Research Statement

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1 General Overview

After some years of hesitation typical for teenage minds, I ultimately decided to study economics from equal admiration of philosophy and mathematics, and with a desire to figure out the key forces behind social evolution. I completed my undergraduate diploma majoring in international money and finance (1986–1991, University of National and World Economy, Sofia, Bulgaria). But I went on to the MSc/PhD level (1997–2003, University of Lausanne, Switzerland) and then switched to academia (2003-present) only after first working as a central bank research economist (1991–1996, Bulgarian National Bank). Due to such a 'formative background', my core interests have largely remained at the intersection of monetary policy and international finance. In a very general sense, I have been driven by the challenge to better understand if and how (optimal control) theory could be applied to model and steer (heterogeneous) social systems and their institutions under inertia, ambiguity, incomplete information, learning, sequential markets and strategic interactions toward (evolving) equilibria that (potentially) improve welfare. As this is a rather broad motivation, my research has proceeded piecewise: I have focused so far on various more specific but often interdependent issues that also illuminate certain parts and mechanisms inside the mentioned bigger whole. I have addressed them by alternative, yet complementary, approaches and methodologies, and intend to investigate further links as well as deeper details. In particular, the main themes in my research to date, and the techniques to explore them, could be grouped and summarized by subfield as I try to do (imperfectly) below.¹

2 International Macroeconomics and Finance

This area has been the focus of my long-run interests, even before my central banking experience, and has remained there – together with monetary theory and policy – until now.²

2.1 Theoretical (New Open-Economy) Macroeconomics

My PhD years at the University of Lausanne (1998–2003) got me interested in theoretical New Open-Economy Macroeconomics (NOEM) that was at its heyday about that time. I then worked on extending the early two-country NOEM models in order to evaluate the effects of the exchange-rate regime on trade under monetary uncertainty, alternative currency of price setting, trade costs and more structure on preferences, allowing to distinguish between key elasticities of demand.

¹The papers and work in progress summarized further below are available to download from RePEc, https://ideas.repec.org/e/pmi59.html, or my webpage, http://www.personal.reading.ac.uk/~les05am/. The code and data used are accessible via my GitHub webpage, https://www.github.com/AlexanderMihailov. Technical details on mathematical or statistical derivations are generally available via my webpage or the websites of the journals of publication. If code, data or derivation details cannot be found publicly, they can be provided upon request.

 $^{^{2}}$ I co-founded the Lille–Reading Workshop on International Finance: https://sites.google.com/view/lille-reading-workshop-intfin/home. The workshop is annual and is held in rotation at the universities of Lille and Reading.

2.1.1 Past and Published Work

[30] and [31] constitute almost final versions of the two theory chapters of my PhD dissertation, [32], and were completed during my first year as faculty member at the University of Essex, United Kingdom (2003–2006). They derive conditions under which a peg would increase trade relative to a float, and vice versa, showing at the same time that deeper real fundamentals matter more for trade than nominal determinants such as the exchange-rate regime.

In a baseline stochastic two-country NOEM model, [30] revisits the question whether the exchange-rate regime matters for trade, in its intra-industry version when national output mixes are substitutable. Its main contribution is to focus the analysis along an explicit microfounded parallel of two alternative invoicing conventions, local currency pricing (LCP) versus producer's currency pricing (PCP), and to uncover the mechanism generating their polar implications for equilibrium consumption allocations across national outputs. Perhaps surprisingly, given conventional wisdom in defence of pegs, it is found that under frictionless trade with symmetry, only money shocks and separable utility, the exchange-rate regime is irrelevant in affecting expected trade-to-output, no matter the price setting assumed. A peg-float comparison remains, however, meaningful even with frictionless intra-industry trade under (some degree of) PCP – although not (full) LCP – in terms of the volatility of national trade shares. By shutting down the pass-through and expenditure-switching channel, a peg then stabilizes equilibrium trade-to-GDP across countries in any state of nature at its expected level.

[31] extends [30] to embed intra-industry trade (in similar output mixes) and inter-industry trade (in different output mixes) within a common framework, focusing on the implications of 'iceberg' trade costs under alternative invoicing, namely PCP versus LCP. Its principal contribution is to show that with (some degree of) PCP – although not (full) LCP – a peg slightly reduces expected trade, measured in terms of GDP, relative to a float under (symmetrically) elastic import demand. Inelastic (symmetric) import demand reverses this conclusion.

The bottom line from my NOEM work in my PhD thesis, [32], on the effects of the exchangerate regime on trade-output ratios is, essentially, that a peg does not necessarily increase them: it all boils down to the production and export structure of each pair of modeled national economies, and the degree of similarity and substitutability of their output mixes; so, theory remains ambiguous and what actually can happen to bilateral trade after an exchange-rate regime change is, ultimately, a specific empirical question. This theory-derived conclusion nicely summarizes why the huge empirical literature on the effects of exchange-rate variability on export or import volumes (relative to GDP) has led to all sorts of contradictory findings.

2.1.2 Ongoing and Intended Future Work

Along a similar type of theoretical framework, [41] proposes an extension to a production economy of an earlier endowment small open economy (SOE) model, bringing together two strands of literature that have developed independently and separately from each other over many years, namely neoclassical growth theory of the 1950s and 1960s and the open-economy theory of capital flows under the risk of sudden stops since the late 1990s. We explore the implications of such an extended, more realistic setup for the optimal reserves-to-output ratio in emerging market economies (EMEs). More precisely, to study the effects of investment and production on optimal reserves in EMEs, we develop two different model versions of a production SOE. First, we derive optimal reserves-to-output where capital is the sole factor of production, and we refer to this version as the one-factor production SOE AK model, or simply the AK model (of endogenous growth); this version implies increasing returns to scale (IRS) and is justified on the grounds of the ability of the AK-model to generate endogenously, via the influence of policy such as subsidies or taxes on investment – on capital accumulation, sustained long-run growth. We, then, derive the same ratio in a two-factor production model where labor is also included, and we refer to this version as the two-factor production SOE Cobb-Douglas (CD) model with labor-augmenting technological progress and exogenous population growth, or simply the CD model (of exogenous growth); in turn, this version implies constant returns to scale (CRS) and is justified on the grounds of being consistent with a long-run balanced growth path (BGP) in exogenous growth models and with sustained per capita income growth in these models. Under a plausible calibration for typical emerging market countries facing the risk of sudden stops in capital inflows, we find that the optimal ratio of international reserves to output in the IRS capital-augmenting productivity model version is 1.7%, which is quite lower than that in [16],

2.2 Empirical (International) Macroeconomics

My dominant preference is for theory, but in macroeconomics empirical research is of no less importance, especially when (as we saw above) theory is inconclusive, and presents an interesting alternative, especially when one occasionally gets stuck amidst the abstraction of formalism. Ideally, theory should inform applied work, and atheoretical data analysis should feed back into theory. In this mutual enrichment and evolution consists the relevance of the methodology of scientific enquiry, and I have most of the time in my research attempted to stick to this principle of considering theory and empirics in their joint informativeness, whenever possible.

2.2.1 Past and Published Work

So, naturally, I have worked along predominantly empirical lines of study as well and as early as during my Lausanne period (1998–2003): in [36] and [19], completed at Essex (2003–2006). Then, during my period as faculty member at the University of Reading, United Kingdom (2006–present), I have continued my empirical investigations, in particular as testing theoretical equations: in [47] and [46].

[36], building upon the third and last, empirical, chapter of my PhD dissertation, compares exchange rate pass-through to prices in the US, Germany and Japan across a number of dimensions. Building on the empirical approaches in the recent literature, its contribution is to perform a thorough sensitivity analysis of alternative pass-through estimates. It is found that the econometric method, data frequency and variable proxy employed matter for the precise magnitudes and patterns, yet they often broadly accord on the general trends. Pass-through to import prices has declined in the 1990s relative to the 1980s, pass-through to export prices has been country-specific and pass-through to consumer prices is nowadays negligible in all three considered major economies.

Scientists and epistemologists generally agree that a scientific law must be (a) relatively simple and (b) not contradicted by the available evidence. [19] proposes and tests one such law pertaining to international economics, the triple-parity law. It integrates three well-known equilibrium conditions: uncovered nominal interest rate parity; relative purchasing power parity; and real interest rate parity. Using a cross-section of trend growth rates for 18 OECD countries in the post-Bretton-Woods/pre-EMU floating rate period (1976-1998) and employing a variety of single-equation and system estimation methods, we present robust evidence that the triple-parity law ultimately holds.

[47] applies the generalized method of moments (GMM), to handle expectation terms under the rational expectations hypothesis, in econometric estimation aiming to assess the relevance of domestic versus external determinants of CPI inflation dynamics in a sample of OECD countries typically classified as SOEs. The analysis is based on a variant of the small open-economy New Keynesian Phillips Curve (SOE NKPC), where the novel feature is that expectations about fluctuations in the terms of trade enter explicitly. For most countries in our sample the expected relative change in the terms of trade emerges as the more relevant inflation driver than the contemporaneous domestic output gap.

A sequel paper, [46], evaluates the relative influence of external versus domestic inflation drivers in the 12 new European Union (EU) member countries. Employing the same GMM estimation technique, we find that the SOE NKPC is well supported in the new EU member states. The inflation process is dominated by domestic variables in the larger countries of our sample, whereas external variables are mostly relevant in the smaller countries.

2.2.2 Ongoing and Intended Future Work

Ongoing work, [17] and [51], exploits two alternative state-of-the-art quantitative approaches in modern macroeconomics, an empirically-led cointegrated VAR and a theory-guided DSGE simulation, respectively, to address issues of central policymaking interest in African economies, as follows.

While the transmission mechanism of monetary policy has been studied by a huge literature in industrialized economies with sophisticated financial markets, very little is known on it in developing countries with structural weaknesses and inefficient financial systems. The lack of understanding of the operative channels of monetary transmission in the latter type of countries provides a more acute challenge to policymakers and central bankers alike, particularly because in such underdeveloped economies monetary policy is often the only countercyclical tool available. [17] addresses the major issue of the effectiveness of monetary policy transmission in three post-liberalization Sub-Saharan African (SSA) countries – Ghana, Tanzania and Zambia – focusing on the roles of interest rates and exchange rates and highlighting structural and policy similarities as well as heterogeneities. We empirically examine the presence of long-run, steadystate, theoretically motivated macroeconomic relations in each of the three countries using the cointegrated VAR model with exogenous variables. We also apply the structural VAR model in the cases of Ghana and Tanzania because of the lack of evidence for cointegration. Using monthly time series since the mid-1990s and up to the global financial crisis, we find the transmission of monetary policy in Ghana and Tanzania, and less so in Zambia, to have been weak and often ineffective in controlling inflation because of structural deficiencies in their economies and underdeveloped financial systems. Overall, our empirical analysis points to a limited power of monetary policy and to a transmission mechanism with many impediments and some puzzles in these three SSA countries in the post-liberalization period – findings consistent with those in most of the broader literature on developing countries.

[51] aims to evaluate quantitatively the macroeconomic effects of remittances in a host developing country that has experienced relatively large remittance inflows over the recent decade. We do so by estimating two alternative DSGE models on a quarterly data set from Nigeria (1977-2011). Nigeria is the African economy that has accounted for the highest, and increasing, inflows of remittances within the sample period. Our assessment also seeks to identify the government policies that would help maximize the macroeconomic benefits for the receiving country. Applying Bayesian methods, we first estimate the SOE New Keynesian DSGE benchmark and, then, a portfolio adjustment cash-in-advance-constraint DSGE alternative, enriched with financial frictions. The latter model leads to refinement of the conclusions from the former model, and essentially shows that as the percentage of the remittances inflow used for immediate consumption as opposed to being deposited in the banking system decreases, the negative impact on output decreases and turns to positive when the percentage is below 30. The inflationary effect, though positive all through, decreases with a decrease in the percentage used for immediate consumption, and becomes negligible as this percentage approaches zero. These findings suggest that there is a need for policy measures to ensure that a higher proportion of the large and increasing inflow of remittances into the Nigerian economy is left in the banking system at least for some time; otherwise, the inflow will, contrary to the micro/household level positive impact on poverty and consumption, lead to a decrease in aggregate output and an increase in inflation, which may cause a prolonged recession in the economy.

3 Monetary Theory and Policy

3.1 (Theoretical and Empirical) Analysis of Monetary Policy and Central Banks

3.1.1 Past and Published Work

My work – basically at the University of Essex (2003–2006) – has also involved theory-grounded empirical analysis of monetary policy within the framework of the New Keynesian or New Neoclassical Synthesis (NNS) model. I have employed, in particular, alternative Taylor rules estimated via OLS, TSLS and GMM on final and real-time quarterly data to recover the reaction function of the Bank of England and to assess UK monetary policy before and after operational independence of the Bank within the period of inflation targeting. [34] evaluates empirically the feedback and stance of monetary policy in the United Kingdom under inflation targeting, implemented since October 1992. Its principal import is in comparing two subsamples, before the Bank of England was granted operational independence in May 1997 and after that. It is found that the operational independence subperiod has differed from the pre-independence one in terms of a weaker response to inflation but stronger sensitivity to the output gap and a less restrictive stance of monetary policy. Such a behavior appears justified given the Bank's mandate and the evolution of the business cycle.

A denser companion paper, [35], based on its detailed earlier version (with explicit derivations in its appendix), [33], asks whether a shift to instrument independence affects central bank behavior when monetary policy is already operating under the constrained discretion of an inflation targeting goal. Taking advantage of the unique UK experience to identify such an exogenous break, Taylor rules are estimated via alternative methods, specifications and proxies. It is found that the institutional move to greater autonomy of the Bank of England, having augmented its responsibility, accountability and transparency in achieving the delegated inflation target, has also increased its sensitivity to, and the freedom to counter, inflationary pressures arising – with anchored inflation – via the output gap.

A later empirical paper along related – yet somewhat different – lines, [10], studies the determinants of the support for the European Central Bank (ECB) in the member countries of the European Monetary Union (EMU) and their evolution from 1999 to 2015. Our contribution is to examine micro-level socio-demographic characteristics from the Eurobarometer surveys jointly with macroeconomic indicators of trust in a central bank in order to evaluate econometrically their relative importance over time. Pseudo-panel logit estimates reveal that the former have a dynamically stable, and generally stronger influence taken altogether, when compared with the latter. Interestingly, we find that while expected inflation becomes a positive determinant of trust in the ECB after the global financial crisis (GFC), actual inflation gets no statistical significance. Having taken centre stage in the monetary policy debate in the Euro-area post-GFC and especially since 2013, excessive disinflation and risk of deflation attracted strong attention by the public and have consequently affected its perceptions about the ECB. Accordingly, our results emphasize forward-lookingness of the EMU population with regard to 'deflation scares' in determining trust in the ECB, in addition to disentangling the contributions of the key individual-level socio-demographic factors, and can duly inform ECB's communication strategy.

3.1.2 Ongoing and Intended Future Work

The next four, recent and ongoing projects employ Bayesian estimation of DSGE models with various aims and nuances, as follows.

[26] uses Bayesian estimation techniques to uncover the central bank preferences of the big five Latin American inflation targeting countries: Brazil, Chile, Colombia, Mexico, and Peru. The target weights of each central bank's loss function are estimated using a medium-scale small open economy New Keynesian model with incomplete international asset markets and imperfect exchange-rate pass-through. Our results suggest that all central banks in the region place a high priority on stabilizing inflation and interest rate smoothing. While stabilizing the real exchange rate is a concern for all countries except Brazil, only Mexico is found to assign considerable weight to reducing real exchange rate fluctuations. Overall, Brazil, Colombia, and Peru show evidence of implementing a strict inflation targeting policy, whereas Chile and Mexico follow a more flexible policy by placing a sizeable weight to output gap stabilization. Finally, the posterior distributions for the central bank preference parameters are found to be strikingly different under complete asset markets. This highlights the sensitivity of Bayesian estimation, particularly when uncovering central bank preferences, to alternative international asset market structures.

[43] is an early work in progress that focuses on the similarity and variability of the Bayesian estimates of a number of parameters in a baseline medium-scale NK DSGE model when estimated on four different economies.

[44] studies the effects of single monetary policy by the ECB on the national rates of unemployment and other key labor market variables in Germany, France, Italy and Spain since the introduction of the euro in 1999. Estimating by Bayesian method and simulating a version of a canonical medium-scale New Keynesian DSGE model with indivisible labor proposed by [14], we find that ECB's monetary policy has had heterogeneous effects in these four largest economies of the European Monetary Union (EMU). The EMU economies, further, display important differences with respect to the United States.

[22] is an early work in progress along similar lines which models the labor market in a more explicit and detailed way, within a simpler NK DSGE setup, aiming to estimate the key parameters of the labor market.

A sequel paper to [44], [45], focuses on gender differences in unemployment rates, examining four types of macroeconomic shocks under single monetary policy in the Euro Area. The paper also explores the role in shock absorption and transmission played by different labour market institutions. We apply panel data estimation to 11 Euro Area countries over the 2000-2013 period, disaggregated by age, marital status and education. We find that adverse macro-shocks, such as reductions in labour demand, similar to those experienced during the current COVID-19 pandemic, or a contractionary monetary policy, as in the build-up to the global financial crisis of 2007-2009, are associated with a larger increase in unemployment rates for women than for men, specifically for the young and less-educated. However, labour market institutions, in particular unionisation or labour tax wedge abatement, mitigate the widening of the gender unemployment gap.

[40] considers 3 scenarios regarding the duration of the COVID-19 pandemic lockdown, staying for 1, 2 or 3 quarters, and 2 types of exceptionally rare and devastating disruptions in employment modeled as adverse labor supply shocks, a temporary one with negligible loss in the labor force due to deaths or a permanent one, with significant loss from deaths. The temporary labor supply shock simulations delimit a lower bound, designed to match about 1/4 of the labor force unable to work, and an upper bound, matching about 3/4 of the labor force made economically inactive, broadly consistent with estimates. The permanent labor supply shock is designed to match, in 3 scenarios again, up to 1% loss of the labor force due to mortality, twice milder than the Spanish flu 2% death rate. Estimated calibrations of the Galí-Smets-Wouters (2012) model with indivisible labor for 5 major and most affected by the COVID-19 pandemic economies are simulated: the US, France, Germany, Italy and Spain. The simulations suggest that even in the most optimistic scenario of a brief (lasting for 1 quarter) and mild (with 1/4 of the labor force unable to work) lockdown, the loss of per-capita consumption (6-7% in annualized terms down from the long-run trend in the impact quarter) and per-capita output (3-4% down) will be quite damaging, but recoverable relatively quickly, in 1-2 years. In the most pessimistic simulated scenario of temporary loss the effects will be 10-15 times more devastating, and the loss of output and consumption will persist beyond 10-15 years. Permanent loss of up to 1.5 percentage points of per-capita consumption and output characterizes the simulated permanent labor supply shock.

For decades, the monetary economics literature has considered multiple deposit expansion via the money multiplier as empirically corroborated. However, the developments witnessed in advanced economies since the Global Financial Crisis challenged this settled view. [15] revisits the issue empirically, but also within a 'narrative' context of the evolving institutional frameworks for banking activities and monetary policy that ultimately shape it out. Using a vector autoregression model estimated on Russian data, we find robust evidence that nowadays lending is constrained mainly by credit demand. Consequently, the money multiplier mechanism does not work anymore, similarly to the case of the United States.

3.2 Theoretical Analysis of Equilibrium Determinacy and Optimal Policy

3.2.1 Past and Published Work

One of my recent and ongoing areas of research interest involves investigation of equilibrium determinacy and optimal (monetary and fiscal) policy in open-economy NK models. [23], extended in [24], allow for a role of real balance effects by modeling money in a non-separable way from consumption. In turn, [21] allows instead for heterogeneity of types by introducing credit-constrained consumers in a NK SOE and studies optimal policy. Essentially, this work builds upon the stochastic NOEM setups of my Lausanne years and the New Keynesian policy analysis of my Essex years by adding to both the explicit dynamics of richer theoretical frameworks, allowing a deeper investigation of the properties of equilibrium in open economies and a formal characterization of optimal control choices by policymakers.

[23] re-considers the importance of trade openness for equilibrium determinacy when monetary policy is characterized by interest-rate rules. We develop a two-country, sticky-price model where money enters the utility function in a non-separable manner. Forward- and current-looking policy rules that react to domestic or consumer price inflation are analyzed. It is shown that, under specified conditions, the introduction of real balance effects substantially limits the validity of the Taylor principle and challenges recent conclusions concerning the relative desirability of the inflation indicator targeted.

An extended revised version, [24], examines the determinacy implications of forecast-based monetary policy rules that set the interest rate in response to expected future inflation in a Neo-Wicksellian model that incorporates real balance effects. We show that the presence of such effects in closed economies restricts the ability of the Taylor principle to prevent indeterminacy of the rational expectations equilibrium. The problem is exacerbated in open economies, particularly if the policy rule reacts to consumer-price, rather than domestic-price, inflation. However, determinacy can be restored in both closed and open economies with the addition of monetary policy inertia.

3.2.2 Ongoing and Intended Future Work

Limited asset market participation (LAMP) and trade openness are crucial features that characterize, in a particular combination of differing degrees each, all real-world economies. It is surprising that no paper has yet addressed the issue of optimal policy and equilibrium determinacy in a model of a small open economy (SOE) with LAMP. [21] fills in this gap in the literature. We study equilibrium determinacy and optimal monetary policy in a model of a small open economy with LAMP. With low enough participation in asset markets, the conventional wisdom concerning the stabilizing benefits of policy inertia can be overturned irrespective of the constraint of a zero lower bound on the nominal interest rate. In contrast to recent studies, in LAMP economies trade openness can play an important stabilizing role. We also show that the central bank must balance the opposing influence of openness and LAMP on the aggressiveness of optimal policy, and that the equivalence between efficient and equitable optimal allocation found in closed economies breaks down in open economies. We derive targeting rules and demonstrate the superiority of commitment over discretion in implementable optimal interest rate rules.

3.3 Synthetic Surveys of Monetary Theory and Policy

3.3.1 Past and Published Work

Another type of research that marks my more mature, Reading period (2006–present) has attempted – in coauthorship, for a broader perspective and more balance – synthetic surveys of recent developments in the field of monetary policy and monetary economics. Such overview papers have helped me periodically update and order my partial awareness of an ever-increasing body of knowledge on diverse and challenging topics and methods in my primary areas of interest.

[1] demonstrates that recent influential contributions to monetary policy imply an emerging consensus whereby neither rigid rules nor complete discretion are found optimal. Instead, middle-ground monetary regimes based on rules (operative under 'normal' circumstances) to anchor inflation expectations over the long run, but designed with enough flexibility to mitigate the short-run effect of shocks (with communicated discretion in 'exceptional' circumstances temporarily overriding these rules), are gaining support in theoretical models and policy formulation and implementation. The opposition of 'rules versus discretion' has, thus, reappeared as the synthesis of 'rules cum discretion', in essence as inflation-forecast targeting. But such synthesis is not without major theoretical problems, as argued in [1]. Furthermore, the GFC, that had not yet begun to unfold while we were completing the first (discussion paper) version, made it obvious subsequently that the inflation targeting strategy of monetary policy, which rested upon the pre-GFC consensus paradigm in modern macroeconomics, seems at best a 'fair weather' model. In the turbulent economic climate of deep financial crisis and world-wide, abrupt economic slowdown in the post-GFC years, this approach needed, we had argued, and has engaged into ex-post, serious rethinking, until nowadays.

In a companion paper, [2], we propose a simple, yet sufficiently encompassing classification scheme of monetary economics. It comprises three fundamental fields and six recent areas that expand within and across these fields. The elements of our scheme are not found together and in their mutual relationships in earlier studies of the relevant literature, neither we attempt to produce a relatively complete systematization. Our intention in taking stock is not finality or exhaustiveness. We rather suggest a viewpoint and a possible ordering of the accumulating knowledge. Our hope is to stimulate an improved understanding of the evolving nature and internal consistency of monetary economics at large.

Along similar lines of synthetic research presentation in scientific volumes, my summary articles [37], [38] and [39] contribute to *The Encyclopedia of Central Banking* and my coauthored chapter [18] to a volume on banking competition. I have also completed in coauthorship an MSc/PhD textbook with 12 chapters contracted with Oxford University Press, [20], that adapts and updates recent models and empirical findings in international macroeconomics and finance. The editorial of a special issue I coauthored, as guest coeditor, [9], reviews recent developments in the theory and applications of macroeconometric modeling and forecasting.

3.3.2 Ongoing and Intended Future Work

Monetary theory and policy has recently been challenged by the expansion, boom and bust of cryptocurrencies. [7] begins by a recap on the ambition and mechanism behind Bitcoin, followed by an overview of the top 10 cryptocurrencies by market capitalization. Our focus is on their price dynamics and volatility relative to those of fiat paper money and gold, assets that have traditionally served the functions of money and international reserves. We then perform a counterfactual analysis using the Bank of England's foreign currency reserves to determine the hypothetical performance in terms of relative volatility of two alternative reserve portfolios consisting of 0.1%, 1%, or 10% holdings of either Bitcoin only, since July 2010, or of a portfolio of 50% Bitcoin and 50% Ethereum, since July 2015. Revisiting in this light the functions of money and international reserves, we expound on why private cryptocurrencies do not meet the inherent requirements for both money and international reserve assets, whereas central bank digital currencies do meet these requirements. We, finally, 'scale' the magnitude and dynamics of the recent Bitcoin bubble into a historical perspective, and conclude by a discussion of areas where blockchain-based and FinTech technologies could be beneficial in international trade, payments, banking and finance.

Along similar lines, [8] proposes a complex dynamic systems subpopulation model for the construction and validation of a novel form of local complementary currency, namely the Grassroots Economics Foundation's Community Inclusion Currency (CIC) implemented recently in Kenya. Differently from other related work in computer science or of a legal nature, we frame our analysis in a deeper economic context, thus bridging the gap across these parallel literatures. First, we highlight the potential usefulness of the emerging blockchain-technology backed CICs now popular in the new – and interdisciplinary – field of cryptoeconomics. Essentially, CICs can act as a local liquidity-provision institutional device in poor or isolated economic regions to increase their internal exchange and economic value added, thereby serving as a market-based mechanism to alleviate poverty, in addition to government aid and akin in its automatism and credibility to a currency board monetary regime in national economies. The ultimate goal of these CIC systems is to promote a transition toward complete inclusion and integration into the national and global economies, pulling over the communities and regions out of self-sufficiency and poverty into more advanced stages of economic development and well-being. Second, we elicit 50 heterogeneous utility types according to observed transactions behavior and build a corresponding model and simulation at a meso-economic level, which for many purposes could prove more insightful for policymakers than the usual extreme perspectives of micro and macro.

3.4 Theory-Informed Inflation Forecasting

3.4.1 Past and Published Work

Theory-informed, microfounded macromodels have not had much success so far when competing with agnostic statistical models of inflation dynamics in terms of predictive accuracy. Our aim in [27], extending [25], is to attempt an improvement over this negative result. We develop a novel forecasting procedure based upon a New Keynesian Phillips Curve that incorporates time-varying trend inflation, to capture shifts in central bank preferences and monetary policy frameworks. We generate theory-implied predictions for both the trend and cyclical components of inflation, and recombine them to obtain an overall inflation forecast. Using quarterly data for the Euro Area and the United States that cover almost half a century, we compare our inflation forecasting procedure against the most popular time series models. We find that our theory-based forecasts outperform these benchmarks that previous studies found difficult to beat. Our results are shown to be robust to structural breaks, geographic areas, and variants of the econometric specification. Our findings suggest that the skepticism concerning the use of theory in forecasting is unwarranted, and theory should continue to play an important role in policymaking.

3.4.2 Ongoing and Intended Future Work

The above studies, [27] and [25], are part of continuing research seeking to build better theorybased forecasting procedures, which in practice combine with econometric methods of implementation. Present lines of enquiry include searching for an optimal length of the re-estimation window, considering alternative methods of trend adjustment, and robustifying the forecasts to possible structural breaks, all of which may improve the TVT-NKPC forecasts, and including metrics other than quadratic loss to evaluate the forecasts.

4 Political Macroeconomics and Socioeconomic Dynamics

Other current issues of interest, also likely to remain in my research agenda, relate to modeling optimal delegation of monetary and (the stabilization task of) fiscal policy to expert committees with view to mitigate the time inconsistency problem, in particular of fiscal policy, evident in a deficit bias; and to exploring by appropriate frameworks and data the intergenerational aspects of evolving preferences under the influence of cultural transmission and/or social learning. This subfield of my research also overlaps and shares many aspects with the next subfield to be outlined: bounded rationality, information and learning; both outgrow and extend into the longer run my two main subfields of primary expertise already summarized above and centred on optimal macroeconomic policies in the shorter run under market imperfections that empower money to have real effects.³

4.1 Evolving Institution Design of Monetary and Fiscal Policies with the Emergency of Global Climate Change Mitigation

4.1.1 Past and Published Work

Building upon and extending [49], [50] explores the normative aspects of the institution design for macroeconomic policymaking when a society legislates specific objectives and sequencing of decisions for the involved authorities. We develop a general theoretical framework that adds fiscal policy to the flexibility-credibility trade-off well-established in monetary policy. We find that delegation of both monetary and fiscal policy to autonomous institutions of appointed experts improves macroeconomic outcomes by delivering lower average inflation and lower average public-sector deficit-to-output ratio over alternative policies conducted with interference by elected politicians. Yet greater independence of monetary and fiscal policymakers from the government also generates increased output variability around normal output. The latter effect is minor in magnitude, and the simulated expected social losses in all considered 24 institutiondesign regimes demonstrate the long-run welfare dominance of delegation of both monetary and fiscal policy to independent expert committees over joint government optimization. In addition, preannouncing an escape clause to be activated following extreme negative shocks may help mitigate short-run output and employment fluctuations, but at the cost of expected social losses that rise considerably.

However, my earlier views on the mandate of central banks and its relation to fiscal policy has evolved recently because of the emergency of the global climate change mitigation crisis. [13] endorses an interdisciplinary approach to the complex and urgent issue of intergenerational

³Actually, a broader scope of relevance of this work of mine has resulted in that I co-founded the European Workshop on Political Macroeocnomics (EWPM): https://sites.google.com/site/ewpmhome/. The workshop takes place on an annual basis and wanders from one European location to another.

climate justice, and proposes a rich menu of policy options, in particular some novel and unconventional ones, to resolve it immediately but flexibly. We incorporate the realistic features of economic growth, nominal interest, expected inflation, and the option for nonrepayment or partial repayment of public debt across generations as well as a central bank institution, or rather the global network of central banks, to implement climate mitigation policy in the stylized model proposed by [52]. Similarly, but even without repayment, we find such kind of policy, which we label 'green quantitative easing', or 'green QE', to be Pareto-efficient across generations. Differently, we argue that neither the present, nor future generations need to repay the novel greening compensatory transfers (GCTs) to households and firms we envisage to serve as a main financial instrument of central banks in triggering a decisive reversal in environmental deterioration right now, without further delay, given the emergency of the situation. Moreover, and in support of the economic considerations and incentives, we argue from philosophical, legal and politicaltheory grounds that such a financial scheme intermediated by central banks worldwide serves two types of principles of intergenerational climate justice: (i) principles that tell us to mitigate climate change now and avoid harm for future generations; and (ii) principles that tell us how to share mitigation costs fairly across generations. Our spectrum of suggested pragmatic green QE initiatives includes potential issuance by firms and households of super-long-term coupon bonds to be held by central banks over up to a century, possibly GCT-based only, and allows for much flexibility and complementarity in the practical solutions to be potentially chosen, with voluntary partial repayment or not of the mitigation costs across generations.

4.2 Evolution of Beliefs, Conflict and Institutions

4.2.1 Past and Published Work

While there is a voluminous literature on short-run inflation dynamics, not much is known on what drives the long-run evolution of inflation preferences. To study this important issue, [11] develops a stochastic overlapping-generations model with heterogeneous beliefs on the degree of inflation protection that can be provided by markets versus the monetary authority. A distinct feature is that it incorporates adaptive learning from inflation history and imperfect empathy in the cultural transmission of individual beliefs, allowing social beliefs to evolve endogenously. Analytical results on endogenous inflation beliefs and socially-optimal inflation are derived first in a within-generation voting equilibrium that defines a particular degree of inflation aversion of a society's monetary institution. Then, the intergenerational dynamics of inflation and inflation beliefs are analyzed, providing insights into the long-run evolution of population types and social institutions. The framework allows exploring the interactions of three mechanisms: the persistence of inflation, the degree of inflation aversion of the central bank and the recurrent irregular cycles of agent type proportions (and subsequent majority switches). It is thus shown how the endogenous transmission of inflation beliefs and monetary institutions in a stochastic economic environment can be understood as a process of intergenerational learning from history, combined with a political economy mechanism that amends legislation, and a socialization process that transmits experienced knowledge.

[11] focuses on, and models in an innovative way, cultural transmission of beliefs and institutions in heterogeneous intergenerational societies under the assumption of market democracy and majority representation in political decision making or institution design; it also involves a very agnostic informational setup, where agents know almost nothing about the underlying model and learn inflation asymptotically. We further extend theoretically this line of research in [12], to address the rise and fall of communism, a complex theme examined from different theoretical and methodological perspectives in social sciences. Here the option of democratic institutions is replaced as an assumption with the extreme of impossible voting, so the dynamics leads to the nondemocratic variant of the otherwise similar intergenerational cultural transmission mechanism, but now, in [12], regarding ideology. Our approach, in effect, formalizes the interactions of economic incentives and social learning through experimentation with an unattempted economic system so that agents learn from its establishment and (failed longer-run) functioning and feasibility. We introduce inequality-averse and inefficiency-averse agents responding to incentives and transmitting their ideology as they are affected by evolving outcomes. Their conflict is analyzed through a repeated game between a leader with economic power and a follower with ideological determination. The socioeconomic dynamics of our model generate a pendulum-like switch or rather up-the-spiral move – from markets to a centrally-planned economy abolishing private

ownership, and back to restoring market incentives. The grand experiment of communism is, thus, characterized to have led to the discovery of the trade-off between equality and efficiency at the scale of alternative economic systems.

4.2.2 Ongoing and Intended Future Work

[3] makes use of the natural experiment of the length, and abrupt end, of the Cold War in Europe to examine empirically the persistence and evolution of social preferences. Using data from six West and four East European countries plus Germany in the 2016 wave of the International Social Survey Program, we focus on the role of government in providing living standard to the unemployed. We find an "East-West divide" of attitudes, still existing in 2016 across Europe, a generation after the collapse of communism. Perhaps surprisingly, the divide reveals less support in Eastern Europe for a role of the government in correcting adverse labor market outcomes, which we attribute empirically to preference persistence in the older generation (educated during communism). Nevertheless, we also show that social preferences do evolve, relatively fast, as the younger generation (educated after communism) does not reveal the same beliefs. We interpret the East-West Europe divide in terms of two hypotheses, reinforcing each other even if originating in the respective worldviews of the opposite social fractions that coexisted inside the communist society, and contributing both to preference persistence in the older generation: (i) the "lazy unemployed" stigma indoctrinated by the communist propaganda and those loyal to it; and (ii) the "defiance of the state apparatus" experience transmitted by dissidents and silent opponents to the regime. Our main results and their suggested interpretation are corroborated by several robustness checks and placebo tests.

Coming to modern times, the theme of beliefs and conflict has become prominent once again in the fact that many Christian supporters of President Trump favor restrictive immigration policies against Libya, Syria and other Muslim countries. A cause behind this seems to be a persistent divide in certain beliefs between Christianity and Islam, even though the two religions also share many common beliefs. [42] builds a simple model in which such divide over a historical fact can persist even when strong scientific evidence exists in favor of the fact and all agents are using Bayesian learning. In the model, both innovation and conflict are more likely to occur in firms with more diversified workers, while education can reduce the probability of conflict to occur. Given these results, we argue that education to honor and understand other people's beliefs (rather than educating that one particular view is rational and the others are not) is beneficial for promoting innovation, in addition to impeding conflict.

5 Bounded Rationality, Information and Learning

A final line of current and likely future research, and as noted much interrelated with the preceding subfield, focuses attention on the role of bounded rationality, information and learning in affecting the behavior of economic agents, valuation and asset prices, signal processing with dispersed information, and the properties of the business cycle.

5.1 Past and Ongoing Work

5.1.1 Asset Prices and History Dependence

Macroeconomic data at the business cycle frequency is persistent and theory is still needed to develop a convincing mechanism to heighten persistence and amplitude of the business cycle. Asset prices, representing the present value of expected payoffs, all too often seem 'disconnected' from these persistent macroeconomic events which ultimately drive the payoffs. To investigate these anomalies, we analyze a process of financial market learning about the state of the economy (nature). Uncertainty about the true state of nature, or fundamentals, encompasses many recent ideas explored by macroeconomists, from real-time data evolution through to model uncertainty.

[5] develops a model of learning, in which informed and uninformed agents combine to form an average forecast of the state of the economy, and over time the uninformed agents also learn the true state. Inspecting this process, which we use to price assets, leads to a number of observations about the decision rules of aggregate agents, for example: (i) current period forecasts of fundamentals at long horizons tend to be rather uninformative about long-run returns; (ii) the adjustment of asset prices to shocks is partial within period; (iii) with asymmetric information and learning, forecasts are revised at every time period, even when no other shock occurs because a larger fraction of agents become progressively informed, and this improves the information content of the knowledge dispersed across society, and hence the average forecast; (iv) but this process also generates greater volatility of asset prices than under the usual assumption of homogeneous expectations.

In a deterministic version of the model, the key determinant of the evolution of knowledge about the true state and, ultimately, the dynamics of asset prices is a particular combination of the fraction of agents that are initially informed and the speed of learning. Permanent shocks can be shown to have a persistent impact on perceptions of the current state of nature, as the average agent takes time to learn the true state. And the impact of temporary shocks is magnified as agents again take time to learn the truth, and this amplifies the initial shock. Naturally, some combination of the two can be shown to act to heighten the volatility of asset prices, compared to their future payoffs. Stochastic versions of the model introduce further considerations, and complications.

Performing computations and simulations, we are able to quantify the implications of heterogeneous information with learning on asset pricing. In the deterministic version of the model, we allow (i) the fraction of the initially informed agents to vary much below 1 and (ii) the speed of the asymptotically complete learning process to be faster or lower. The key finding is that with heterogeneous information generic (state-dependent) asset prices are much (twice, even from an initial condition of 0.9 informed agents) lower than asset prices with full information at all finite horizons at which an asset yields expected cash flow (we have simulated up to 1000 dates). A qualitative difference in the shape of the respective asset prices at different horizons, and starting from different initial conditions, is that with full information and asymptotically complete learning the finite-horizon asset price converges to the theoretically computed 'ideal' or infinite-horizon asset price: i.e., we obtain a monotonically increasing dynamics. By contrast, the heterogeneous information asset price reaches a maximum at some horizon and then falls down slowly and gradually: i.e., we obtain a concave but smooth dynamics. Moreover, the maximum reached emerges very early with low fractions of initially informed agents and very late with high fractions. One interesting implication is that asset prices with heterogeneous information are much 'undervalued' relative to the full information benchmark. In other words, if the profession had mostly relied on asset pricing models based on full information assumptions, the prices (or valuation) of assets so obtained were much higher that they should have been if accounting for information heterogeneity. That is, a resulting overoptimism may have contributed to cause the asset price bubble that burst and precipitated the current Great Recession.

5.1.2 Model Disagreement and Macroeconomic Dynamics

To study a richer DSGE framework featuring heterogeneous expectations arising from model disagreement, [6] incorporates in a simple way an ex-ante average real interest rate over a given horizon (2, 5 or 10 years) into the respective IS equation of two standard – but differing – macromodels, each used by a particular type of agents. One of the agent types follows the 'central bank' (CB) model, which is an extension of the basic forward-looking New Keynesian (NK) model, while the other type does not know or believe the CB model and follows an alternative, 'financial market' (FM) model, a variation of the backward-looking (BL) model. Both the NK and the BL benchmarks are limited to a single interest rate and a lead or lag of 1 period (quarter), whereas their extensions in the CB and FM macromodels our agents rely on imply multi-period nominal, and hence real interest rates, as well as a completely defined model-consistent yield curve based on the expectations hypothesis. Employing Bayesian maximum likelihood applied to a US quarterly data set, we then estimate the CB and FM components of our 'two-model' economy. We use the estimated parameters of the CB and FM models to simulate impulse responses for our 'mixed-model' macroeconomy. We conclude that its dynamics is characterized by higher volatility and higher inertia of output, inflation and the policy rate, and less so of the 5-year and 10-year forward rates, generated by the longer-horizon forward-lookingness relative to the NK 1-quarter benchmark, but also a dampening regular cyclical pattern and, thus, slower convergence to the steady state relative to the BL 1-quarter benchmark.

5.1.3 Housing Risk and Endogenous Housing Cycles

[29] is a denser and less technical version, building on [28], which looks into the implications of uncertainty in modeling house prices and explaining their booms and busts. Extending the standard life-cycle housing approach to a three-asset model which incorporates interactions with financial markets and uncertainty, it can be shown that endogenous housing cycles can explain volatility. Three parameters drive the system: the income and price elasticities of housing demand and the degree of risk aversion. Furthermore, a key feature of UK housing policy over the last ten years or more has been an attempt to increase housing supply in order to stabilize affordability. The model demonstrates that stabilization is impossible for any plausible level of construction, if affordability is measured by the ratio of house prices to incomes. Nevertheless, the market has built-in stabilizers; this is demonstrated through the use of stochastic simulations, which illustrate the dynamics of house prices implied by our expected utility model. The model derives explicitly a housing risk premium as a key determinant of the user cost and, hence, house prices and affordability, a factor commonly ignored in many housing models. Moreover, we find that exogenous, persistent 'ups and downs' similar to the Great Moderation – Global Financial Crisis period complement the endogenous propagation mechanism of our model.

5.1.4 Financing Conditions and Sectoral Output Comovement

[48] proposes an additional channel through which sectoral shocks may result in aggregate fluctuations, based on the idea that financing conditions vary only little across sectors. Empirical evidence that various types of asset prices comove across sectors and time domestically as well as internationally has been presented in a voluminous literature. To the extent that asset prices reflect fundamentals (such as, e.g., the productivity of a firm) and financing conditions (such as, e.g., the rate at which it finances investment), the mechanism we propose here of how industryspecific idiosyncratic shocks spread out into sectoral output comovement appears justified. Suppose one sector of the economy is hit by an adverse shock. Some firms in this sector will no longer be able to repay loans and – by aggregation – the economy-wide default rate will increase. To the extent that lenders cannot distinguish between aggregate and industry-specific sources of the increase in the default rate, they will adjust interest rates for all borrowers in the economy. Therefore, even firms from sectors which are not directly affected by the shock will now face less favorable financing conditions. Thus, the financial sector in the economy, by using aggregate information at least in part, may propagate industry-specific shocks into aggregate movements in output. In such a sense, our model relies on the widely accepted role of the financial system in information acquisition, processing and aggregation originating in the idea that knowledge about the economy is dispersed among market participants. The contribution of our paper is to highlight precisely this central importance of the financial sector in synchronizing output across the economy from the supply side of the credit market – while earlier related work has focused on the demand side – and thus generating aggregate comovement, even if the initial productivity shocks have been restricted to a particular subset of industries.

It is shown that as lenders become more informed in our setting, they are able to condition the probability of default on a more individual basis, and to offer consequently a firm-specific menu of interest rates to borrowers. This, in turn, induces a larger dispersion of the set of choices made by firms on their capital inputs, and ultimately sectoral output is desynchronized. Less informed lenders, on the other hand, that have no way to condition on individual default probabilities will set a common interest rate to all borrowers as a function of the aggregate probability of default.

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