Identifying and Estimating the Longrun Effect of Income Distribution on Aggregate Consumption

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Abstract
This paper identifies and estimates the longrun effect of income distribution on aggregate consumption. Permanent components of income and consumption are obtained by functional Beveridge-Nelson decomposition of U.S. Consumer Expenditure Survey data. From the permanent income distribution, we identify two factors – the level (aggregate) and the spread (redistribution) – that affect permanent consumption. Longrun consumption is most positively affected by households with monthly earnings of around $2,000, households with lower income have negative effects on aggregate consumption, and those with $5,000 or more respond little to income redistribution. Limited income sharing across households, high entry barriers, and nontrivial adjustment costs associated with both human and physical capital accumulation may contribute to the empirical findings. Taking the estimated longrun response function as the optimal behavior of households, counterfactual taxation exercises suggest that purely redistributive policies can increase the permanent component of aggregate consumption up above 200%.

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1 Introduction

Consumption and income distributions change over time, and certain cross-sectional moments of these distributions feature highly persistent variations. In this paper, we study the long-run relations between income distribution and consumption distribution using distributional time-series models. The permanent income distribution consists of two stochastic trends, from which we identify two factors - the level and spread factors - affecting permanent consumption. The factors affect permanent consumption through changes in aggregate income and in redistribution of income, respectively. Then, we evaluate hypothetical redistributive policies to find that income transfers from high-income households to low-income households can substantially improve social welfare measured in terms of aggregate consumption.

It is widely agreed that aggregate consumption and aggregate income each contain a unit root, and this unit root component is typically interpreted as representing their permanent component. It is also well known that aggregate consumption and aggregate income are cointegrated, consistent with a long-run equilibrium relation suggested by macroeconomic models such as the permanent income hypothesis by Friedman (1957). Related, studying the degree of consumption responses to income changes using macro and micro data is an important research topic since the work of Hall (1978). Jappelli and Pistaferri (2010) review the literature to conclude that various forms of heterogeneity in households play important roles in understanding the differential responses of consumption to income changes. Not only the differing households’ characteristics but also the institutional features of an economy, such as social insurance contracts, tax policies, and the degree of risk sharing among and within households via informal and formal financial markets, can interactively determine the economic links between consumption and income. Thus, consumption is a function of households’ characteristics and the whole income distribution.

Much attention is being paid to the dynamic evolution of consumption and income inequalities. Existing works, such as Cutler and Katz (1992), Krueger and Perri (2006), and Blundell et al. (2008) find that both income and consumption inequalities are persistent and have been increasing over the last few decades. In particular, the rising income inequality is more pronounced over time as shown in Piketty and Saez (2003) and Piketty and Saez (2014), and the portion of income and wealth held by top earners has been significantly increasing over the past few decades. The aforementioned and related papers emphasize roles of incomplete markets or a lack of risk sharing among heterogeneous agents that can generate nontrivial cross-sectional dispersion of the key macroeconomic variables. Persistence in income or wealth inequality can make risk sharing among households difficult and
weaken the sustainability of financial systems. For instance, Kumhof et al. (2015) argue that income inequality without government redistributive policies can be a contributing factor to real and financial crises, because of increases in lending by high-income households to low- and middle-income households, leading to higher debt burden and associated default likelihood.

Taking the above together, an extremely interesting question arises - to find stable long-run relations between consumption and income distributions. While the existing approaches exploiting individual consumption-income relations are plausible, the lack of available long panels and related aggregation issues pose nontrivial problems in quantifying the effects of income distributions to households’ consumption in the long-run. This has obvious implications for proper evaluation of public policies and counterfactual policy and social experiments.

In this light, we propose an alternative strategy in which cross-sectional distribution functions are viewed as time-series variables. Our approach is appealing especially if there exist multiple persistent components in both income and consumption distributions. The persistent features of individual time series of cross-sectional distributions are characterized by distributional unit roots, and the long-run relationships between two time series of cross-sectional distributions having distributional unit roots are modeled as distributional cointegration. Our framework requires only pseudo panels, and therefore is widely applicable in practice. In our approach, we consider time series of probability densities as representing cross-sectional distributions. The densities for cross-sectional distributions are estimated from cross-sectional observations, and we analyze them as time series of functional observations. Our analysis relies on the statistical theory that has been developed by several authors including Bosq (2000), Park and Qian (2012) and Chang et al. (2016), among others.

The monograph by Bosq (2000) presents a basic idea and methodology on how to analyze the stationary time series of functional data. Park and Qian (2012) propose a framework to analyze the time series of probability densities representing cross-sectional distributions and develop the relevant statistical theory, assuming stationarity of the underlying probability densities over time. More recently, their framework has been extended by Chang et al. (2016) to allow for the unit root type nonstationarity. They demonstrate that the time series of cross-sectional distributions such as the time series of income distributions may be nonstationary and have distributional unit roots, and develop the methodology to draw inference on the nonstationarity in time series of cross-sectional distributions. In this paper, we further extend their approach to multiple nonstationary time series of cross-sectional distributions individually having unit roots, and create a new framework to accommodate
the presence of common stochastic trends in their time series that is named distributional cointegration.

As discussed, we only use pseudo panels, instead of genuine panels, in our study. Most panel studies in economics have used genuine panels, and the use of pseudo panels has been rather limited. While it is true that pseudo panels do not contain as much information as genuine panels, however, they include much more information to be exploited than their cross-sectional aggregates used in conventional time series analysis. The studies relying on genuine panels typically use data sets that include large dimensional cross-section observations with relatively much smaller time series dimensions. When there is a need to analyze observations over a long span, which is necessary to study persistent changes in any economic relationships over time, only pseudo panels are available in most cases. In our approach, heterogeneous agents are defined and labeled by distributional times series. This significantly reduces the need for following individual samples, because econometricians need to identify and track only the distributions. Related, as Hansen and Heckman (1996) point out, having a compatible and interchangeable interface between macroeconomic models and microeconomic underpinnings is notoriously difficult due to the availability of data, lack of proper aggregation theories in case of incomplete risk sharing and market frictions, and various econometric issues. In this light, our econometric methods attempt to surmount this difficulty, and one can view our econometric tool as a macroeconometric approach to identifying microeconomic foundations without having to make many simplifying assumptions and without having to face aggregation problems.

Our new framework and methodology are applied to analyze the distributional cointegration between the time series of cross-sectional income and consumption distributions, using the U.S. households monthly income and consumption data from the Consumer expenditure (CE) survey series during the period from January 1980 to December 2015. We demonstrate that both the time series of income and consumption distributions have unit roots: The time series of income distributions has two unit roots, whereas the time series of consumption distributions has only one unit root. Furthermore, we find the presence of cointegration between the time series of income and consumption distributions: There is one cointegrating relationship between them. As usual, we interpret their cointegrating relationship as their long-run relationship representing an equilibrium relationship. In our framework, the long-run relationship between aggregate consumption and income distribution is measured and interpreted using what we define in the paper as the long-run response function, which shows how aggregate consumption is affected by income distribution at each of the different income levels. We find that the long-run response function of aggregate consumption to income distribution is inversely U-shaped, and consumption responds most in
the longrun to changes in income of households with monthly earnings of approximately $2,000.

Our empirical results have important policy implications. First, the longrun response result indicates that there exists possible room for improving social welfare. Given that long-run consumption changes are minimal in high-income households and significantly negative among the low-income group, redistributive public policy may be effective, and reducing income inequality especially from the lower end of income distribution can help achieve higher aggregate consumption growth. In case of the middle income group in our data, their long-run consumption corresponds significantly and positively to income. In conjunction with the size of fraction of this income group, it is critical to have policies that maintain and enlarge this group for the purpose of increasing aggregate consumption.

Using the estimated income density function as well as the longrun consumption response function, we perform hypothetical experiments to find optimal redistributive policies to maximize aggregate permanent consumption. Regarding the estimated consumption longrun response function as the condition depicting the household decisions and imposing a budget balance condition, this counterfactual exercise is reminiscent of optimal taxation by Ramsey (1927) and Mirrlees (1971), where the social planner solves for a constrained optimal allocation when heterogeneities in demand or abilities exist.\(^1\)

Our results show that permanent income transfers from the higher income group to the lowest-income group via a flat tax system with transfers can increase aggregate consumption by up to 250%. This is attainable with minimally affecting the permanent consumption of the high-income groups, which is surprising. In addition, tax rates are constrained to be relatively low, and the rank-order of the after-tax household incomes are maintained in this experiment. Even a small increase in tax from the high income group can have significant effect onto the aggregate consumption, provided that the middle income group is not distorted via taxation. Granted, the implementing nonlinear tax policies has complications due to incentives to change behaviors and other caveats. However, the fact that our estimated mapping between consumption and income distributions describes persistent and stable link between the two distributional time-series, hence, this stickyness in income and consumption distributions may work as a leverage device for government to use.

We believe that there exist substantial barriers to access technologies in accumulating

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\(^1\)The literature of optimal taxation has been evolving to incorporate capital, dynamic and stochastic environment. Recent contributions include Lucas Jr and Stokey (1983), Judd (1985), Chamley (1986), Lucas (1990), Diamond (1998), Saez (2001), Kocherlakota (2005), Golosov and Tsyvinski (2006), and Golosov et al. (2006). However, whether higher tax should be imposed to high-income households is still an open question, because of possible trade-offs between efficiency and equality. Empirical studies in this context are quite limited, and our paper contributes to this literature by identifying and estimating the fundamental links between consumption and income distribution to facilitate policy evaluations.
human and physical capital. In the case of physical capital, it is true that various innovations in financial markets lower participation and transactions costs. However, many developed countries already have high levels of physical capital accumulated, and the rate of return from this capital is quite low, which lowers incentives to invest, compared to human capital. While investing in human capital is still attractive in terms of rate of returns due to fundamentally inalienable features, labor market competition and many hidden layers of entry barriers prevent the low-income group from active participation. As a result, the low-income group focuses on consumption smoothing and bear sizable costs for investing in human capital with minimal benefits from physical capital investment due to the lower return. On the other hand, top-earning households with high human capital can significantly invest in physical capital as well. In this case, they will not be affected much by changes in monthly earnings due to their diversified portfolios. If precautionary savings motive is high for these households, they tend to save excessively in physical capital, and the resultant consumption smoothing effect can be strong. Therefore, our findings suggest that policymakers should provide more targeted public policies to the low-income households to incentivize education and human capital accumulation, and implement policies to help them for additional income support, provided that the threshold is properly set based on their rates of returns from investments. In so doing, it is important not to burden the middle-income group with additional taxes.

The rest of the paper is organized as follows. Section 2 presents the model and methodology. Time series of cross-sectional distributions are formally introduced with the basic framework to analyze their long-run relationships. In particular, how to extract the permanent components of income and consumption distributions and how to identify their long-run relationship, as well as the basic functional regression and autoregression, are introduced. In Section 3, we present all statistical procedures required to do inference on our model. The methods of inference on the unit root in income and consumption distributions and their cointegration are discussed, and the estimation procedure to obtain the long-run average and distributional effects of income distribution on aggregation consumption are provided. The empirical results are summarized in Section 4. The section summarizes all our findings on the time series properties of income and consumption distributions and their long-run relationship. Section 5 offers an economic explanation and discusses policy implications based on our empirical findings, and Section 6 concludes the paper.