax-benefit system. Often due to data constraints, the previous investigations were mainly focused on decomposing the redistributive effect given by the personal income tax (hereinafter PIT) and its income surtaxes collected at the regional and municipal level (Di Nicola et al. 2015; Barbetta et al., 2018; Di Caro, 2018). Few evidence were offered so far regarding the redistributive impact of income sources currently exempt from progressive taxation and subject to alternative proportional tax rates (Boscolo, 2019), as well as for the relative contribution to redistribution of each tax-benefit instrument considering the whole tax system (Fuest et al., 2010). No attempt has been recorded yet which seeks to explain redistribution at a comprehensive and extended simulation scenario using the methodology discussed as follows below, including into the exact decomposition approach not just all those income sources taxed accordingly to different tax regimes from the PIT one but also earnings from various cash benefits which are traditionally tax free in the Italian context.

This paper aims to fill this gap by applying the generalization of the Pfähler-Lambert decomposition method of the Reynolds-Smolensky index provided by Onrubia et al. (2014) jointly with the geometric decomposition approach for the reranking term as defined by Di Caro (2018) on the Italian tax-benefit system for the 2005 and 2018 tax period in a comparative perspective. Exploiting the simulation capabilities provided by the static microsimulation model EUROMOD, we first ran the model under the baseline policy scenario for both year interested, employing the corresponding best-match datasets. Once these introductory results were obtained, the above mentioned decomposition methodologies were applied in order to determine and compare the redistributive nature of each tax-benefit instrument over the time span chosen as replicated by the model. Initially, the comparison is carried out by isolating the relative effect of marginal tax rates, tax credits and tax allowances for PIT and the regional surtax taking gross income subject to PIT before tax allowances as income definition in the decomposition formula; second, moving towards the expanded scenario, the analysis was repeated for the tax system as a whole. In light of the changes occurred in the structure of PIT during the last thirteen years, the results of the analysis show that tools which drove redistribution for PIT and the regional surtax in the 2005 tax period differ substantially in relative terms once compared to the 2018 year. While the greatest majority of the redistributive power was given by tax allowances in 2005 ($D_{05}$: 82.1%), the relative effect of the government tools considered is inverted in 2018, where redistribution is mostly determined by tax credits and tax schedules (respectively: $C_{18}$, 54.5%; $S_{18}$: 45.3%). Indeed, it is worth highlighting that the results obtained for the 2018 tax period are highly consistent with previous studies which analysed redistribution using individual tax returns instead of sample survey data (Barbetta et al., 2018; Di Caro, 2018). When moving to the assessment of the overall tax-benefit system, it is interesting to note how PIT and the regional surtax were still almost entirely determining the redistributive nature of the tax system in 2005 ($PS_{05}$: 98.2%; $PS_{18}$: 72.0%). Furthermore, income sources exempt from progressivity and tax-free cash benefits have a higher equalising effect on income inequality in 2018 than in 2005. Although the pre-tax Gini index computed on gross income subject to PIT for the 2005 tax period is 0.04 points lower than the 2018 one ($G_{05}$ : 0.40481; $G_{18}$ : pre pre 0.441188), the level of post-tax inequality is almost the same once broadening the income definition ($G_{05}$ : 0.36166; $G_{18}$ : 0.36273). This suggests that,
despite the loss of rationality which has been \emph{post post} accompanying the Italian tax system through the gradual departure of the structure of PIT from a comprehensive income tax scheme, a greater role in determining redistribution is now given by earnings exempt from progressive marginal tax rates. As a result, the overall redistributive effect as measured by the Reynolds-Smolensky index increases when shifting from the restricted scenario to the expanded one in 2018 ($\Delta R_{2018}: 0.00019$), while for the 2005 tax period it decreases ($\Delta R_{2005}: -0.00125$).
Validating risk factor and chronic disease projections in the Future Adult Model

Authors: Bryan Tysinger (Presenter)

Objectives Over the past several decades, the United States has experienced a dramatic rise in obesity rates, due to both a rightward shift of the body mass index (BMI) distribution and a “pushing out” of the right tail. This shift has led to increases in obesity-related chronic diseases, particularly diabetes, as well as impacts on longevity, medical expenditures, and quality of life. This public health epidemic has led to a broad range of policy proposals intended to reverse these trends. Microsimulation modeling is a potentially useful tool for assessing the impacts of these policies, but reliably assessing policies requires a model that performs well in projecting health risk factors and disease outcomes. This research assesses the internal and external validity of a microsimulation model of the U.S. adult population.

Research Questions

There are three key research questions addressed in this analysis: 1. How well does the Future Adult Model perform in projecting BMI and diabetes over a ten-year horizon compared to the host data? 2. How well do the microsimulation model’s predictions compare to external surveillance data of BMI and diabetes? 3. How do alternative approaches to modeling the transition functions change this performance?

Theoretical Framework

The Future Adult Model (FAM) is an economic-demographic microsimulation model of the United States population over the age of 25. Based on the nationally representative Panel Study of Income Dynamics (PSID), FAM models individual’s transitions of health risk factors, chronic disease incidence, functional limitations, mortality, and a broad set of economic outcomes. Researchers utilize FAM to forecast obesity and obesity-related disease outcomes, as well as to assess policy proposals that target reducing BMI or decreasing diabetes incidence. Consequently, validating these projections is of critical importance.

Methodology

For this validation exercise, all Markov transition models are estimated using the 1999-2005 waves of the PSID. The simulation is then run from 2005-2015. For internal validation, simulated outcomes in 2015 are compared to actual PSID outcomes. Population means are compared between the simulation and the host data with a two-tailed t-test. Receiver operating characteristic (ROC) curves are used to assess model performance for binary outcomes using the area under the curve (AUC) statistic, with an analogous area under the surface for continuous outcomes. For external validation, simulated outcomes for 2005-2015 are compared to the Behavioral Risk Factors Surveillance System (BRFSS), a large, nationally-representative survey of the United States population. Finally, alternative approaches to modeling transitions are assessed.

Results

After ten years of simulation, FAM projects a mean BMI of 27.99 for those 35 and older in 2015, whereas respondents in the host data report an average BMI of 27.86, the difference of these two is not statistically significant at standard levels (p=0.058). Projected prevalence of diabetes for this cohort is 14.4%, compared to 14.9% for in the host data. The difference of these is also not statistically significant (p=0.113). In the ROC analysis, the preferred model for BMI has an AUC of 0.9136 for categorizing individuals as obese (BMI>30) and an AUC of 0.9403 for categorizing individuals as morbidly obese (BMI>40). The preferred transition model for diabetes incidence has an AUC of 0.7478 on a ten-year horizon. Compared to BRFSS in 2015, FAM projections for BMI compare favorably for the mean (27.95 for FAM, 27.85 for BRFSS) and 90th percentile (35.66 for FAM, 35.51 for BRFSS). The 95th percentile begins to diverge (38.40 for FAM, 39.33 for BRFSS) and the 99th percentile is quite different (44.73 for FAM, 48.81 for BRFSS). FAM performs well for projecting increases in BMI and diabetes consistent with both the host data and surveillance data. However, it does not do as well with...
the right tail of the BMI distribution. Researchers using FAM should be cognizant of these strengths and limitations. Disclosure Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health under award number P30AG024968, which funds the Roybal Center for Health Policy Simulation, part of the Leonard D. Schaeffer Center for Health Policy & Economics at the University of Southern California. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Schaeffer Center.
OBJECTIVES: The elderly population in the United States (US) is living longer than that in any other period in history. However, these longer lives are punctuated by chronic disease that is associated with reductions in both quality of life and functional status. Innovations in chronic disease prevention may provide a means to slow declines in quality-of-life in the American life cycle. Our study goal is to understand the effect of chronic disease prevention on elderly lifetime outcomes. RESEARCH QUESTION: What is the impact of chronic disease prevention on remaining life expectancy (LE), quality-adjusted life-expectancy (QALE), and disability-free life-expectancy (DFLE) in the elderly American population? THEORETICAL FRAMEWORK: The US Future Elderly Model (FEM) is a demographic and economic microsimulation model that projects the future costs and health status for all Americans aged 51 and older based on their current health status, as well as a broad set of risk factors. Compared to other projection models that utilize aggregate measures of health traits when modeling a population, the US FEM uses information on how health characteristics change at the individual level through the use of longitudinal survey data. In specific, it models the Health and Retirement Study (HRS), which is a representative, longitudinal panel survey of Americans aged 51 and older. METHODOLOGY: Simulations were run by adapting the US FEM to simulate interventions that set the incidence of either diabetes, cancer, lung disease, hypertension, heart disease, or stroke to 0% among a population of individuals 51 years of age and older. We then calculated LE, QALE, and DFLE until time of death for each individual. RESULTS: This study modeled individuals who were aged 51-52 in 2012. Among these simulants, the lifetime risk of developing heart disease after age 51-52 was 55.4%. The corresponding value for hypertension was 48.8%, for diabetes 41.9%, for cancer 37.4%, for stroke 35.2%, and for lung disease 22.7%. In simulants without disease at age 51-52 who would have eventually developed chronic disease (defined as the treatment-on-the-treated [TOT] population), preventing cancer increased mean years of LE the most (3.12), followed by lung disease (2.79), diabetes (2.59), heart disease (2.17), hypertension (1.49), and stroke (1.38). In these same simulants, mean QALE increased the most when preventing lung disease (2.56), followed by diabetes (2.50), cancer (2.31), heart disease (2.16), hypertension (1.85), and stroke (1.56). And in these same simulants, preventing lung disease increased mean DFLE the most (2.03), followed by diabetes (1.80), stroke (1.54), heart disease (1.38), cancer (1.11), and hypertension (0.96). CONCLUSIONS: Our findings suggest that innovations in chronic disease prevention may provide an opportunity to improve quality-of-life at older ages. In our analyses on the TOT populations, we find that while cancer prevention increased LE the most, the prevention of lung disease increased QALE and DFLE the most. Furthermore, for each year gained in LE, the relative increase in QALE and DFLE increased the most when preventing lung disease. Although the cancer prevention options available at present are limited, effective interventions for preventing lung disease are available and should be pursued to improve quality-of-life in individuals at risk for lung disease.
Toward stronger fiscal integrations in the European Union: An agent-based approach

Authors: Marko Petrovic (Presenter), Andrea Teglio, Bulent Ozel, Marco Raberto and Silvano Cincotti

Despite the recent economic recovery, the European Union (EU) remains financially fragile, continuing to struggle with many challenges onward. It still under-performs with respect to economic growth while the populist and nationalist movements are rising along with a deeper political divisions. An important contributor to these problems is a poorly designed fiscal and financial architecture (FFA) of the EU, which often creates conflicts among its member states instead, jeopardizing long-term growth. Thus, the need for reforms of the euro area FFA remains imperative. In this paper, we propose and examine several FFAs scenarios that can be considered in the EU. We argue that new stabilization and risk-sharing mechanisms should benefit the performance of a union, decreasing inequality among its member states and making it more balanced and resistant to shocks, especially when the union consists of highly heterogeneous countries. In addition, these new mechanisms should increase the well being of the union citizens and contribute to its long-term growth. To examine the fiscal reforms of the euro area, we design several computational experiments, based on the agent-based Eurace framework. The model is able to host N countries that can run independently, as closed economies, or in unions. The unions can include different types of interactions among countries: 1) international good markets; 2) international labor markets; 3) international financial markets (a financial architecture that resembles a capital market union) where all the citizens of the Union can trade stocks and bonds; 4) a common monetary policy (Monetary Union). Within the framework, it is possible to simulate any combination of independent countries and unions, where any number of the four cited properties can characterize the unions. In this paper, we consider a setting, which includes countries belonging to a monetary union (a common monetary policy) with free trade, the labor movement that is subject to frictions and a free international financial market. We introduce mobility frictions in terms of monetary costs. Households account these costs on their reservation wage while considering a job offer from abroad meaning that if mobility frictions are 0.1 for instance, the foreign wage offer must be 10% higher than domestic wage offers to make them indifferent between domestic and foreign jobs. In the following, we denote the level of mobility frictions with $\rho$. The paper explores several FFAs, showing which mechanisms the union should adopt in the case of everlasting productivity gap among countries. In particular, we design a new fiscal stabilization instrument at the level on the Monetary Union that allows transfers from countries with a fiscal surplus to countries that need to finance their deficit spending. We call this mechanism the “fiscal pool”. We further explore the effects of introducing a debt-based union-area safe asset that offers investors an alternative to national sovereign bonds. We call them Union-Bonds. In addition, we study the effects of the introduction of a federal tax and of union-based homogeneous public wage. In general, new FFAs help to stabilize member countries economies. In the following, we present the results of the fiscal stabilization instrument at the Union level (fiscal pool).

To examine its effects we study a statistical measure defined as the mean of the difference:
Given one random seed, the statistical measure $\Psi_{AB}^{s}(Y)$ represents the average value in the time subset $T$ of the difference of the observed economic indicator $Y$ between the two considered countries (A and B). Using this measure on the graph below we explore the difference of the average difference ($\Delta \Psi_{AB,CD}^{s}(Y)$) between the total production per-capita and the total consumption per-capita in the two countries of the union with and without the fiscal pool. Hence, A and B are countries in the union with the fiscal pool while C and D are countries identical to A and B but in the union without the fiscal pool. The result shows that when the fiscal pool is present, the difference between the countries in the union in terms of production and consumption per-capita is smaller (the difference in difference indicator is negative) implying that the inequality between the two is smaller when the fiscal pool is active especially in the case when the productivity gap among countries is large and the mobility friction is small (low mobility barriers). This is the most critical case where the union of two countries collapses since the majority of population move to the highly productive country leaving the low productive country with the unsustainable level of production and sovereign debt. Thus, the fiscal pool, in this case, behaves as a stabilization mechanism helping the low technological country to prevent a massive emigration and to maintain production, consumption and sovereign debt at a sustainable level.

\[
\begin{align*}
\Psi_{AB}^{s}(Y) &= \frac{1}{|T|} \sum_{t \in T} (Y_{A,t}^{s} - Y_{B,t}^{s}) \\
\Delta \Psi_{AB,CD}^{s}(Y) &= \Psi_{AB}^{s}(Y) - \Psi_{CD}^{s}(Y)
\end{align*}
\]