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*Conference held July 11 – 13, 2023*

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## Director's Message

*Finn Kydland*



### **XXVI Workshop on Dynamic Macroeconomics**

The XXVI Workshop on Dynamic Macroeconomics was held in Vigo, Spain at Castello Soutomaior, 11-13 of July, 2023. What a beautiful castle in a magnificent region. By tradition, we recruited mostly European scholars early in their careers to give presentations. Importantly, we gave them feedback. The “seasoned” professors included, but were not limited to: Victor Rios-Rull, Arpad Abraham, Tim Kehoe, Jaime Alonso-Carrera, and myself. As Tim would say, “Oof.” If I did not mention your name, I will catch you next time. The event was sponsored by Universidad de Vigo and LAEF, with collaboration from Deputacion Pontevedra. Topics included wage expectations, rural-urban migration, the minimum wage, supply chain issues, and much, much more. A good time was had by all.

### **Human Capital in Macroeconomics**

Back on home turf in Santa Barbara, LAEF held the Human Capital in Macroeconomics meeting on September 15-16, 2023. This conference was co-sponsored by the Federal Reserve Bank of St. Louis. The academic organizer was Oksana Leukhina, Research Officer in the Research Division of the Federal Reserve Bank of Saint Louis, and Guillaume Vandenbroucke, Assistant Vice President in the Research Division of the Federal Reserve Bank of Saint Louis. Topics included demographics, inequality, the effects of college education, and much, much more (again!). Please enjoy this issue of From the Lab. It's chock-full of bright ideas with timely applications.





## **XXVI Workshop on Dynamic Macroeconomics**

July 11 – 13, 2023, Conference Participants

Adrien Wicht – *European University Institute*  
Alexander Abajian – *University of California Santa Barbara*  
Andrej Mijakovic – *European University Institute*  
Clara Arroyo – *CEMFI*  
Diego Bohórquez – *Universitat Pompeu Fabra, Barcelona*  
Fabrizio Leone – *ECARES – Université Libre de Bruxelles*  
Finn Kydland – *University of California Santa Barbara*  
Franck Portier – *University College London*  
Jamie Alonso Carrera – *Universidade de Vigo*  
Joris Hoste – *KU Leuven*  
José Victor Rios Bull – *University of Pennsylvania*  
Lauri Esala – *Universitat Pompeu Fabra, Barcelona*  
Lorenzo Pesaresi – *Universität Zürich*

Maria Frech – *Toulouse School of Economics*  
Mariia Kovaleva – *ECARES – Université Libre de Bruxelles*  
Marta Cota – *CERGE-EI*  
Marta García Rodríguez – *Universitat Autònoma de Barcelona*  
Morgane Richard – *University College London*  
Nick Pretnar – *University of California Santa Barbara*  
Paula Sánchez Gil – *University of Lucerne*  
Pedro Amaral – *California State University-Fullerton*  
Segio Feijoo Moreira – *University of Bristol*  
Stéphane Bouché – *Universitat de les illes Balears*  
Thomas Fullagar – *University of California Santa Barbara*  
Tim Kehoe – *University of Minnesota*  
Tomás Budí-Ors – *CEMFI*



## Efficient Sovereign Debt Management in Emerging Economies

**Adrien Wicht**

The recent increased issuance of government debt to fund fiscal policy in response to the Covid-19 pandemic, coupled with recent rises in interest rates, has made the question of governmentsolvency rear its head globally on a scale not seen since the Eurozone crisis. In countries considered emerging market economies, borrowing in the past several decades can be characterized by three stylized facts: frequent and costly defaults, relatively rare repurchases of outstanding debt, and a shortening of the term structure of existing debt in response to changes in international credit market sentiments on the ability of nations to remain solvent. Using a model that combines these three aspects of sovereign borrowing and debt repudiation, Wicht shows sufficient conditions under which a planner and market economy can achieve efficient levels of borrowing and avoid default.

Wicht models of sovereign borrowing with limited commitment to characterize the mechanisms through which governments can avoid defaulting on public debt. In the modeled economy, a government must borrow on international capital markets using short- and long-term debt in order to provide a capital input to production. The government, unlike a planner, is myopic in that it may repudiate its debts despite the resulting exclusion from capital markets. The modeled government may adjust its international borrowing position both through default and repurchasing outstanding perpetuities (bonds that pay an infinite stream of coupons, but no principal). The option to default is costly as repudiating debts leads to a drop in output due to a lack of capital inputs in the following periods. Participants noted in contrast to a model of immediate exclusion, it may be hard in practice for international lenders to immediately recall financial or physical capital located in a sovereign country immediately after default.

A contribution of Wicht's model to the literature stems from the observation that Brazil (unlike Argentina) repurchased some of its outstanding debt in the 1990s. In his model, sovereign borrowers can repurchase long term debt either through invoking official repurchasing agreements that come as covenants on the bonds issued at a markup over market price, or by repurchasing them through financial intermediaries on the open market. Several participants noted the label of emerging economy may not be a good fit for economies with higher propensities to default, and that it may be difficult to use these two economies as laboratories for testing the model implications, given the difference in observed behaviors of each government's debt portfolio. Participants further noted that the assumption of the existence of covenants allowing for a flexible markup price for repurchasing outstanding debt may be inconsistent with the evidence of specific debt issuances in Brazil and Argentina.

Wicht first shows that with access to these two mechanisms, a country's welfare is improved when international lenders impose a limit on the level of debt they issue to a sovereign, which prevents (unlike in the baseline case with no borrowing described above) default from occurring. Wicht then characterizes conditions on international lenders under which the government can be disciplined into achieving the first-best outcome for a benevolent planner with access to only the two term options for financial instruments. The resulting competitive equilibrium that coincides with the planner's solution hinges on the ability of lenders to collectively enforce credit stops. However, he concludes that this is unlikely to be achieved under current market conditions.

Finally, Wicht takes his model to the cases of

Argentina and Brazil, where he characterizes the shortfall of each economy to obtain the above constrained-efficient allocation during their respective fiscal crises. His results suggest that over the past three decades, Brazil's realized path of macroeconomic conditions and borrowing were closer to the theoretical efficient frontier than those of Argentina

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The financial crisis in the 2000's gave rise to many new frameworks for understanding the global economy. Diego Borhoquez began his presentation with a short introduction in which he described the paper as introducing a tractable framework to formalize the role of the Fed as the international lender of last resort from a macroeconomic perspective. The framework captures important features of the global financial system in the run-up to the 2008 crisis through three stylized facts that serve as the basis of the model.

Borhoquez then presented these facts. First, the dollar appreciates and liquidity shortages arise during a crisis. Second, non-US global banks have a large footprint in dollar banking. Third, dollar funding of these banks is short-term and fragile, which exposes them to liquidity shortages.

Several participants commented on the language used in the presentation, requesting that more formal definitions be given. Furthermore, the presenter used words such as "euros" and "dollars," which indicate nominal or paper currencies, not real prices, which is what the paper is about.

The presenter went on to describe how in his framework the world is exposed to self-fulfilling crises because of a feedback loop between the exchange rate and the capacity of foreign global banks to raise funds. Due to the presence of financial frictions and balance sheet mismatches, an exchange rate depreciation (increase in the value of the dollar relative to other currencies) results in tighter market conditions for banks with short-term liabilities in dollars that need to be rolled over. If the depreciation is significant, foreign banks may not receive the necessary funding to meet their obligations, leading to a banking crisis and a "sudden stop" in their economy. Consequently, aggregate demand in the affected country

drops, and their exchange rate further depreciates. These are all characteristics of a global financial crisis.

Next, Borhoquez described how the model highlights the possibility of multiple equilibria. This has important implications for the role of the Fed as the international lender of last resort to foreign global banks during periods of crisis. The model shows that the Fed can intervene by providing dollar liquidity directly, but its incentives to bail-out foreign global banks might not be necessarily in line with the interests of the rest of the world. Moreover, the model suggests that the presence of multiple equilibria can amplify the impact of an exchange rate depreciation on banks' soundness, making financial crises more likely. This underscores the importance of understanding the factors that can lead to the emergence of multiple equilibria and the role of international lenders of last resort in preventing self-fulfilling crises.

Borhoquez goes on to argue that the potential consequences of the Fed acting as the international lender of last resort to foreign global banks during periods of crisis are complex and depend on various factors. On the one hand, the Fed's intervention can prevent a global financial crisis by providing dollar liquidity directly, which non-US central banks without significant dollar reserves might lack the resources to do. On the other hand, the Fed's incentives to bail-out foreign global banks might not be necessarily in line with the interests of the rest of the world.

Participants pushed Borhoquez to consider how the model incorporates what happened during the financial crisis. That is, they wanted a better explanation of how the model can explain lending and recovery as it actually occurred. Participants also were curious about what happens between the two equilibria. One participant suggested considering a continuum of banks, with only some receiving help from the Fed.



## The Role of Wage Expectations in the Labor Market

**Marta García Rodríguez**

Robert Shimer first noted in 2005 that the standard search and matching model of unemployment has difficulty in reconciling the relatively high volatility of labor market tightness in relation to the limited volatility of productivity (measured by output per hour) observed in the United States. García Rodríguez argues this and other portions of the textbook search-and-matching model that fail to match the data can be explained by a break from the traditional rational expectations framework that allows agents to form expectations based on only a limited set of observables in the economy.

García Rodríguez begins her paper reviewing the evidence and data on the twin “Shimer puzzles,” namely the shortcomings of the benchmark search model in recreating the high volatility of labor market tightness and its lack of contemporary correlation with output observed in U.S. data. Participants first noted that although these phenomena were the ones initially posited by Shimer, others features of the model have also garnered the puzzle label. Another participant asked how allowing deviations from rational expectations improved the model versus other changes, namely those adopted by Hagedorn and Manovskii (2008), such as raising the flow value of agents’ outside options to employment.

The main contribution of García Rodríguez to the search literature is achieved by relaxing the assumption of perfect foresight by workers. In the benchmark model, workers know the exact bargaining process for wages and form beliefs using all available information in the economy. In her model, workers are uncertain over the exact process determining future wages and instead update subjective beliefs relying on only a subset of current conditions; they estimate next period’s wages as a linear function of current productivity. These subjective beliefs in turn evolve based on the realized

productivity and wages the agents observe along with contemporaneous shocks to beliefs. Based on the size of their errors, agents update their linear belief coefficients and improve their method of forming expectations to better-reflect the data within the set of possible linear coefficients governing expectations. The learning process allows for a form of internal rationality; although the agents use a limited set of information to predict the future, they change how they think in order to best-approximate the mathematical expectations operator.

With this belief formation system in hand, García Rodríguez embeds this mechanism in a standard search-and-matching model. Several participants raised a set of technical questions regarding the appropriateness of her decision to form the worker side of the model using a representative household. Specifically, it was posited that the case of a representative household allows marginal employment decisions to be affected by the current level of employment for the agent, a feature that may be absent from more-standard formulations where the economy is populated by a continuum of households. The presenter responded that it is likely the case that the two formations – that of a representative agent and that of a large number of households – coincide.

García Rodríguez evinces that a break from rational expectations of this form substantially aids the search model in terms of fitting the data. The fixity of wage expectations causes workers to adjust their expectations to shocks slowly, not absorbing the full extent to which productivity shocks translate to changing wage offers by firms. As worker expectations adjust slowly, the wedge between wages and productivity grows and fewer jobs are created, causing negative shocks to propagate through time. This allows for her model to solve both the volatility and contemporaneous correlation puzzles

posited by Shimer in 2005. She concludes with illustrative cases under which this friction has important implications for considering the effects of future unemployment insurance policies when compared to results implied by the benchmark model.



## Working-from-home: Geographic and (Counter?) Redistributive Implications

**Morgan Richard**

The movement of people away from city centers towards suburbs during the Covid-19 pandemic and the resulting outward shift in the density of populations has been labeled the “donut” effect. While this phenomenon has been shown in both European and American cities, the distributional consequences of shifting population distributions with metropolitan areas are less well-studied. Richard forms a model to consider how structural changes in the amount of work that can be done from home affects the distribution of where agents live, and the resulting distributional consequences for housing prices, commute times, and welfare for urban and rural sections of metropolitan areas. Her findings suggests the gains from increased working from home are ambiguous as lowered commuting costs are offset by higher demand for space inside houses and imply both gains and losses across income groups

Richard began her exposition showing evidence of changing size and distance premia in British housing data for the London metropolitan area. Prior to the pandemic, hedonic evidence suggested that larger houses and houses closer to the urban core of London earned higher prices. Using distance property-level cardinal data on distance from the Bank of England as a proxy for centrality of locations, she measures the effect of centrality and size on housing prices during the pandemic. A participant noted that access to transit and transit times, as measured by proximity to a public transit station, may serve as a better notion of distance. Richard shows that while prices for properties near the city center of London remained below 2020 levels through the pandemic, suburban prices increased by over 10 percent of pre-pandemic averages by the end of 2022. Price increases were more pronounced for larger homes and for homes further from the city center for both owned

and rented residences. She argues this increase in size premia and reduction in distance premia as evincing a donut effect – a change in how households balance commute costs against the benefits the lower costs of housing when working from home became more available in the wake of the pandemic.

With these empirical results in hand along with similar dynamics observed in United States cities, Richard forms a core-periphery general equilibrium model of housing choice to highlight how working from home affects the tradeoff between commute times and housing preferences. In the model, households select whether to live in a city center and whether to rent or own a home based on their occupation. The key occupational heterogeneity that drives location decisions is the ability to telecommute; while some households have the option of splitting their work between their employer’s physical location and their home, others may log hours only from their workplace. Taking these features as given, the model solves for a steady state distribution of demand for owned and rented structures along with relative mortgage and rental prices in each location, taking each agent’s abilities to work from home and preferences over housing as given.

Richard takes the calibrated model to the data to illustrate a baseline and counterfactual scenario where the number of agents who have flexible occupations is set at observed pre- and post-pandemic levels. She solves the model for economies with low and high levels of preferences for working from home – illustrative of the pre- and post-pandemic setting – and compares steady-state location, housing, and employment across each economy. This comparison of steady-state outcomes under different preferences for work-from-home and its availability ignited an extended discussion. Participants



first noted that the Covid shock is likely not reflected by a change in steady state outcomes and should instead be a transition between equilibria. Others noted that it is difficult to falsify an assumption of changing preferences for working from home or residing in suburbs in the post pandemic period, and whether these changes will be persistent.

The author's preliminary results suggest that the impact of more-available remote work on welfare is ambiguous across the income distribution. She argues that while inequality grew at the bottom of the wealth distribution, it also shrunk at the top, implying that a permanent transition to remote work may bring about important tradeoffs between efficiency in avoided commuting costs and equity across the distribution of income and preferences of housing location.



## The Hidden Demand for Flexibility - A Theory of Gendered Employment Dynamics

**Maria Frech** and Gerard Maideu-Morera

Despite narrowing in recent years, three stubborn facts remain when comparing male and female employment and wages: (1) the gap between male and female wages diverges over time; (2) women are less attached to the labor force; and (3) women experience significant earnings declines after childbirth. Frech and Maideu-Morera propose females' asymmetric needs for hours flexibility as a novel channel for explaining the persistence of the gender wage gap. Their model illustrates that even in a world where men and women are equally productive, employers offer lower wages to female employees because they more frequently incur unforeseen child-rearing responsibilities on a day-to-day basis.

Frech and Maideu-Morera posit that the difference across genders in flexibility of hours, made explicit as the odds of having to limit the time an employee can provide labor on a given day, can explain the historical gender wage gap. In their model, a worker-employer pair bargains recursively over one-period contracts governing a worker's wages and hours. Prior to bargaining, workers are subject to idiosyncratic flexibility shocks only they observe. Each period they face a chance of being obligated to care for a child and only being able to provide a fraction of full-time hours. After observing their time availability, workers report this information to the firm. Because the information on availability is private (known only to the workers), the firm-worker pair bargains over a contract that incentivizes workers not to misreport their type. Conditional on remaining employed, the worker then works the hours stipulated in the contract and the employer decides whether to fire the worker before the worker receives another shock in the following period. At this stage a participant gave a technical comment that the contract structure in mathematical terms may leave which party terminates the employment relationship ambiguous.

The driving force behind gender differences in the model is that women face a higher risk of exposure to flexibility shocks each period. The unobservable nature of shocks for the firm leads to a problem of imperfect information; the firm knows only the employee's historical reported availability. This leads to a principal-agent problem, as agents have perverse incentives to misreport availability when wages and hours are decided and the firm must construct contracts according to these incentive constraints. An audience member noted that the notion of flexibility encompasses more than the intensive margin (time spent within a given period) the authors consider, and should potentially allow for positive shocks on the extensive margin as well. This was neatly summarized by a subsequent comment raising concerns over whether modeled employees should be allowed to offer greater-than-normal hours (i.e., promise overtime) in order to disincentivize termination even after receiving a string of negative shocks.

Unlike in the case of perfect information, which would allow for full insurance of shocks and prevent separations, the modeled friction leads to endogenous separation and rich wage dynamics. This friction of imperfect information paired with women's higher frequency of availability shocks leads to differentiated wage dynamics by gender. The model of Frech and Maideu-Morera generates lower initial wage offers for women, and that women experience higher wage growth conditional on continued employment. Conversely, men's wages are higher initially, but grow more slowly over time and face penalties after experiencing availability shocks.

The presentation of these results prompted a lively debate. A participant noted that this dynamic of faster wage growth for women and larger penalties for men's absences may be inconsistent with what can be observed

in U.S. data. Others saw difficulties in reconciling the contract period in the model with how employment contracts function in a real world setting. Although the period length may be set to any length of time, the audience saw it unlikely that for contracts longer than a day, an employee who experienced a flexibility shock one day would not try recuperate some of those lost hours the next. The presentation concluded with a discussion over how Frech and Maideu-Morera could incorporate gendered selection into different occupations in their model going forward.



## Personality Traits, the Marriage Market, and Household Behavior

Gastón P. Fernández and **Mariia Kovaleva**

Both research and anecdotal evidence suggest personality traits are essential determinants of marriage, time allocation, and divorce outcomes. However, many empirical studies on how personality types affect lifetime earnings to date have had little to say about these intrahousehold outcomes. Using individual-level Australian panel data, Fernández and Kovaleva document large differences in socioeconomic outcomes across personality types and calibrate a lifecycle model illustrating how personality types can better explain observed intrahousehold dynamics.

To paraphrase the authors, while common sense suggests character should be critical for marriage patterns and intrahousehold dynamics, there remains a paucity of research on how personality traits determine these outcomes. Fernández and Kovaleva follow the psychology literature and measure how agents allocate their time, conditioned on being one of three types of people: resilient, overcontrolled, and undercontrolled. Using longitudinal survey data from Australia, the authors track lifetime earnings, time use, and marriage decisions for Australian individuals. The data are unique in that the survey also measures respondents' scores along the so-called "Big Five" psychological traits, which the authors map into the personality types described above. They find that across cohorts, strong differences between personality types for men and women emerge for hours worked, propensity for marriage, and at-home production.

Conditioning on these personality types provoked an extended debate over whether economists should take the notion of these fixed and measurable aspects of a given person as structural parameters. A question was repeatedly raised: 'What is personality?' as measured by psychologists, and whether it can be elicited in an unbiased manner analogous to economic "deep"

parameters. A discussant made an excellent point in terms of the relativistic nature of typing agents through immutable parameters— as other disciplines may find it improbable that agents' discount factors or risk aversion are measurable fundamentals (let alone that are fixed with time or method of elicitation), so too should we allow for the fundamentals as-positing by other social sciences.

Fernández and Kovaleva subsequently present a lifecycle model of marriage, divorce, and home production calibrated to the observed differences between types in the Australian data. Agents begin as one of the three immutable personality types above, each of which determines the dynamics of marriage due to both differentiated match qualities and differences in preferences over intrahousehold decisions over time between market and home labor. The remainder of the session, due in part to the intensity of discussion, focused on an additional debate in the audience over the types of shocks that lead to marriage and divorce and whether it was appropriate to attribute these to personality types based on the limited set of observables in the data.





## Equilibrium Effects of the Minimum Wage: The Role of Product Market Power

Salvatore Lo Bello and **Lorenzo Pisari**

The labor share has increasingly become a metric by which equity-oriented policymakers judge the extent of inequality. An often-debated tool to increase the labor share of national income is raising the minimum wage; the logic being that higher minimum wages can eat away at profits accruing to capital and/or monopoly rents. Pisari and Lorenzo show in a multisector model that the effects of minimum wage regulations on the labor share can be ambiguous in the presence of market power in both the goods and factor markets.

A standard justification for raising minimum wages is that the costs from raising incomes at the lowest end of the distribution are borne by the capital or profit share of national income. Pisari and Lorenzo illustrate with a simple model that in the presence of concentration in the goods and factor markets, two forces compete to determine the net effects of minimum wages on labor shares. While minimum wages offset markdowns – the amount which firms discount what they pay workers below marginal value product, they can also lead to higher market concentration in the presence of fixed costs. If the minimum wage shrinks the number of firms operating in a given industry, the surviving firms can exert additional market power and will increase their markups further beyond marginal costs of production.

In their simple setting, Pisari and Lorenzo show analytical conditions under which a rise in the minimum wage has ambiguous effects on the share of income that goes to labor. Increased minimum wages push out firms in some sectors which in turn gives the remaining (larger) firms more market power and the ability to further increase markups. The effects of minimum wages on the labor share in this context become ambiguous, and depend on the initial concentration of markets, parameters governing substitutability between and across products.

A participant noted that in the simplified case some of these conditions may impose a restricting level of structure on model parameters.

The full model illustrates these findings in a richer environment consisting of monopolistic competition among a continuum of sectors, each populated by oligopsonist firms that hire specialized labor through an on-the-job search and matching process. A key assumption is that while workers vary in idiosyncratic productivity, they are confined to working in only one sector of the economy. The combination of oligopsonistic firms and sector-specific labor leads to both product markups and wage markdowns in equilibrium. These twin assumptions engendered considerable debate among participants over whether these two assumptions in tandem were too restrictive; concern was raised over whether these assumptions imposed the desired conclusions on the model without accounting properly for how each came about.

After calibrating the full model to the Italian economy, Pisari and Lorenzo run counterfactual experiments to determine how the modeled steady-state aggregate labor share varies with an externally set minimum wage. The effects of the wage floors on the aggregate labor share is hump-shaped in nature; while initial increases in wage floors beyond zero increase the labor share, the effect mediates before reaching an inflection point where further increases in the minimum wage actually decrease the aggregate labor share. Discussions concluded with commenters suggesting future work could shift focus away from the labor share as an outcome in favor of other metrics, due to the difficulty in relating changes in the labor share to agents' consumption level, labor supply, and welfare.



## Rural-Urban Migration and Structural Change: A Reinterpretation

**Tomás Budí-Ors**

Urbanization has been a major driver of development around the world. Tomás Budí-Ors began his presentation by describing urbanization as it relates to economic growth. Structural transformation and urbanization are two defining features of economic development. As countries grow richer, employment moves away from agriculture, and people migrate from rural to urban areas. To the extent that rural and urban locations are associated with agricultural and non-agricultural activities respectively, this migration is typically regarded as an important driver of structural change. Similarly, frictions that prevent migration from villages to cities are seen as important deterrents of economic development. However, there is little direct evidence on whether workers migrate to cities when they leave the agricultural sector, or on whether rural-urban migrants were farmers in the villages they leave behind.

Budí-Ors uses data from Indonesia to arrive at two notable findings. First, most worker-level reallocation out of agriculture happens within rural areas. Switches from the rural agricultural sector to urban non-agriculture are very limited; rural-urban migrants generally work in non-agriculture before moving to cities, which suggests that the non-agricultural sector in rural areas can serve as a stepping-stone for workers to move to cities. Second, worker-level reallocation out of agriculture is much lower than aggregate reallocation, which is mainly driven by the entry of younger cohorts of workers into the growing sectors of the economy.

Motivated by this empirical analysis, Budí-Ors builds an overlapping generations general equilibrium model with two locations (rural and urban) and two sectors (agriculture and non-agriculture) where workers decide their location-sector of work considering that their offspring will get educated in that location. The model combines traditional elements from the literature on structural

change, such as preferences featuring non-unitary income and substitution elasticities, with common elements in quantitative spatial models, such as costly migration and trade.

With this model, Budí-Ors can generate both within- and between-cohort reallocation of employment out of agriculture and can also cohort effects in structural change from several channels. Furthermore, the model can generate structural change out of agriculture due to asymmetric changes in productivity, trade costs, or migration costs across sectors and locations. The model can also generate cohort effects in structural change, and younger generations will have a lower share of employment in agriculture when they join the labor force than the existing old generation if there is some net rural-urban migration of older generations and certain conditions are met. Rural-urban migration of older generations serves as a mediator of the increase in educational attainment that makes younger generations work more in non-agriculture, which the model captures.

Participants had several comments. First, there was a general confusion over the difference between sector and location. That is, the audience did not understand the difference between the urban and rural distinction and the agriculture and non-agriculture distinction. Second, they were unclear about the interpretation of the model, and they wanted to know the implications of the model findings. Finally, several participants wanted to hear a clearer story behind the model; why should anyone care about the generational aspects of the model and what happens if agents no longer value their children's welfare as much as their own.



## Commodity Booms, Variable Markups, and Misallocation

**Clara Arroyo**

Commodity booms often do not result in lasting benefits for the countries experiencing them. Clara Arroyo studies whether commodity booms can have additional effects on aggregate productivity through increased misallocation within the manufacturing sector. She then briefly argued that this can happen if the real exchange rate appreciations that typically follow commodity booms result in an increase in markup dispersion among firms.

The audience was critical of Arroyo's description of markups, asking her to describe how she was able to establish that markups exist. One audience member went so far as to liken markup dispersion among firms to thievery on behalf of those firms that were charging higher prices. Arroyo responded that she saw some firms charging higher prices than others for similar products, which she attributed to markups; she denied making any moral claims. Another audience member claimed that markups can be thought of as companies "passing through" costs to the consumer. Another participant argued that the quantity of interest is profits, not markups. Furthermore, markups depend on one's definition of fixed and variable costs, which are dependent on the time period considered. So in a sense focusing on markups seems a bit arbitrary – which is why, again, profits should be the focus.

Arroyo went on to describe the variable markup framework she uses to quantify her claims. Her framework involves a two-country model with domestic and foreign producers that engage in Cournot competition in both markets. She calibrates the model to match some features of the data for Chile before the substantial increase in the price of copper, its primary export product, in the early 2000s. Specifically, she uses firm-level data from the Annual Industrial Survey

conducted by Chile's statistical office. She then feeds the model the real exchange appreciation observed during the boom (between 2002 and 2007), and analyzes its impact on markup dispersion and misallocation.

Next Arroyo presented preliminary results based on solving the partial equilibrium of the model. These results indicate that commodity booms can indeed lead to increased misallocation and lower aggregate productivity through higher markup dispersion. As the markups of large firms increase more than those of small firms, markup dispersion rises and total factor productivity losses increase by almost 4.5 percentage points over the period. These findings can have important implications for policymakers in countries that rely heavily on commodity exports, as they suggest a new margin to consider when taking monetary and fiscal policy decisions.

One participant was curious how Arroyo defined "large" firms. She explained that large firms are those that are in the top 25% of market share distribution. Another participant was skeptical about the size of the markups, noting that in one of Arroyo's slides, the markup was nearly 50%, which seems unrealistic. Another member of the audience pushed back against the skepticism, saying that the markup is only on variable costs which represent, for example, 40% of costs; so, the true markup would be closer to 20%.



## Welfare Consequences of Fiscal Consolidation Plans: The Role of In-Kind benefits

**Paula Sánchez Gil**

Fiscal stimulus packages rolled out during the COVID-19 pandemic have been the subject of much debate. Paula Sánchez Gil studies the United Kingdom and finds that the provision of in-kind benefits has a progressive redistributive character. This fact is important to adequately capture how social expenditure retrenchments affect households' welfare and inequality during and after fiscal consolidations. Households at the bottom of the income distribution rely on the consumption of in-kind benefits to a greater extent than those at the top. Therefore, the provision of in-kind benefits has a significant and progressive redistributive effect, leading to a reduction in inequality. When considering the imputed consumption of in-kind benefits, the decrease in the Gini coefficient from post-tax income to final income amounts to 10.96%.

She began the presentation by showing that households at the bottom of the income distribution consume in-kind benefits at a much higher rate than richer households. She goes on to say that the redistributive role of these policies and their effect on household welfare have been understudied in current literature. Her paper aims to address this gap in two ways. First, it provides a novel approach to model social expenditure consumption by households, which generates a distributional consumption pattern that matches the observed one. Second, it analyzes the welfare effects of a cut in social expenditure, considering two types of instruments: the quality of provision and the user-cost of in-kind benefits. The study distinguishes between partial and general equilibrium effects to disentangle the different distributional welfare effects, quantifies the redistributive role of in-kind benefits in reducing the Gini coefficient, and compares consolidation speed strategies: front-loaded, linear, and back-loaded consolidations.

Gil went on to describe her model. She proposes a heterogeneous agents model with incomplete markets and idiosyncratic risk with no aggregate uncertainty, following the tradition of Bewley-Hugget-Aiyagari. The economy is composed of three sectors: Households, a representative firm, and a government. Agents are infinitely lived, the time is discrete, and the environment is a closed economy.

At this point, participants had some comments and questions. One person asked why Gil decided to focus on quality of public goods provided rather than the quantity of goods provided. Gil responded that this is the easiest way to capture convexity of choices. Other audience members were confused when Gil introduced the maximization problem. They did not see how substitutability between publicly and privately provided goods was captured in the equations that Gil was presenting.

Gil continued, explaining the analysis she conducted. She analyzes the welfare effects of a fiscal consolidation performed through a decrease in the quality of the in-kind benefits provided by the government and a hike in the user-cost of in-kind benefits. She investigates both short and long run effects. In the long run analysis, she performs a steady state comparison, whereas in the short run analysis, she evaluates the transitional dynamics between the two above referred steady states. In the short run, she considers three types of fiscal consolidation plans: front-loaded, in which most of the debt is consolidated in the first periods, a linear plan, in which the debt decreases linearly within consolidation period, and backloaded, in which the debt is reduced in the final periods.

Gil finished the presentation by briefly describing the results. She finds that the positive long-term effects of fiscal consolidation are not offset by the short-term



detrimental welfare effects. However, households in the lowest quintiles suffer the most during consolidation if we rule out price effects. Thus, the plausibility of price effects generated during the fiscal consolidation is crucial in determining the distributional welfare consequences of such a plan. Easing access to public healthcare and education is marginally preferred by households in the long run, compared to improving their quality, assuming factor prices adjust. However, the opposite holds in the short run. In terms of the preferred fiscal consolidation speed, linear consolidation is preferable in general equilibrium, while back-loaded consolidation is the least welfare-detrimental if factor prices do not respond to the fiscal consolidation.



## Marginal Propensities to Consume with Behavioural Agents

**Andrej Mijakovic**

After the advent of Keynesian economics, the notion of the marginal propensity to consume (MPC) has featured prominently in discourse concerning fiscal and monetary policy. Despite the eminent role played by the MPC, standard models of consumption and savings fail to capture several empirical regularities. Benchmark models typically do not predict three patterns of consumption found in the data: it is sensitive to transient income and insensitive to changes in wealth future income, and the MPC is asymmetric, responding more strongly to income losses than gains. To address these shortcomings, Mijakovic argues that a standard lifecycle consumption model, augmented with mental accounting costs, helps explain these gaps between the data and standard formations.

Mijakovic begins his paper by presenting results from survey data on reported marginal propensities to consume. Richness in the survey of consumer finances solicits the different shares from both a positive and negative income shock respondents would allocate towards savings (or paying down debts) vs. towards consumption. This analysis shows a substantial asymmetry in MPCs for losses and gains; agents consume only 20% of a positive income shock on average, while reduce consumption by over 70% for each dollar lost. Mijakovic shows that while this behavior could be rationalized for liquidity constrained agents at the bottom of the wealth distribution, this pattern holds true across all five quintiles in the data. A brief discussion ensued over the external validity of respondents' answers to these questions in a hypothetical setting, to which the presenter responded this asymmetry is also present in lab trials and quasi-experimental evidence.

With empirical evidence in-hand, Mijakovic begins with a stylized savings decision problem to illustrate the role

of liquidity constraints in tandem with mental accounting. The latter helps explain MPC asymmetries for low-wealth agents. When faced with a negative income shock, an agent at their borrowing constraint must decrease consumption one for one; in contrast, they may save a large portion of a positive income shock to buffer against future shocks. However, this mechanism cannot explain the asymmetry for high-wealth agents who are not borrowing constrained and should in principle dissave to smooth consumption.

Mijakovic provides a solution in mental accounting; he imposes a preference structure in which agents find it costly to reduce their savings below a "planned" level they feel obligated to maintain. This mental accounting constraint puts a kink in agent's MPCs; when an income shock forces them to dissave they find it especially costly to do so if it drops them below planned savings. The resulting extra cost of smoothing consumption helps explain both the asymmetry in MPCs as well as loss aversion seen in survey data. A participant asked whether these preferences satisfied standard desirable properties such as monotonicity and transitivity. Another questioned whether the mental accounting framework was observationally equivalent to a model with one-sided transaction costs imposed on agents liquidating assets. The discussion concluded with another technical question over the formation of planned savings levels, and how they might be better constructed to provide a more exact benchmark against which to compare the mental accounting model.



## Supply Chain Dynamics with Search Frictions

**Lauri Esala**

In the years since the pandemic, nearly everyone has become familiar with problems in supply chains. Lauri Esala studies supply chain disruptions when there is a network of connected suppliers and buyers. His framework imposes supply chain disruptions that sever ties between suppliers and buyers. This necessitates a post disruption rematching of suppliers and buyers, which Esala treats as a search friction cost.

Esala began his presentation by giving evidence that supply chain networks exist. That is, suppliers and buyers form relationships that are lasting and meaningful with buyers typically only using one supplier. These network dynamics have not been fully considered in the extant literature.

Esala then described how he attempts to fill this gap. In particular, he proposes a model of multi-stage production where firms' choice of trading partners is subject to search frictions. In the baseline version of the model, production is organized in linear supply chains, where each firm matches a maximum of one buyer and one seller. Each intermediate goods firm is endowed with a stage-specific Cobb-Douglas technology combining labor and a single input that can either be produced in-house or bought from an upstream supplier. Buyer-supplier linkages are formed using random search, while allowing for chains of different lengths to emerge. Matched firms continuously search for better trade partners, similarly to "on-the-job search" in labor market models. Pricing is kept simple, with each firm matched with a customer earning a mark-up on their unit cost.

There are several important mechanisms built into the model. First, the key adjustment cost in the proposed framework is a search friction. This friction affects the formation and maintenance of buyer-supplier linkages between firms by making them persistent, time-

consuming to form, and difficult to replace. Firms look for both buyers and sellers in a continuous-time model of a multi-stage production process and seek to join chains with high flow profit while taking into account forward-looking considerations such as the fragility and growth potential of a chain. Second, the model accounts for these considerations by having firms consider a notion of mismatch in chains when making their matching decisions. For example, a highly productive upstream firm may find it advantageous to join a production chain with an inefficient final goods producer, if its other suppliers are also highly productive. The logic is that the new chain will likely be able to replace the final goods firm with a more efficient one and start earning much higher profits.

Many participants were curious as to how the supply chain disruptions in this context should be interpreted. Esala responded that you can imagine a firm's "phonebook" of connections getting destroyed. No firms are destroyed, but the connections are. Other participants were critical of the pricing and profit mechanism, suggesting that Esala incorporate bargaining into his analysis. Others were concerned that the exercise lacked realism.

Esala concluded by presenting an illustrative calibration that highlights the key mechanisms shaping the steady-state distribution of productive chains. Through this exercise he illustrates a striking result that the highest-productivity firms in every stage tend to sort into matches with each other, while the lowest-productivity firms often remain completely unmatched. Even the lowest-productivity firms in the middle stage receive some boost to their chances of matching from their key role in the elaboration of upstream inputs for usage by downstream firms.



## Financial Skills and Search in The Mortgage Market

**Marta Cota**

In recent decades efforts have been made to improve the financial literacy of lower-income individuals. Marta Cota and coauthor Ante Šterc investigate the role of financial literacy when it comes to searching for and acquiring a mortgage loan. They find that, compared to those with lower financial literacy, people with high financial literacy are more efficient at searching and procuring mortgages with lower interest rates. Indeed, they find that a large proportion of the dispersion in borrower interest rates can be attributed to differences in financial literacy.

Cota began by describing the data sources that they brought together for analysis. For mortgage and borrower data, they use the National Survey of Mortgage Originations (NSMO). One key question from the survey asks respondents how many different mortgage borrowers/lenders they considered before choosing where to apply for their mortgage. The authors use this variable as a measure for search effort. They show that respondents who are more educated tend to spend more time searching. The second data source they use is the Survey of Consumer Finances (SCF). Using this survey, they show that more educated respondents are more likely to answer financial literacy questions correctly.

Next, Cota described how the authors were able to link the NSMO and SCF data using Bayesian Record Linkage. With this merged data, they find that the interaction of search effort and financial literacy explains a significant portion of the mortgage interest rate dispersion for borrowers that refinance.

A participant asked if she accounts for other things that may be confounding the relationship between financial literacy and search effort, such as income. Cota responded that while they do not employ any methodology to account for unobservable confounders,

they include a slew of controls including income. Another person asked how exactly financial literacy is measured. Cota responded by saying that there are three levels to their measure of financial literacy corresponding to how many of the three questions on the survey the respondent answered correctly.

From here, Cota described their model. The model is a dynamic stochastic general equilibrium (DSGE) model that incorporates costly search for refinancing options in the mortgage market. They parameterize it at the annual level and include exogenous and endogenous parameters. The exogenous parameters combine data estimates with literature standards, while the endogenous parameters are determined by the model's equilibrium conditions. They use the model to evaluate the consumption and wealth inequality differences in alternative mortgage offer rate settings and to test the financial education policy that implicitly decreases search costs in the mortgage market. The model performs well in matching the joint data patterns in mortgage rates, financial skills, and assets level.

The authors find that the decrease in the average mortgage offer rate implies greater consumption inequality in the economy. Homeowners exert more effort due to lower mortgage rates, and eventually consume and save more. In contrast, search costs disincentivize renters from exerting effort, keeping their housing costs relatively higher. Consumption inequality increases by 2.6%, whereas wealth inequality increases by 2.2%. They also find that financial education policy that implicitly decreases search costs in the mortgage market can increase the homeownership rate by 2% due to the loss in additional value of becoming a renter, with locked-in mortgages exhibiting an increase in dispersion. Moreover, consumption and wealth inequality decrease by 1.8%.



## Global Robots

**Fabrizio Leone**

Automation has long been a focus of modern economies. Fabrizio Leone uncovers novel facts about the robotics industry, using a novel dataset about the global presence of the major robot suppliers worldwide, which he constructed. Second, he develops a quantitative multi-country general equilibrium model of robot demand and supply, which he uses to investigate the effects of a robot tax.

Leone started the presentation by describing the supply side of the robotics industry, which is the focus of his paper. The supply chain of robots consists of three stages: production, integration, and adoption. Producers (which I also refer to as suppliers) are technologically advanced multinational enterprises, typically headquartered in central Europe and Japan. Users tend to be large manufacturing firms. The most peculiar stage is the integration one. Robots are complex machines, and adopters usually require the help of integrators, i.e., specialized intermediaries that purchase robots from producers, help users to select the appropriate robot for their needs, and provide post-sale services such as customization, installation, and maintenance. Even if robots are tradable, these services are not. Therefore, frequent interactions and physical proximity between integrators and end users are crucial for the adoption, and suppliers must establish a retail network of branches in each market they intend to serve. This feature limits the scope of direct sales to end users and horizontal and export-platform foreign direct investment (FDI), which are common in other sectors.

One participant criticized Leone for not stating more clearly the concrete contributions of his paper before launching into the details of the industry. Taking this criticism into account, Leone skipped forward to describe the key contributions of his paper: first, he constructs a new dataset about the global retail network of the major robot suppliers in the world to document novel facts

about the industry. Second, he develops a quantitative multi-country general equilibrium model of robot demand and supply, whose key novelty is accounting for the role of integration services, the formation of global retailing networks, and competition between suppliers. Third, he uses the model to revisit the welfare and distributional effects of policies aimed at slowing down or fostering the adoption of robots.

From here, Leone described the data he created. Using the list of members of the International Federation of Robotics (IFR) and Orbis Bureau van Dijk, he compiles the list of the top ten suppliers of robots in the world, which accounted for approximately 90% of worldwide robot sales in 2021. Information about the location of their headquarters (HQ) and financial accounts also comes from Orbis. From the suppliers' web pages, he collects information about the number of countries they served and their number of integrators per country in 2021. The characteristics of these countries (e.g., stock of robots, GDP, employment, productivity, trade flows, and geographical location) come from commonly used data sources. The final dataset provides a comprehensive snapshot of the global retail network of major robot suppliers and the countries they serve.

Next, he described some stylized facts that the data allows him to uncover. First, robot supply is highly concentrated. Second, suppliers' entry choices follow gravity. Suppliers show a higher propensity to enter countries that are geographically closer to their HQ. Upon entry, they also tend to establish more branches in these countries.

Leone explained that his model is based on three building blocks: the households' problem, the final goods producers' problem, and the robot suppliers' problem. It is the last of these where Leone offers new analyses. In line with the stylized facts, he lets robot suppliers compete



oligopolistically in the global economy. Second, he allows for international trade in final goods and the formation of global retail networks to evaluate the local and global outcomes of a robot tax. Robot suppliers make three choices: which markets to serve, how many retail branches to establish in each market, and the price to charge local firms. Both entry choices require paying a cost in terms of non-routine local labor. Suppliers are heterogeneous in terms of demand shifters, which reflect differences in their appeal to robot users potentially arising from the different post-sale services offered.

Leone concluded by reporting his results as they pertain to the EU. An EU-wide tax on robot adoption would increase the welfare of routine EU households by 4.19% and decrease the welfare of non-routine EU households by 0.81%. A tax would lead to suppliers exiting EU markets mostly at the intensive margin. This would result in higher robot prices, increased welfare gains for routine households, but also higher consumer prices and more significant welfare losses for non-routine households. Comparing welfare changes emphasizes the importance of considering supply-side reactions when evaluating the effects of a robot tax in the EU: ignoring these reactions would result in underestimating the welfare gains of routine households by 80% and the welfare losses of non-routine households by 40%.



## Commodity Exporters, Heterogeneous Importers, and the Terms of Trade

**Joris Hoste**

Predicting shocks to trade has become an increasingly important motivation to build trade models. Joris Hoste presented a paper coauthored with Guilherme Tonsig Teijeiro in which they develop a tractable version of Gopinath & Neiman (2014) with segmented financial markets and realistic real exchange rate determination and provide a bridge to the standard frictionless small-open economy (SOE) framework. First, they show how the differences between the models are captured by two partial elasticities for which they provide analytical expressions. Second, they show that a combination of these two partial elasticities determines the relative importance of shocks to the terms of trade independently of assumptions on market structure, returns to scale, selection into importing, and financial markets.

Hoste began by giving an overview of the current literature on commodity-exporting countries. Researchers typically use small-open-economy (SOE) models to understand the fundamental shocks that generate aggregate economic fluctuations. A large body of literature has focused on evaluating the importance of shocks to the terms of trade relative to exogenous productivity shocks as a source of aggregate consumption volatility. Many papers suggest that these unobserved productivity shocks are necessary to match the observed volatility in the data. To reduce the reliance of these models on unobserved shocks, recent work has highlighted the importance of accounting for the heterogeneity in firm-level trade adjustment in generating endogenous movements in aggregate productivity.

Next, Hoste described how their paper expands the research frontier in this domain. Namely, they study whether models that can match the stylized facts of trade adjustment at the firm level also predict that shocks to the terms of trade are relatively more important than

models that do not. In the former, the largest and most productive firms are the ones that are most reliant on imported inputs, so it stands to reason that in these models, movements in the relative prices of imports and exports may have a larger impact on aggregate consumption. To do so, we develop an SOE model of a commodity-exporting economy that nests a frictionless benchmark model with representative producers, a general equilibrium version of the heterogeneous trade adjustment model, and other models in between.

Hoste described their results. The first result is that any differences in market structure and technology are summarized in the expression of a general equilibrium elasticity, which sits between zero and the input share of services. In models where general equilibrium elasticity is quantitatively high, changes to the terms of trade became more important relative to changes in the productivity of the manufacturing sector. The second result summarizes the relative importance of terms-of-trade shocks and productivity shocks as a share of aggregate consumption volatility in a single equation.

Hoste spent the rest of the presentation going through the mathematics of the analysis. Many participants pushed Hoste to frame their findings in a more positive manner. That is, rather than pointing out what other papers and research is lacking, they ought to focus on what their paper does.



## Human Capital in Macroeconomics

September 15 – 16, 2023, Conference Participants

Harun Alp – *Federal Reserve Bank of St.*  
 Pedro Amaral – *Cal State Fullerton*  
 Alexander Bick – *Federal Reserve Bank of St. Louis*  
 Andrea Eisfeldt – *University of California Los Angeles*  
 Chao Fu – *University of Wisconsin-Madison*  
 Carlos Garriga – *Federal Reserve Bank of St. Louis*  
 Christopher Herrington – *Virginia Commonwealth University*  
 John Kennan – *University of Wisconsin-Madison*  
 Tatyana Koreshkova – *Concordia University*  
 Finn Kydland – *University of California Santa Barbara*  
 David Lagakos – *Boston University*

Amartya Lahiri – *University of British Columbia*  
 Oksana Leukhina – *Federal Reserve Bank of St. Louis*  
 Lars Ljungqvist – *Stockholm School of Economics*  
 Nick Pretzner – *University of California Santa Barbara*  
 Michelle Rendall – *Monash University*  
 Peter Rupert – *University of California Santa Barbara*  
 Yongseok Shin – *Washington University in St. Louis*  
 Pedro Silos – *Temple University*  
 Guillaume Vandenbroucke – *Federal Reserve Bank of St. Louis*  
 Oliko Vardishvili – *University of California Irvine*





## Risk and the Misallocation of Human Capital

**Pedro Silos**, *German Cubas*, and *Vesa Soini*

If students choose to learn skills that fail to match up with the needs of employers, the economy can suffer from poor productivity. But there are risks when students choose to specialize in a technical field. A technological advancement could render the certain special skills obsolete. This has become especially salient recently, as new technologies have the potential to replace many jobs, even those with high skill levels. In recent decades, international trade has played a similar role for workers who chose to develop manufacturing skills. It's hard to predict which skills will be valued in the future, and there's no established way to insure against new developments that may reduce the availability of jobs or wages.

Talented but risk-averse workers may try to avoid occupations with more risk of technological change, which can result in poor economic outcomes for them and the economy overall. Pedro Silos presents work with his co-authors in which they study how uninsurable permanent risk to a worker's human capital shapes the aggregate allocation of talent. The paper proposes an occupational choice model, with occupation-specific and idiosyncratic earnings risk and workers heterogeneous in occupation-specific abilities. This is sometimes referred to as the Roy model.

The authors' model allows for a derivation of wage and earnings premia, ultimately allowing for measures of distance between the first best, constrained efficient, and laissez-faire allocations. More specifically, by using an equilibrium Roy model with incomplete markets, the authors show that risk-averse workers choose an occupation based on the occupation-specific risk they face and on their comparative and absolute advantages. The tractability of the Frechet distribution allows for a closed-form solution of the competitive equilibrium

allocation. In a competitive equilibrium, human capital is misallocated because workers avoid risky industries. The social planner allocates more workers to risky industries. The higher the risk aversion and the lower the degree of comparative advantage, the larger the misallocation.

The conference attendees asked about the definition of risk in this paper. For example, they mentioned technology risks, like ChatGPT. They were interested in seeing validation of the assumption that workers are risk averse. The author responded that survey data could be used to address this. Audience members also inquired about why the authors show two stages and why each stage has different distributions.

Quantitatively the authors estimate a permanent output loss of about 0.6 percent due to market incompleteness and welfare losses in the order of one percent of GDP. About a third of these losses are generated by pecuniary externalities that workers do not internalize.

The exercise abstracts from many aspects of the labor market and the career choices of the individuals. From this perspective, they think their measured misallocation can be a lower bound in quantitative exercises and hope their findings encourage future research that relaxes these assumptions, such as through the inclusion of policy or the addition of other ingredients to the model.



## Cross-Country Income Dispersion, Human Capital, and Technology Adoption

**Pedro S. Amaral** and Alberto Rivera-Padilla

One of the oldest and most debated topics in economics is the question of what factors drive differences in economic output between countries. While human capital, which we typically think of as education, has been shown to be an important driver, less is known about how human capital might interact with other important determinants of such productivity differences, such as the presence or absence of barriers to technological adoption. Pedro S. Amaral presented work written with his co-author Alberto Rivera-Padilla that argues the extent to which countries adopt better, more efficient technologies, is related to their human capital level in a way that is quantitatively important to account for cross-country income differences. They argue that their approach better captures empirical differences between countries' economic output statistics.

Amaral and Rivera-Padilla document that schooling is robustly correlated with measures of technology adoption and usage, as well as with the prevalence of traditional forms of organization of production, where technology adoption is relatively limited and productivity is lower. Motivated by these raw facts, the authors build a general equilibrium model with endogenous occupational choices and human capital investment. Technology choices are endogenous and depend on human capital and country-specific barriers to adoption. Organization of production matters for technology choice, and technology choice is only available in the modern sector.

In their quantitative experiments, the authors use rich microdata to calibrate the model to the United States to ultimately use for comparison with counterpart countries. They vary schooling years and barriers to technology adoption across countries and compare the quantitative importance of education years and barriers

to technological adoption for income gaps between country. Their benchmark economic model appears to capture more than 85 percent of the income differences between the United States and the average country in the bottom quartile of the world income distribution. As a comparison, a model in which individuals acquire education but where technology adoption is absent can only generate predictions that explain half of the income differences between the United States and the average bottom-quartile country. Amaral and his co-author conclude that the complex interaction between education and technology adoption is quantitatively meaningful in accounting for cross-country income dispersion.

A participant asked about the possibility of including the schooling quality. The speaker responded that since they have the data, they might consider this factor. The speaker also found that the relative income of the poorest quartile countries more than doubles when each channel is considered in isolation. The relative income of the poorest quartile countries is three times larger than in a one-sector span-of-control model with human capital. Accounting for education differences significantly reduces the size of adoption barriers needed to rationalize data in low output economies.





## Aggregate and Distributional Effects of ‘Free’ Secondary Schooling in the Developing World

**David Lagakos**, with Junichi Fujimoto and Mitch VanVuren

A common opinion among economists is that raising human capital levels through improved education is the key ingredient to economic development. As a result, many developing countries are currently considering or already implementing free schooling policies, which they expect to raise human capital levels. David Lagakos presented work co-authored with Junichi Fujimoto and Mitch VanVuren that analyzes the aggregate and distributional effects of free secondary schooling policies in the developing world.

Lagakos and his co-authors employ an overlapping generations model of human capital accumulation with credit constraints. They incorporate the opportunity costs of working during schooling years, merit requirement for admission that can be relaxed under free schooling, and fertility levels that depend on education levels. The authors ultimately find that the hope that developing countries may place in free universal schooling appears to be misguided, leading to declines in gross output. However, they also detail how alternative policies can be engineered to have better effects on the economy.

The authors consider the nation of Ghana, for which they find evidence that students randomly assigned to receive free secondary schooling led to higher secondary school completion rates and higher average test scores. The paper suggests that human capital levels would improve more in poor countries by raising the quality of existing schools rather than by expanding the reach of education to more young people through new, free schools. In simulating the effects of free schooling policy, secondary attendance increases by 33 percent, but GDP drops by one percent. The estimated model implies a relatively high opportunity cost of entering school, particularly for new entrants to secondary schools who are less academically talented. From the alternative

policy, which improves school quality, GDP increases by 3 percent, with the same costs as the free schooling policy.

Noting the aggregates effects is important, but it is also worth pointing out that free schooling’s complex effects are a result of heterogenous effects on different segments of the population. Richer households suffer welfare losses from the higher taxes required to fund free schooling, but the poorest households gain from the policy. So, free schooling redistributes. While improving school quality but limiting access may be more efficient for the economy overall, such policies would not be supported by low-income citizens.

A participant asked the speaker about the quality of free secondary schooling in other countries. The speaker gave examples from developing countries, pointing out that the quality of free secondary schooling is not nearly as high as it is in the United States. Another participant was curious about what the control group is and what kind of test the people who do not attend schooling must take to be an appropriate comparison. The speaker was able to answer this question in detail. Other participants asked whether the authors considered that education could affect fertility through many channels. The speaker responded that they only considered the distributional effects of free secondary schooling as a channel.



## Convergence Across Castes

Viktoria Hnatkovska, Chenyu(Sev) Hou, and **Amartya Lahiri**

Countries like India have undergone transformative macroeconomic changes in recent decades. Amartya Lahiri presented work with co-authors that asked how such changes affect inequality between advantaged and disadvantaged groups. India is notable for its historical caste system, and the country has witnessed a remarkable catch-up by the historically disadvantaged scheduled castes and tribes in their education attainment levels, occupation choices, and wages from 1983-2012. But it remains unclear exactly which mechanisms, be they economic changes or government policies, are most responsible for driving the progress that has been experienced among disadvantaged groups. India had affirmative action policies in place for much of this period, and the authors find that these policies played a smaller role than structural changes to the economy and education.

The authors first examine data on the evolution of caste gaps in education attainment rates broken down by age and birth cohorts. A key finding from this exercise is that caste education gaps within birth cohorts remained relatively unchanged until 1993, after which there was a decrease. The authors interpret this as evidence of people perceiving educational attainment as a key determinant of the opportunity to change employment to new sectors. By using a heterogeneous agent, multi-sector model, the authors show that sectoral productivity growth during this period can explain 72 percent of the observed wage convergence between the castes. Convergence was mostly driven by education, and re-sorting had an important role. They also find that affirmative action policies that reduced skill acquisition costs for scheduled castes and tribes may have reduced the levels of the caste wage gaps, but played a limited role in accounting for the dynamics of the wage gap. Growth has mitigated

caste-based talent misallocation.

Participants were interested in how much education and wage affect the gap, and what drives the real wage gaps between scheduled castes and tribes and other groups. The speaker showed some figures that report the relative gaps in education attainments and median wages between the groups, broken down by employment sector. The education gaps have narrowed significantly over time between the two caste groups. Median wage gaps declined in services, but persisted in manufacturing, and widened somewhat in agriculture.

It was primarily the switch into service sector jobs by lower castes, the authors claim, that drove the improvements among disadvantaged groups, and this switch to the service sector was enabled by education opportunities and improvements in the productivity and compensation in the service sector that made those educational opportunities more attractive.

Using their model, the authors try estimate the economic costs that caste distortions introduce. They do this by hypothetically equalizing the cost of education and of entry into an economic sector, which are the two factors distorted by caste discrimination. This hypothetical exercise increases average per capita consumption by 10.2 percent in 1983 and 10.3 percent in 2012. These numbers are for the overall population, and are naturally much higher for those belonging to the disadvantaged groups.



## Hours Worked and Lifetime Earnings Inequality

**Alexander Bick**, Adam Blandin, and Richard Rogerson

There is naturally some variation in the amount of time in a week that people choose to spend working. Of course, this choice of hours worked will influence earnings and can contribute to observed inequality of income. But to the extent that we care about the welfare implications of inequality, it's important to understand the potential role that preferences about how many hours to work plays in income inequality. The human capital model often overlooks the significance of hours worked. This study illustrates the importance of hours worked by extending the standard model. It aligns with unique findings on lifetime earnings and hours from the NLSY79 dataset.

The study reveals a substantial disparity in lifetime hours, primarily driven by variations in weekly hours worked. The 75th percentile of hours worked exceeds the 25th percentile by approximately 500 hours per year, correlating higher lifetime hours with increased earnings. A 500-hour difference results in a 45 percent disparity in lifetime earnings, persisting even 20 years into one's career. While years and weeks worked exhibit little variation except in lower distributions, weekly hours worked show significant variation.

Models assuming only leisure preference heterogeneity, while lacking initial human capital heterogeneity, learning ability heterogeneity, human capital and leisure preference shocks, tax systems, and transfers, can only explain a third of earnings variation. This paper emphasizes the importance of these factors in explaining how hours worked impact lifetime earnings inequality with only minimal assumptions, such as on-the-job investments and classical measurement errors in hours and earnings. The result shows that lifetime hours variation explains 18 percent and 40 percent of lifetime earnings variance in

homogeneous and heterogeneous models, respectively. Audience members asked about the substantial role of preference heterogeneity in lifetime earnings. The presenter responded that it influences human capital accumulation decisions, subsequently affecting time allocation and lifetime earnings.

The study conducted a counterfactual tax policy experiment, switching from progressive to linear taxation. In the heterogeneous preference model, the mean level and standard deviation of human capital investment both increased significantly, resulting in a 17 percent and 45 percent rise in mean and standard deviation of lifetime earnings. This underscores the relevance of heterogeneity in aligning time allocation and lifetime earnings.

This research emphasizes the pivotal role of hours worked in lifetime earnings inequality, with 40 percent of earnings variation attributed to hours dispersion. Counterfactual tax experiments underline the significant impact of human capital and preference heterogeneity on both time allocation and lifetime earnings. We might consider treating human capital and preference heterogeneity differently in terms of their effects on incomes, because each of these factors have different welfare implications.



## Time Averaging Meets Labor Supplies of Heckman, Lochner, and Taber

*Sal Seb Graves, Victoria Gregory, **Lars Ljungqvist**, and Tom Sargent*

The technical choices that economists select when modeling economic decision making can have major consequences for how we understand the aggregate implications of economic conditions and policies. Lars Ljungqvist presented work with several co-authors in which they incorporate time averaging into the canonical model of Heckman, Lochner, and Taber (1998), or HLT, to study retirement decisions, government policies, and their interaction with the aggregate labor supply elasticity. Policy details, like how retirees become eligible for pensions, can have dramatic effects of labor decisions. To the extent that we can better, more realistically model labor decisions in the presence of these kinds of policies, the analysis provided by economic modeling can become more reliable.

The paper extends the HLT model, allowing all agents to choose their career length, in contrast to the original HLT model, which mandated retirement for all agents at age 65. This model introduces two additional extensions. First, there is an idiosyncratic nonpecuniary random cost associated with attending college. This shock is expressed in utilities rather than dollars. Second, a pay-as-you-go social security program is introduced to the model to reduce aggregate savings, aiming to achieve the targeted capital output ratio. This ratio is a crucial calibration target for this paper.

Several counterfactual experiments are conducted to answer vital questions, such as explaining the shorter career lengths of high school workers compared to college workers. The paper finds that the social security system, redistributing from high-ability to low-ability agents, serves as a key mechanism. All workers pay the same proportional payroll tax on their labor income. The equal social security benefit given to all retirees means that agents with low earnings receive more than they

contribute to the system. The income effects of this net transfer to low-ability agents, who are more likely to be high school workers, induce them to supply less labor. This finding is related to an earlier result from an economy with earnings experience profiles, where the optimal career length increases with the elasticity of earnings concerning accumulated working time.

The paper then discusses the impact of endogenous career lengths and indivisible labor on labor market outcomes and human capital accumulation. The inclusion of a social security system affects individuals' choices regarding retirement age, especially for those with varying abilities and education levels. The study shows that workers with more elastic earnings profiles tend to have longer careers, particularly if their human capital technology is more productive, as is the case with college-educated workers.

Changes in tax rates significantly influence career choices and human capital investments. High labor taxes can lead to a divided labor market, with active workers and marginalized individuals. The study also highlights nonconvexities in career strategy choices, indicating that minor changes in determinants can lead to discontinuous and significant shifts in career length and human capital investments. Lastly, the paper discusses the policy implications of its findings, emphasizing that government policies affecting tax wedges and distortions can impact labor market participation, potentially causing economic instability if not managed carefully.





## Racial Gaps in Student Loan Repayment and Default: A Life Cycle Approach

Kartik Athreya, **Chris Herrington**, Felicia Ionescu, and Urvi Neelakantan

Black borrowers have higher default rates on their student loans than White borrowers, even when controlling for educational attainment. This is despite the similarity in the distribution of the amounts initially borrowed by Black and White borrowers and the fact that Black borrowers are likelier to enroll in repayment plans with smaller monthly payments. Interestingly, Black college graduates are more likely to default than Black nongraduates.

While many have discussed the role of student debt on different racial groups, a study that carefully models default decisions and captures racial disparities has yet to be offered. This paper builds and calibrates a model to match lifecycle moments for college graduates, aiming to understand the implications of student debt repayment and default on lifecycle outcomes. The study demonstrates how initial conditions impact default rates and lifecycle choices across racial groups.

Black students are 1.4 times more likely to borrow than White students and accumulate more student debt, although initial differences are not substantial. Black borrowers pay off their debts more slowly, their balances are more likely to rise over time, and they are significantly more prone to default. The Black-White default ratio for non-graduates is 2, and for graduates this number rises to 4. Questions about how initial conditions, such as family income and parents' education, affect the default choice were raised by the audience. Surprisingly, even with the same initial conditions, Black students are more likely to default.

In the model, individuals start their lifecycle as graduates or non-graduates. They differ in unobserved learning efficiency and human capital, as well as observed financial wealth and student debt. Individuals allocate their time between labor and learning, make

consumption decisions, and decide whether to default on their student debt. There are two payment options: fixed payments per period for 10 years or payments based on a fraction of current income above a threshold level for 20 years, with any remaining principal forgiven. The calibration strategy aims to match observable group-specific parameters outside the model and jointly calibrate group-specific parameters for unobservable initial conditions, initial learning efficiency, and human capital distributions within the model to match key earnings moments.

The paper finds that student debt depresses average human capital, earnings, and wealth over the lifecycle more for Black individuals than for White individuals. For example, Black individuals accumulate 27 percent fewer financial assets than their White counterparts. This is because student debt compels individuals to spend more time earning money rather than learning early in their lifecycle. An important question addressed in this paper is the contribution of initial conditions to the default gap. Counterfactual experiments reveal that removing learning efficiency, initial human capital, and initial wealth reduces the default gap by 19 percent, with 83 percent of this effect attributed to learning efficiency and initial human capital.

Student debt and default affect lifecycle outcomes differently across racial groups. While student debt impacts lifecycle choices for both races, its effect is more significant for Black individuals. Both White and Black defaulters experience lower earnings and accumulate less wealth. The initial distribution of learning efficacy and human capital plays a crucial role in understanding racial disparities.





## The Limited Impact of Free College Policies

Maria Marta Ferreyra, **Carlos Garriga**, Juan David Martin-Ocampo, and Angelica Maria Sanchez-Diaz

With higher education's status as an important contributor to the formation of human capital, free college advocates have been garnered attention. But does free college actually increase graduation rates? It seems that countries with higher college subsidies tend to have higher enrollment, but not higher graduation rates. To address this paradox and resolve the corresponding policy question, Carlos Garriga and coauthors use a dynamic model of college enrollment, performance, and graduation, estimated using student-level data from Colombia.

A participant wondered whether intra-country variation in financing models when it comes to educational spending is reflected in the paper. Garriga emphasized that they took a parsimonious approach by focusing on one country only, to control for idiosyncratic institutional features. In the model, students differ in ability (a feature that is predetermined and fixed), family income, and idiosyncratic preferences for college enrollment. Hence, the students choose whether to enroll in college or to enter the labor force after high school. There is no provision for vocational education and no associated premium in the model, as one of the participants inquired, but the sample most likely does not include the students who choose to go the vocational route, Garriga said.

Central to the model is the idea that student effort that is costly to the student and is chosen yearly affects class completion and mitigates the risk of performing poorly and dropping out. College graduation, in turn, requires completion of several classes and rewards the graduate with a college premium that is averaged across sectors. The combination of ability, effort, performance, and a dropout shock determine class completion. The dropout shock simulates life events that are outside of the students' control and allows the model to include

the empirical fact that the dropout rate is non-zero even among the high-income, high-ability students.

Any effect of increased enrollment on the university quality is ignored, as well as capacity constraints of the educational institutions. A participant inquired about the share of private and public colleges in Colombia. Garriga said the educational system is a mix of public and private institutions, and the authors use an average cost across all of them as an estimate, ignoring the college and major quality effects. He also noted that the model could potentially be extended to include these effects. Another attendee inquired whether the model includes peer effects. Garriga replied that it did not, adding that he would have reservations about including peer effects since the model is already a good fit and could be potentially overfitted with the addition of peer effects.

The authors simulate multiple free college policies: universal, need-based, ability-based, performance-based, and a combination of need-based versions conditional on ability and performance. An audience member asked whether the authors have considered other changes to the pricing mechanism, such as a convex incentive where a student gets a refund if their grades are strong. Garriga said that they had not tested this option exactly, but that performance-based free college approximates it. The results suggest that while universally free college expands enrollment the most, it has virtually no effect on graduation rates. Performance-based free college, meanwhile, delivers a higher graduation rate at a lower fiscal cost, about 20 percent less than the universally free option.

Possible explanations include either (1) a loss of urgency, e.g., students enjoying the college experience, delaying graduation, and thus, lowering effort; (2) a substitution effect, i.e., students being willing to exert

effort to increase consumption sooner by entering the job market with a post-graduate premium; or (3) a risk effect, i.e., effort changing students' capacity to withstand future shocks. By making college free conditional on performance, the loss of urgency effect is eliminated and thus the students exert greater effort. The drop in enrollment in performance-based policies can be explained by the risk effect and the associated variation in consumption.



## College Majors and Labor Market Mismatch

**Michelle Rendall**, Satoshi Tanaka, and Yi Zhang

College students often find jobs in fields far from their chosen major. In this paper Michelle Rendall and her co-authors propose a novel approach to quantify the mismatch of college major to occupation over the life cycle. Using Australian data, the authors measure misallocation by directly quantifying mismatch from wage penalties.

A participant expressed concern over the paper's external validity, questioning how Australia might compare to Germany, which has clear college major to labor pathways. The speaker addressed the concerns by expressing that Australia lies comfortably between the American model, where general education comes prior to major-specific education and market outcomes are less determined by chosen major, and the European model that the participant mentioned. This middle ground, the presenter argues, allows this paper to contribute to understanding mismatch in either setting. A question was asked about whether the data documented potential frictions in the college major selection process. The speaker confirmed that the data unfortunately did not capture these frictions.

Another presenter requested clarification on the meaning of labor misallocation in this context, as presumably college major and choice of work are optimal decisions. The speaker clarified that this work presents an upper bound on skill mismatch. This bound is established under the assumption that all mismatch is a result of constrained decision making and other structural frictions. However, if all mismatch is a function of individual taste, then no improvements can be made via labor reallocation. A participant asked if managers would be considered misallocated labor, as they are not usually explicitly trained to manage people in their college education. The speaker confirmed that managers have been purposefully omitted from the dataset for this reason, as well as having relatively large pay.

The authors model a worker's maximization problem as

a static occupation decision in each period with imperfect labor mobility. Mismatch is then measured by computing the perfect mobility and imperfect mobility outcomes with fixed prices and then in general equilibrium. The speaker noted that the extant literature tended to use fixed prices in their welfare analysis. However, redistributing labor causes prices to change, which impacts aggregate welfare. This paper contributes to the literature by measuring changes to aggregate output.

Regarding the model, a participant asked why individual tastes and these frictions are not accounted for separately. The speaker answered that, due to limitations in the data, the two are difficult or impossible to disentangle. New data may help address this entanglement. Another participant asked if any consideration was given to the variance of wage opportunities, because a portion of mismatch might be explained by the shape of wage distributions. The speaker replied that there was no consideration given beyond the first moment of compensation.

The authors conclude that, after controlling for selection, large wage penalties result from labor mismatch. In partial equilibrium, an average of 28 percent of the labor market is mismatched, with substantial increases in recent years. In general equilibrium, about 10 percent are mismatched, also increasing drastically in recent years. In a counterfactual analysis, the source of the labor mismatch appears to be due to sorting, not skill composition. As young graduates enter the labor market, a large percentage are misallocated, with this mismatch abating over their life cycle. The speaker notes, however, that the sorting of young graduates has deteriorated over time, leading to an increasing share of mismatched labor fresh out of school. The speaker concluded that though this appears to be a self-correcting learning problem, gains to output can be made by addressing the growing share misallocated labor at an earlier stage.



## The Macroeconomic Cost of College Dropouts

**Oliko Vardishvili**

Of the students who enroll in college, 40 percent leave without a degree. The literature on college dropouts has focused on two drivers: (1) students learn more about their own academic ability upon entering college, and (2) those who discover themselves to be of low ability choose to leave. To put it another way, college dropouts receive more rewarding opportunities outside of college and leave to pursue them. Oliko Vardishvili presented work proposing that a large portion of college attrition can be explained by financial shocks during a student's college career, primarily uncertainty in the federal grants process, and concludes by offering two policy proposals to lower the college dropout rate.

Using administrative data on post-secondary education and two longitudinal surveys, the speaker begins by modeling the student's problem as an overlapping generations general equilibrium model with three life stages (college, work, and retirement), and credit constraints on college-bound individuals. The college student's enrollment decision is based on prior beliefs about their ability, an idiosyncratic productivity shock, and family wealth levels. An enrolled student is then faced with a decision to stay or drop out, to be made over grades, an idiosyncratic productivity shock, and financial grant outcomes.

A participant asked whether institutional grants are reflected in the datasets used in the paper. The speaker confirmed that the percentage of tuition costs that federal aid covers is net of institutional and other grants. On the topic of grants, another question was asked on whether poorer students differ from richer students in grant achievement. The speaker confirmed that poorer students have more grants on average, 33 percent more across all ability

levels than richer students. A participant asked if the dataset included community college students. The speaker assured them that community college students are exempted from the data to avoid overestimating the effect that a loss of federal aid would have on dropout decisions, as many of them are much closer to their borrowing constraints than the typical college student.

Vardishvili makes the intuitive finding that the impact of realizing a negative grant shock impacts dropout decisions differently across wealth strata. For the poorest students, a loss of grant funding causes the marginally enrolled student to move from the 60th to 80th percentiles of ability; the median student goes from 40th to 70th; and the for the richest, the marginal student moves from the 0th to 20th percentile. And federal grant funding is an uncertain and variable process, with average Pell grant coverage deteriorating from 100 percent in the first year to 54 percent and 42 percent in the second and third years, respectively. This fall in coverage persists after controlling for family wealth. Taking this fact in hand with the results of the model, college students that drop out due to loss of grant funding are concentrated in the upper percentiles of ability and lower wealth levels.

A participant raised the question of how many students generally drop out of college due to financial pressure. The response by the speaker was that in the calibrated model, about 15 percent of student dropouts are from financial pressure alone. A follow-up question asked about the role of family wealth shocks on the dropout decision. The response was that the model didn't extend to such considerations, but that it would be an interesting avenue for further research. One participant asked if the poorer

students' behavior could be explained by being at their borrowing constraint prior to loss of a grant. In response, the speaker assured them that an individual at the constraint is still able to borrow more next year, or work in the meantime to fund their tuition obligations.

The suggested policy interventions of this model are twofold: (1) to eliminate the stochastic nature of federal grant funding so that students only lose their funding if grades fall below a certain point and (2) to eliminate minimum grade requirements altogether. The first intervention would increase enrollment rates by 3.1 percent and graduation rates by 2.1 percent and reduce the wage premium by 1.7 percent. Dropout rates are mostly unaffected. The desirable effect of this policy is an increase in ability sorting, increasing the dropout rate from higher wealth levels and decreasing them in lower ones, so that the graduation rate of high-performing students increases. According to the model, in general equilibrium, this policy results in gains to productivity of 2.1 percent. The second intervention fails to impact graduation or enrollment rates meaningfully, but it does reduce the dropout rate and the wage premium by 0.7 percent, ultimately resulting in a productivity gain of 0.2 percent.





## Information Friction and the Labor Market for Public School Teachers

Mark Colas and **Chao Fu**

Improving the quality of the education system is a social priority, but the labor market for public school teachers exhibits a classic case of information asymmetry. Schools that are interested in hiring teachers do not have information regarding teacher quality that only the teacher and their current school are privy to. Often the current schools are not at liberty to discuss their internal evaluations with other schools. Naturally, this results in inefficient labor allocation that could be addressed by breaking the information asymmetry. However, there is another consideration to contend with in the equity implications of efficient teacher allocations, as often efficiency disadvantages poorer schools with lower achieving students. Chao Fu presented work with her co-authors that utilizes data from two policies, ASPIRE and ETI, to model the labor market for public school teachers and glean insights into the equity and efficiency implications of this information asymmetry.

The ASPIRE policy is a performance-based pay scheme that selectively breaks the information asymmetry between teachers and schools for high-performing teachers and publicly financially rewards them. In comparison, the ETI policy is one that breaks the information asymmetry completely by introducing a teacher evaluation system, the results of which are available to both teachers and schools. A participant asked why potential employers don't just conduct an in-person evaluation for every teacher they are interested in hiring, evaluating the quality of the applicant by simply attending one of their taught classes. The speaker responded that within the context of the model, it is assumed to be too costly to the potential employer. Other participants also contested the legality of such a strategy in the real world.

The authors model the problem as a two-

sided job search with stochastic taste shocks to the individual teachers. Each period, teachers receive job offers and select the highest ranked offer in their taste profile, while schools make offers to teachers as standard expected utility maximizers. Regarding the model, a participant asked if the option to teach in a private school was available to teachers. The speaker responded that it was indeed included in the employment decision under the outside option that teachers receive every round. Another participant asked if an individual school's characteristics remained constant over time. The speaker confirmed that, besides teacher composition, other characteristics remained constant. A participant asked if more experienced teachers make their way to better schools. The speaker remarked that while they have the data to answer that question, the answer is not available in this presentation as they only present the static distribution to inform their conclusions. A participant asked if promotion or intraschool mobility was part of a teacher's taste profile. The speaker confirmed that such considerations enter the teacher's tastes in the form of a school's teacher composition, but do not consider other strategic interactions, such as seeking employment at schools that have many near retirement-aged teachers, for mathematical convenience.

The authors then produce two counterfactuals to offer insight into the implications of the model. The first is complete information transparency, breaking the information asymmetry entirely. The associated effects include an increase in job mobility, an overall increase in teacher quality, and a dramatic increase in school inequality. A second counterfactual is presented in the form of a teacher bonus program, where high-quality teachers are rewarded for teaching in low-performing

schools. Under such a policy, the predicted effects are an increase in overall teacher quality and a reduction in school inequality. In an environment with symmetric information, this policy has the effect of increasing quality most in the lowest quality schools, while under asymmetric information both high and low performing schools benefit marginally.

The model suggests that while breaking the asymmetry of information present in the labor market for public school teachers may increase the overall quality of public education, it would come at the cost of increased educational inequality. Approaches like the bonus designed to improve underperforming schools, implemented in a market with transparent information, are more effective with regards to improving both teacher quality and educational inequality.



## Career Choice of Entrepreneurs, Inventors, and Economic Growth

Ufuk Akcigit, **Harun Alp**, Jeremy Pearce, and Marta Prato

Innovation and entrepreneurship are important drivers of economic growth. Harun Alp presented work with co-authors that delves into the intricate relationship between entrepreneurs, inventors, and growth, using empirical evidence from Denmark to shed light on the key factors that influence these dynamics. The study first explores the data and finds that education, IQ, and parental characteristics are all crucial factors in career choice and success. Parents being entrepreneurs highly increases the likelihood that an individual becomes an entrepreneur. However, it does not cause the children to have a more successful career. Having a high IQ was found to increase the chance of being a research and development worker, i.e. an inventor, but does not increase the chance of being an entrepreneur.

High-IQ entrepreneurs hired more and higher-IQ R&D workers. And entrepreneurs with high IQ have almost 15 times the number of patents per employee than those with low IQ. Firms with a higher quantity and quality of R&D workers grow faster. Using these facts the authors constructed a life-cycle model that considers career choices, entrepreneurship, matching, and innovation. The model can detail the matching pattern among high IQ entrepreneurs. It illustrates that high-IQ entrepreneurs see much higher productivity with high-IQ R&D workers than low-IQ entrepreneurs with high-IQ R&D workers. There is a substantial shortage of R&D workers in the baseline economy. It was also found that higher quality R&D workers contribute more to aggregate innovation, so it is optimal to subsidize them more. With optimal subsidies, the model predicts a large increase in aggregate growth rate, firm size, and welfare. A key novelty to the model is the complementary matching of high-type entrepreneurs and high-type R&D workers. In a counterfactual with no assortative

matching, aggregate growth decreases by 20 percent.

Participants asked multiple times who made up the data set. They were surprised that Denmark had detailed information that included IQ. One participant pointed out that a graph only included three parental occupations, and the presenter was unsure if they accounted for the possibility of parents being unemployed. The absence of detailed information on college majors was raised as a potential factor influencing career choices and success. Additionally, questions were raised regarding the relative nature of high IQ, with the speaker clarifying that it pertained to the group studied rather than the overall population. Participants asked for clarification on the effect in the model of parent occupation on entrepreneurship success, and it was explained that it only affected the arrival rate of becoming an entrepreneur. Finally, one attendee inquired about the macroeconomic friction introduced by the model, with the speaker clarifying that the model suggests an excessive number of R&D workers attempting to become entrepreneurs.

The study gives valuable insight into the interaction of entrepreneurship, innovation, and economic growth. Using individual-level data from Denmark, occupational sorting and entrepreneur-worker matching, entrepreneur-led teams were placed at the center of a model of innovation and economic growth. The researchers observed that heterogeneous entrepreneur and R&D worker ability have first-order effects on firm dynamics, innovation, and economic growth. Matching talent between high-type entrepreneurs and R&D workers is key to economic growth, an important insight of the study.



## Equity Pay Inequity

**Andrea L. Eisfeldt**, Antonio Falato, Dongryeol Lee, and Mindy Z. Xiaolan

Paying employees in company equity can expose them to the company's profits and incentivize them to act in the interests of their employer. In recent decades, equity-based compensation has become prevalent in the United States, with the median equity pay having quadrupled since 1994. Andrea L. Eisfeldt presented work completed with several co-authors that explores the unequal distribution of equity pay below the executive level across firms.

The paper decomposes firm-level heterogeneity in equity pay to initial values, capital gains, and changes in share granted per high-skilled employee. It was found that initial values are responsible for a significant amount of the discrepancy. Variations in initial values of equity pay are due to factors such as peer effects and financial constraints. Stock price dynamics are also an important factor, with fluctuations in stock prices having a substantial impact on equity compensation. Firms that utilize a higher ratio of equity pay tend to be younger and manage share grants more actively to counteract the effects of stock price changes. Thus, equity pay can be viewed as both a compensation and capital structure decision by firms.

The authors used firm-level accounting data on the amount of shares reserved for employee compensation to evaluate equity pay. It contains information on firms that are within the S&P 1500 from years 1994 to 2019. It was found that high equity-paying firms kept their higher ratios even 10 years after sorting. However, high share granting firms do trend their grants down. Firms that grant high equity pay beyond C-suite employees experience higher employment growth. On the other hand, high CEO pay was linked to lower employment growth in the long run. While traditional firm characteristics, such as financial ratios, play a role

in determining equity pay, firm-level fixed effects are a significant driver of variation across firms. It remains difficult to determine what causes these firm-fixed effects. In the future, a model may be created where firms choose an initial value based on financial and peer constraints, and that initial value becomes a target.

Overall, equity pay has become a large part of compensation among high-skilled workers and is highly varied across firms. Equity pay is highly persistent, as firms with higher initial values preserve a higher ratio of equity pay but do trend down. These initial values for equity pay are largely driven by unexplained fixed effects. Additionally, the persistence in equity pay is driven by highly persistent share-granting policies. Finally, the main quantifiable driver of equity pay is a result of stock price change.

Firm fixed effects may be driven by factors like industry and firm age, and it remains to be seen if firm fixed effects still hold against industry effects. Additionally, the characteristics of firms that initially give higher equity pay were questioned. It was found that firms with intangible assets hold more cash but also give more equity pay. This may contradict the intuition that firms give equity pay as a way of borrowing from employees, instead pointing to the notion of equity as a way of attracting talent.



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