Living Arrangements and Labor Market Volatility of Young Workers*

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October 13, 2023

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Abstract

We provide new evidence on the cyclical behavior of the household size and labor market outcomes of young people conditional on their living arrangements in the United States from 1979 to 2022. Household size is countercyclical, driven mainly by young people moving into or delaying departure from the parental home. We document that young people living with the old work and earn less, and their hours are more volatile than their peers living alone. We argue that living arrangements induce more significant disparities in labor market outcomes than age. Motivated by these observations, we develop a joint theory of household formation and labor market engagement over the business cycle. Young people decide where to live depending on their relative wage rate, utility cost of living within the old household, and implicit transfers received from the old. We reconcile the differences in volatilities across age groups by incorporating household formation channel into the real business cycle model while restricting the labor elasticity of the old to be within the range measured by microeconomists. Our quantitative theory accounts for the bulk of the contribution of the household's size volatility to the volatility of the aggregate hours. Including people living in unstable households yields an implied aggregate, or macro, Frisch elasticity at least 70 percent larger than the assumed micro elasticity.

Keywords: Business cycles; Household formation; Aggregate risk; Elasticity of labor supply

JEL Classification: E32, J22

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*An earlier version of this paper circulated under the title "Business Cycles and Household Formation: The Micro versus the Macro Labor Elasticity". We thank seminar attendants at the ICREA–MOVE Conference on Family Economics and those at the EFACR small group of the NBER's Summer Institute. We thank Matthias Kredler for discussions.

1 Introduction

In macroeconomics, the household and the agents have traditionally been taken as the same entity.[1] This is especially true in business cycle research.[2] In this paper, we document how household composition varies over the cycle: household size is countercyclical, with the bulk of the variation accounted for by young people moving in and out of multiperson households. Moreover, young people move into larger households during recessions and reduce their hours worked. We then construct a business cycle model where agents adjust their household size and the hours they work. We use this model to generate aggregate variation in total hours far more significant than the variation of hours in response to shocks resulting from representative agent models with the same preferences. In this sense, we provide a novel (arguably unique) channel through which the macro-labor elasticity is larger than the micro-labor elasticity.

The first contribution of our paper is to provide new evidence on aggregate business cycle movements in household size, living arrangements and labor outcomes of young adults. Using quarterly data from the Current Population Survey (CPS), we document large cyclical fluctuations in the average size of U.S. households. During economic expansions households shrink, while during recessions households expand. To quantify the overall importance of these movements, we construct a new series for aggregate hours per household and compare it to traditional measures of hours per person. We find that hours per person are around 20 percent more volatile than hours per household, with the difference due to the variation in household size. A substantial fraction of this variation is due to the part of the population that we term *unstable*: people whose household structure is most likely to vary over the business cycle. We identify groups of people that move in and out of households frequently, and use these to partition the population into those that live in stable households and those that do not. Our analysis considers three such groups: people under 30; people that have never been married; and people that are both under 30 and have never been married. In addition to having a large volatility in household size, we show that these people work more hours when living alone than when living with other more stable people, and have a higher volatility of hours worked no matter what type of households they live in. Also, when living alone they earn more and have similar volatility of wages relative to their peers living with the stable individuals.

For at least two reasons, it is important to recognize that living arrangements change with the business cycle, and to incorporate these movements into macro models. First, despite labor market inputs being measured at the level of the individual, consumption is almost always measured at the level of a household. This reflects the fact that for the majority of the population, spending decisions are made in the context of shared living arrangements, which in turn reflects the presence of economies of scale within households. Thus, for any analysis of the welfare costs

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[1] In labor economics, much work treats them separately.

[2] Cubeddu and Ríos-Rull (2003) uses a growth model treating family composition as a shock while Aiyagari, Greenwood, and Güner (2000) Greenwood and Güner (2009), Greenwood, Güner, and Knowles (2003), and Regalia, Ríos-Rull, and Short (2013) study the evolution of family arrangements. None of this work deals with business cycles.

of business cycles (and the welfare implications of policies that affect the cycle), the distinction between individuals and households is potentially important. This is true because, as we document, the relationship between persons and households itself features significant business cycle variation. Yet, there are almost no quantitative business cycle models that make this distinction. Second, a growing literature has recognized that the labor supply decisions of individuals also reflect the opportunities and preferences of the people they live with.[3] Hence, changes in living arrangements can be important for labor market variables even at the individual level.

Our second contribution in this paper is to provide a joint quantitative theory of living arrangements and labor market outcomes over the business cycle. To do this, we build a real business cycle (RBC) model with stable and unstable people (which we also refer to as old and young, respectively), where the unstable (young) optimally choose, on top of labor supply decisions, whether to move and live with a stable (old) person or to live alone. We model the old household as a representative entity, which the young agents can invade. On the production side, we impose a technology featuring complementarity between labor input of the old and capital. However, from the production perspective, young people with different living arrangements are perfect substitutes.[4] A young person living within an old household receives an implicit transfer of consumption on top of her labor income but incurs a utility cost of shared living arrangements. This cost varies across young people in our model. A young person living alone relies only on her market labor income to finance her consumption. Thus, deciding where to live involves a trade-off between additional free consumption and costly living arrangements. On top of utility cost differences, young people in the model differ in labor productivity. This heterogeneity among young people in the model leads to an *endogenous selection pattern* into living arrangements. On average, less productive individuals live with the old despite high utility costs. In contrast, more productive individuals live alone on average, even facing the low utility cost of shared living arrangements. This selection pattern is affected by the business cycle. In a recession, the marginal, less productive young people living alone and facing adverse labor market conditions move in with the old to enjoy additional insurance associated with implicit consumption transfer. The opposite is true in an expansion. The marginal, more productive young people living with the old who face improving labor market conditions, move out to live alone and to free themselves from the burden of the utility cost. This mechanism leads to endogenous, countercyclical household size variation in the model, consistent with the empirical regularities we document in the data. Selection pattern also generate labor market outcomes of young adults, which are consistent with the empirical evidence we provide. Young people living with the old work and earn less than their peers living alone since they are, on average, less productive and receive implicit transfers from the old. In the face of limited intertemporal insurance opportunities for young people, these transfers lead to endogenous differences in labor supply elasticities across living arrangements. Thus, a Marshallian, rather than Frisch, elasticity of labor supply determines responses of hours

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[3] See for instance Guler, Guvenen, and Violante (2012).

[4] As demonstrated by Jaimovich, Pruitt, and Siu (2012) imperfect substitutability between labor input of the young and old is necessary to account *jointly* for the asymmetric volatilities of hours and wages of young and old agents in the standard, real business cycle model.

worked by the young. In our model, Marshallian elasticity is higher for the young living with the old than for their peers living alone. Thus, our theory is consistent with empirical evidence on asymmetric, along living arrangement margin, labor supply responses to the aggregate economic conditions.

We discipline our quantitative model with the sets of first and second moments related to labor supply and living arrangements of both stable and unstable people. The model matches the critical first moments well, including the fraction of the young people living with the old and the average hours and wages across living arrangements. Notably, on top of the first moments, we also target the hours' volatility of the unstable living alone, the hours' volatility of the unstable living in stable households, and the volatility of the fraction of unstable people living alone, *all relative to the volatility of the hours worked by stable households.* It is crucial to understand the importance of targeting these volatilities relative to the hours' volatility of the stable group rather than targeting their absolute magnitudes. The reason is that we do not want to allow technology shocks, the unique and rather conventional source of fluctuations in our economy, to account for any more of the variance of hours of the unstable than they do for the hours of the stable. Finally, we restrict stable people to have the labor elasticity within the range measured by microeconomists. Our quantitative analysis yields several findings based on the calibrated model economy. First, the model accounts for around 75 percent of the contribution of household size variations to the volatility of total hours worked over the business cycle. Using model-generated data, we conduct identical decomposition as in the CPS data, and we find that the contribution of the movements in households per person (inverse of the household size) to the hours per person volatility is 14 percent. In comparison, it is 19 percent in the data. Second, we quantify, through the lens of the model, the size of implicit transfer that the young living with the old receive. They are not directly measurable in the data; thus, our inference hinges on a well-specified and suitably disciplined model economy. By any measure used, these transfers are sizeable. They account for around 17 percent of the consumption of the old household or 80 percent of the market consumption of the young individual living within the old household. Third, we quantify the wedge between Marshallian labor supply elasticities of young people living alone and within the old household. This elasticity for young adults living independently is equal to 0.35 under our baseline calibration, while for the young living with the old, it is 0.52, thus more than 50 percent higher.

The quantitative relevance of household size volatility holds important implications for measuring the macro-labor supply elasticity. To illustrate this point, we examine the volatility of total hours in the model and recover the implicit labor elasticity that a standard representative agent model with only stable people would need to replicate this volatility of hours worked. The required Frisch elasticity of the stand-in household is around 70 percent higher than the micro estimates. The measurement of the aggregate, or macro, elasticity that we provide is consistent with micro estimates yet yields a much higher value. The rationale is that because of available microdata, micro estimates of the Frisch elasticity tend to be based on the behavior of people who live in what we call *stable* households: people whose living arrangements do not change much over time. This usually means focusing on married people or people above a certain age. However, the labor force consists of many other people living in less stable households. Such people, including the young and the single, frequently change whom they live with: sometimes alone, sometimes with a partner, often with their parents. These movements are, in part, a response to changes in individual and aggregate labor market conditions, and thus, they contribute to the overall volatility of hours worked. We systematically measure this contribution and argue that the resulting macro-labor elasticity is substantially higher.

Macroeconomists often argue that the Frisch elasticity of labor supply is more significant than what microeconomists have measured (see Chetty, Guren, Manoli, and Weber (2011a) and Ljungqvist and Sargent (2011) for recent discussions) and sometimes insist that the elasticity of the stand-in household can be larger than that of any real household (Prescott, 2006). While microeconomists' arguments are based on measurements of this elasticity using data on the labor supply choices of actual people, the rationale for macroeconomists preferring a larger elasticity needs to be clarified. Macroeconomists' arguments are implicitly based on the desire to account for aggregate movements in hours worked through price movements. A more explicit or empirical argument for preferring a larger elasticity is based on criticisms about how microeconomists have performed their measurements. These criticisms insist that the micro measurements miss margins relevant to an aggregate economy's behavior. Some of these criticisms (movements in the extensive margin, the existence of more volatile secondary earners in the family, explicit consideration of lifetime labor supply) have been accounted for by microeconomists in recent work and have contributed to increasing the microeconomic assessment of the labor elasticity. However, the gap between the two views remains large. This paper aims to narrow it by highlighting a novel and quantitatively important channel of varying living arrangements.

Related Literature

Clark and Summers (1981) first noted that labor volatility is high for young workers. Kydland (1984), Ríos-Rull (1992), Ríos-Rull (1993), Ríos-Rull (1996), and Gomme, Rogerson, Rupert, and Wright (2005) also documented differences in labor volatility by age or skill groups. They posed models with age or skill variation to explore the business cycle implications of these economies and the possible source of the variation in volatility. More recently, Jaimovich and Siu (2009) exploited the higher volatility of the young to argue that the Great Moderation (the reduction in economic volatility between 1984 and 2007) was due in part (between one-fifth and one-third) to demographic change that reduced the share of young people in the G7 economies. These papers, and, to our knowledge, all existing studies of the business cycle, assume that household size is constant.[5]

Jaimovich et al. (2012) explore the role of imperfect substitution in production between young and old workers to account for the higher volatility of the young. They astutely argue that the relative volatility of wages between young and old workers points to an explanation based on differences in technology rather than preferences. In our paper, the focus is not on explaining the labor

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[5] There are, of course, many papers about household formation, outside of a business cycle context.

market volatility of young workers, but on the interaction between their living arrangements and hours fluctuations. Yet, the evidence on the relative movements of wages for the two groups point to (under competition) a technology where both types of labor are not perfect substitutes. We find that the strategy followed by that paper, where the young have lower Frisch elasticity than the old is not a good one to understand the relative behavior of both types of labor.[6] In our paper the strategy of targeting the same fraction of the volatility of the young both living alone and living with others, and of the coresidence accounted by the model than that accounted of the volatility of hours of the old, yields higher labor elasticity for the young, and a much higher macro elasticity (the elasticity of a representative agent model needed to replicate the movements in aggregate hours generated by our model).

Kaplan (2012) also studies the relationship between the labor market and the tendency for the young to move in with the old in response to labor market outcomes. He estimates a dynamic game between youths and their parents to understand the structural microeconomic relationship between changes in living arrangements and labor supply. In this paper we model this interaction in a much simpler way, in order to be able to build a model that is amenable to equilibrium business cycle analysis with aggregate technology shocks.

The paper proceeds as follows. Section 2 documents business cycle properties of household composition and labor market variables. Section 3 describes a business cycle model with two describes a model with two types of agents, old and young, with the latter moving in and out of the formers' households. Section 4 describes how we discipline model parameters. Our findings for the baseline economy are discussed in Section 5. Section 6 discusses implications of our quantitative theory for macro-labor supply elasticity. Section 7 concludes.

2 Living Arrangements and Labor Market Variables over the Business Cycle

In this section, we show that living arrangements are varied and volatile. Living arrangements are varied in the sense that there is substantial cross-sectional heterogeneity in household structure, both in terms of household size and the relationship between the individuals in a given households. Living arrangements are volatile in the sense that the set of people that make up a household changes over time, in a way that is correlated with business cycles.

The extent of this variability and volatility differs across sub-groups of individuals. For prime-age married couples, living arrangements are relatively homogenous and constant over time; hence we refer to these individuals as stable. For other sub-groups, such as younger unmarried individuals, living arrangements are heterogeneous and cyclical; hence we refer to these individuals

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[6] Jaimovich et al. (2012) choose a Frisch elasticity for the old to match a large volatility of hours in response to productivity shocks. When they do that, to replicate the relative volatility of wages in the data a lower Frisch for the young is needed.

as unstable. We show that unstable individuals are also the group whose labor market outcomes (employment, hours and wages) vary most over the business cycle, and that the labor market outcomes of unstable individuals differ depending on their living arrangements. These findings suggest that the household structure within which any individual lives is an important factor in understanding their hours, employment and wages.

Much, but not all, of the variability and volatility in living arrangements can be attributed to parental coresidence for young people, or more generally, unstable individuals moving in and out of the homes of stable individuals. We also document facts about the cyclicality of this form of coresidence alongside household composition more generally. These facts about coresidence form the basis of our calibration targets for our structural model.

2.1 Data

We use data from the Basic Monthly Surveys from the Current Population Survey (CPS) to measure hours, employment and living arrangements. The CPS is an ideal data set for measuring aggregate movements in household composition at business cycle frequencies because it contains data on hours and employment of all individuals in a given household. Our monthly data covers a large cross section of individuals from 1979 to 2022, which we use to construct de-seasonalized quarterly series from 1979:Q1 to 2022:Q4. For data on wages and earnings we use the Annual Social and Economic Supplement to the CPS, commonly known as the March CPS. Since earnings data are not available in the monthly surveys, we are restricted to computing wage and earnings statistics at an annual frequency.

We define a household in the same way that the CPS defines a household: as the set of all persons occupying a dwelling unit. A dwelling unit is defined as "a room or group of rooms intended for occupation as separate living quarters and having either a separate entrance or complete cooking facilities for the exclusive use of occupants". The empirical definition in the CPS coincides closely with the conceptual definition of a household as a set of people who benefit from economies of scale in consumption.

Because we use cross-sectional samples from the CPS, we cannot discuss a notion of who moves in with whom when household composition changes. We can only observe the other people that an individual is living with, not the physical structure that he or she is living in. To know who physically does the moving, we would need panel data. But large enough panel data with the required information on living arrangements and labor market outcomes are not available for the United States.

2.2 Household composition: variation in the cross-section

In the first column of Table 1, we illustrate the distinction between an individual and a household by reporting statistics on the distribution of household size for the population of adults aged 18 and over. On average, adults in the United States live in households with 1.27 other people. Thus, although it may seem a trivial point, we note that the distinction between an individual and a household is a real one. Moreover, this average household size masks substantial heterogeneity across individuals in the number of other people with whom they live. Column 1 of Table 1 reports a breakdown of this distribution: 17% of adults live alone, 55% live with one other person, 17% live with two other people and 11% live with three or more other people. We will demonstrate that this variation in living arrangements is intimately related to labor market outcomes in both the cross section and over the business cycle. There is more cross-sectional heterogeneity in living arrangements for some sub-groups than for others. The remaining columns of Table 1 report the distribution of household size for individuals of different ages and marital status. Young people (who we define as those aged 18 to 30) and individuals who have never been married live with more people on average than older people (aged 31 and over) and married individuals. Within these groups there is also a greater diversity of living arrangements. For example, 18 to 30 year-olds live in households with 1.59 other people on average, with a standard deviation of 9%, compared with 31 to 65 year-olds, who live in households with 1.22 other people on average, with a standard deviation of 4%.

Table 1: Variation and volatility in household composition

	Age				**Marital status**	
	18+	**18-30**	**31-65**	**65+**	**never married**	**married**
av hh size	2.27	2.59	2.22	1.90	2.58	2.22
frac alone	0.17	0.12	0.15	0.31	0.22	0.11
frac 1 other	0.55	0.46	0.59	0.55	0.29	0.65
frac 2 other	0.17	0.23	0.17	0.10	0.27	0.16
frac 3 or more other	0.11	0.20	0.09	0.04	0.22	0.08
st dev hh size	0.04	0.09	0.04	0.03	0.11	0.03
cyclical st dev hh size	0.63%	0.93%	0.52%	0.48%	1.05%	0.51%
cyclical corr with total hours 18+	-0.62	-0.63	-0.58	-0.32	-0.58	-0.61

These statistics suggest that drawing a distinction between an individual and the household in which he or she lives is more important for some demographic groups than others. The evidence that follows demonstrates a pattern in who these individuals are: the same groups of people that exhibit the most diversity in living arrangements in the cross section are also those with the most volatile living arrangements over the business cycle and the most volatile labor market outcomes (hours, employment and wages) over the business cycle. Anticipating these findings, we will use the label stable to refer to groups of individuals with homogeneous and relatively constant living arrangements (and labor market outcomes), and the label unstable to refer to groups of individuals with diverse and volatile living arrangements (and labor market outcomes).

We propose three definitions of the stable/unstable distinction that partition the set of individuals aged 18 to 65 in different ways. These definitions, which are shown in Table 2, reflect how we will calibrate our model in Section 4. Definition 1 is based purely on age. According to definition 1, unstable individuals are those aged 18 to 30, and stable individuals are those aged 31 to 65. Since this is our baseline definition, we will frequently refer to the unstable as young and the stable as old. Definition 2 is based purely on marital status. According to definition 2, unstable individuals are those aged 18 to 65 who have never been married, and stable individuals are all other individuals aged 18 to 65. Definition 3 is the intersection of these two definitions: according to definition 3, unstable individuals are those aged 18 to 30 who have never been married, and stable individuals are all other individuals aged 18 to 65.

Table 2 reports the fraction of unstable individuals amongst all adults aged 18 to 65 according to the three definitions: 31%, 28% and 19% respectively. Much of the relevant cross-sectional variation in the living arrangements of the unstable is reflected by whether they live in a household that contains a stable individual (not living with a stable individual may entail either living alone or living with other unstable individuals). Table 2 shows that the fraction of unstable individuals who live with a stable individual is 52%, 50% and 66% for the three definitions, respectively. Thus most of the cross-sectional diversity in living arrangements for unstable individuals is captured by only an indicator for living in the home of a stable individual. With a slight abuse of language, we will use the adjective “together” to describe an unstable person who lives with a stable person, the adjective “apart” to describe one who does not, and the label coresidence to describe the state in which an unstable person lives with a stable one.

Table 2: Variation and volatility in household composition

	defn 1	defn 2	defn 3
frac unstable	0.31	0.28	0.19
frac unstable live old	0.52	0.50	0.66
st dev live together	1.72%	1.57%	1.39%
corr with hours 18-65	-0.725	-0.623	-0.710

2.3 Cyclical volatility of household composition

Living arrangements are not only varied, but they are also cyclically volatile, particularly for unstable individuals. We demonstrate this first for average household size in the total adult population, and then for coresidence of the unstable.

Figure 1a plots the raw time series for average household size and average hours worked per person aged 18 and over[7]. The plots show a clear negative correlation between the two series:

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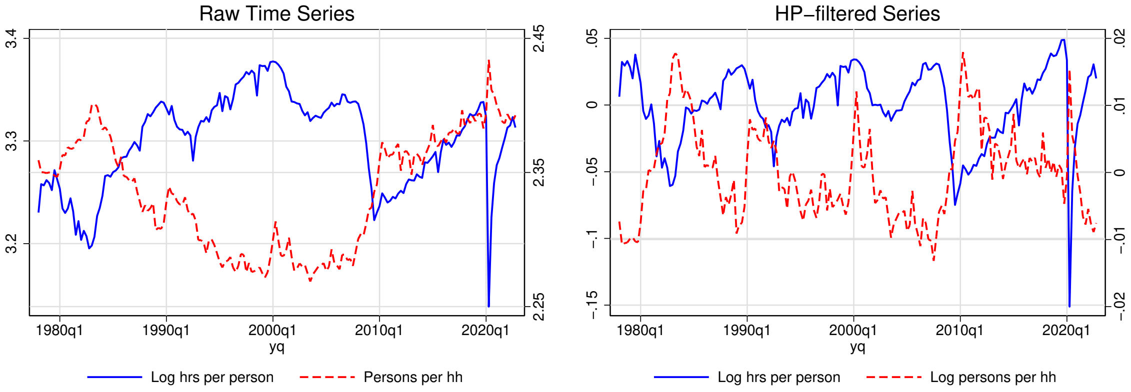
[7] For consistency with the statistics in Table 1, average household size is computed as the average across individuals of the number of people in the household that they live in. Computing average household size as the total number of households divided by the total number of people aged 18 and over yields very similar results.



(a) Raw time series

(b) HP-filtered series

Figure 1: Persons per household, hours per person

Notes: All people 18 years and over. Households with no people aged 18 years and over included. Quarterly data, 1979:Q1-2022:Q4, authors' calculations from Basic Monthly CPS. Deseasonalized. HP-filtered 100,000.

overall this correlation is -0.71. The correlation between the two series is exacerbated at business cycle frequencies. There is a sharp increase in household size in the 1981, 2008 and 2020 recessions, and a smaller increase in the milder recessions of 1990 and 2001. Figure 1b plots the corresponding HP-filtered series. The plot shows a significant negative correlation (-0.62) that is also exacerbated during the two large recessions.

The cyclical volatility of household size is more pronounced for unstable individuals. The bottom two rows of Table 1 report the standard deviation of HP-filtered log household size and its correlation with average hours worked, for the entire adult population and for sub-groups defined by age and marital status. The differences in volatility are large: for example, the time-series standard deviation of HP-filtered log household size is more than twice as large for individuals aged 18 to 30 than it is for individuals aged 31 to 65.

Table 2 shows that the coresidence rate (i.e. the fraction of unstable people living with a stable person) is volatile and counter-cyclical for each of the three definitions. For the baseline definition based on age, the standard deviation of the HP-filtered log coresidence rate for young people is 1.72%. Its correlation with average hours worked of 18 to 65 year-olds is -0.7.

2.4 Household composition and the labor market

It is well established that younger and single individuals have more volatile hours and employment than older and married individuals (Kydland (1984), Ríos-Rull (1996), Gomme et al. (2005), Jaimovich and Siu (2009)). Jaimovich et al. (2012) show that in addition, the wages of younger individuals are more volatile than the wages of older individuals. It also well known that average wages and hours are both lower for younger individuals.

All of these features of the data are inherited by our three definitions of stable and unstable people. Table 3 reports average hours and wages, and the variance of HP-filtered log wages and log hours for the unstable (young), all expressed relative to the corresponding statistics for the stable (old). The differences are large. For example, according to the first definition, hours volatility is nearly three times larger and wage volatility is 1.4 times larger for the young than the old.

This simple fact, that the young have more volatile hours and wages than the old, is the focus of Jaimovich et al. (2012). They show that by augmenting a representative agent business cycle model with young people who are imperfect substitutes to old people in production, they can generate both larger hours volatility and larger wage volatility for the young, and thus higher overall hours volatility than in a model that excludes young people. However, this existing literature has overlooked an important aspect of the differences in labor market volatility between young and old people: young people themselves exhibit very different labor market volatility depending on who they live with.

Table 3 demonstrates the importance of distinguishing young people by their living arrangements by reporting analogous labor market statistics separately for the unstable living apart from stable individuals and the unstable living together with a stable individual. These statistics show that young people who live apart from old people have average hours and wages and hours volatility that is much more similar to old people than the young people who live together with the old people. Most importantly, for the young together HP-filtered log hours is over 4.3 times more volatile than for the old, while it is only 1.6 times more volatile than the old for the young living apart. Similarly average hours of the young together are 0.74 of average hours of the old, while average hours of the young apart are actually higher than average hours of the old. Thus the observed labor market differences between unstable and stable individuals which have been the focus of the existing literature are actually less about whether people are young and single, but more about whether or not they live inside the homes of old or married peoples.

Figure 2a illustrates this distinction by plotting the raw time series for the three groups, according to definition 1: individuals aged 31-65, and individuals aged 18-30 living apart and together. Figure 2b plots the raw time series for the fracrtion of young living with the old.

This distinction is important because whereas it is relatively simple to observe in panel data sets (such as the PSID) the labor market outcomes of young and single people when they are living apart from stable people, it is much more difficult to observe their labor market outcomes when they are living inside the homes of stable people. As a result, almost all existing empirical studies that measure labor elasticities, do not include the unstable living together as part of their sample. Yet this is exactly the group who differ the most from the old. Thus we believe that in order to augment a representative agent business cycle model to capture the high hours volatility of the young, it is crucial to model their living arrangements, in particular their coresidence with the old.

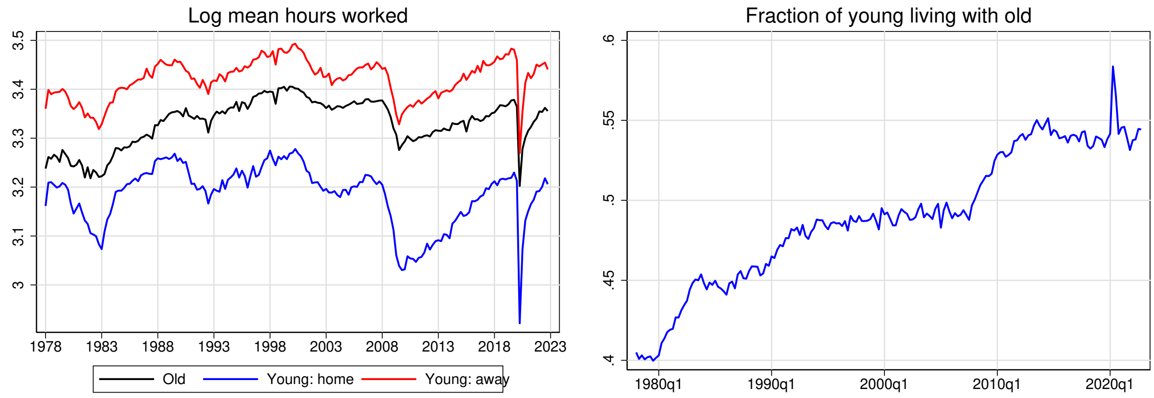
There are two channels through which allowing for variation in living arrangements among

Table 3: Household composition and the labor market

		defn 1	defn2	defn3
Av Hours	All stable	0.89	0.88	0.83
	Stable, apart	1.06	1.01	1.06
	Stable, together	0.74	0.74	0.72
Av Wages	All stable	0.56	0.61	0.50
	Stable, apart	0.72	0.82	0.71
	Stable, together	0.41	0.41	0.38
Var log hours	All stable	2.98	3.11	3.74
	Stable, apart	1.63	1.87	1.74
	Stable, together	4.34	4.95	4.96
Var log wages	All stable	1.42	1.42	1.52
	Stable, apart	1.55	1.48	1.77
	Stable, together	1.54	1.51	1.78
fraction due to mov. in x		15%	7%	13%

the unstable group helps to replicate their high hours volatility. Both channels are important empirically, and both will be active in our model. The first channel arises because hours volatility of the unstable together as a group is larger than hours volatility of the unstable apart as a group. For definition 1, Table 3 shows this difference to be a factor of 2.98. Thus even if living arrangements were constant over the business cycle, the mere fact that there is cross-sectional variation in living arrangements (captured by the inclusion of the young together) yields an increase in overall hours volatility of the unstable. In our model this additional volatility will arise because of shared consumption inside the homes of the unstable. Since young people have very little liquid wealth available to smooth consumption, their hours fluctuations are governed by income rather than substitution effects and it is their Marshallian, rather than Frisch elasticity, that matters for the size of their hours volatility. Living inside the homes of stable people increases their consumption and hence their Marshallian labor elasticity.

The second channel through which living arrangements matter for hours volatility is that, as we demonstrated in Tables 1 and 2, the fraction of unstable people who live inside the home of a stable person is itself volatile. Thus even if the hours volatility of the unstable apart and the unstable together were the same, the fact that the average hours of the young apart is 1.43 times higher than the average hours of the young together, means that total hours of the unstable would be vary mechanically as the fraction of unstable in each group varies. In the bottom row of Table 3 we provide a statistic that measures the size of this channel by computing the volatility of a counterfactual series for hours that is constructed by holding the coresidence rate fixed at its



(a) Log mean hours worked for three types of individuals

(b) Fraction of young living with old

Notes: Individuals aged 18-65 years. Old are aged 18-30, yound are aged 31-65. Quarterly data, 1979:Q1-2022:Q4, authors' calculations from Basic Monthly CPS. Deseasonalized.

steady-state values, i.e.

$$\begin{aligned} M &= 1 - \frac{Var\left(\log\left[x_{SS}h^{yT} + (1-x_{SS})\,h^{yA}\right]\right)}{Var\left(\log\left[xh^{yT} + (1-x)\,h^{yA}\right]\right)} \\ &= 1 - \frac{Var\left(\log\left[x_{SS}h^{yT} + (1-x_{SS})\,h^{yA}\right]\right)}{Var\left(\log h^{y}\right)}. \end{aligned} \tag{1}$$

The difference between the volatility of this counterfactual series and the volatility of total hours of the unstable measures the contribution of volatility in living arrangements to hours volatility. For definition 1, the contribution is 15%.

2.5 A useful decomposition: hours per household vs hours per person

We conclude the section by conducting a decomposition that is useful for measuring the contribution of cyclical movements in household size to the cyclical volatility of hours and employment more broadly. Let hours be denoted by H, the number of employed individuals by E, the number of households by F, and the total number of individuals by N. Then we can decompose total hours per person as

$$\frac{H}{N} = \frac{H}{F} \times \frac{F}{N}.$$

This decomposition expresses hours per person (the traditional measure of aggregate hours) as the product of hours per household and households per person. Similarly, we can decompose total employment per person as

$$\frac{E}{N} = \frac{E}{F} \times \frac{F}{N}.$$

Taking logs and variances yields

$$V\left(\log \frac{H}{N}\right) = V\left(\log \frac{H}{F}\right) + V\left(\log \frac{F}{N}\right) + 2COV\left(\log \frac{H}{F}, \log \frac{F}{N}\right). \tag{2}$$

Table 4 reports the result of this decomposition for employment and hours, using HP-filtered data at annual and quarterly frequencies. The results suggest that around 20% of fluctuations in per person labor market variables over the business cycle are offset at the household level by endogenous changes in household structure. Table 4 also reports analogous calculations when the data are de-trended using a linear trend rather than an HP-filter. De-trending the data in this way yields an even larger contribution of movements in the number of persons per household. Since the difference between the two methods of de-trending is the effect of medium-frequency secular changes due to episodes such as the productivity slowdown during the 1990's, these results imply that the mechanisms we are highlighting in this paper may be important for understanding labor movements over longer frequencies in addition to business cycles.

Table 4: Decomposition of hours and employment per person

	Quarterly Data		**Annual Data**	
	HP-filter (%)	**Linear trend** (%)	**HP-filter** (%)	**Linear trend** (%)
Hours: $V\left(\log \frac{H}{N}\right)$				
Households per person + covariance	19	34	17	34
Employment: $V\left(\log \frac{E}{N}\right)$				
Households per person + covariance	26	42	19	40

3 The Model

In this section we present a parsimonious, business cycle model with endogenous living arrangements. The model features old and young agents, where the latter make a decision about where to live depending on the realization of the individual and aggregate shocks.

Demographics. There are two types of agents in the model: (i) stable, as a stand-in for old, independent, or married households; and (ii) unstable as a stand-in for young, dependent, or unmarried individuals. In what follows, we refer to the former as the *old* and the latter as the *young*. Old agents in the model, like the agents in standard models, have preferences over consumption and leisure in the current and all future periods. Consequently, they make savings and labor decisions. In addition, the old are associated with some young agents whose company they enjoy, in a separable and unmodeled way, but over whom they have no altruistic feelings. In this fashion, if a young agent chooses to join the old household, she is welcomed in, and she shares part of the consumption of the old due to the presence of economies of scale within the household. The arrival of the young occurs after the old have chosen how much to work and save.

We model the young as hand-to-mouth agents, which is convenient in the business cycle model and reflects their limited insurance opportunities. They make consumption, labor, and living arrangement decisions within the period. They are heterogeneous in their labor productivity and living arrangements preferences, which we both model as the i.i.d. shocks in the cross-section and over time. As a result, the living arrangement choice of the young is a function of idiosyncratic productivity, amount of extra consumption due to economies of scale, and preference for living alone. In an ironic abuse of language, we assume that the young and the old never age.[8] We build this structure on top of a standard growth model suitable for quantitative macroeconomic analysis.

The old. There is a measure μ of the old agents that live in stable households of size γ agents per household. Consequently, there are $\frac{\mu}{\gamma}$ of these households. All old household members have identical preferences and consequently have perfect agreement making their decisions unanimous. Old-agent households can be invaded by a young agent, but only after having made their choice of consumption and hours worked.[9] Consequently, old agents consider the probability of being invaded by a young agent, but the history of the young living at home is irrelevant. Let x denote the probability that (or a fraction of) young agents choose to join an old household. Given the relative sizes of the population groups, the per-period utility function of an old agent has to take into account the household size both in the event of being invaded by a young person or not and is given by

$$
\begin{aligned}
u(c^o, h^o, x) = {} & \left[1 - \frac{x(1-\mu)\gamma}{\mu}\right]\left[\frac{1}{1-\phi^o}\left(\frac{c^o}{\zeta^o}\right)^{1-\phi^o} - \psi^o \frac{(h^o)^{1+\frac{1}{\nu^o}}}{1+\frac{1}{\nu^o}}\right] \\
& + \frac{x(1-\mu)\gamma}{\mu}\left[\frac{1}{1-\phi^o}\left(\frac{c^o}{\zeta^o+\zeta^y}\right)^{1-\phi^o} - \psi^o \frac{(h^o)^{1+\frac{1}{\nu^o}}}{1+\frac{1}{\nu^o}}\right], \quad (3)
\end{aligned}
$$

---

[8] This model is isomorphic to another model where agents do age, and the young inherit the assets of the old.

[9] Alternatively, we could have assumed insurance markets among the old. With the separable utility, this would imply that those invaded by a young receive a transfer from those not invaded without affecting hours worked. In any case, all households would hold the same assets the following period keeping the model simple. We think that this is a trivial simplification.

where the first term alludes to the household being composed of only old agents and the second term to being invaded by a young agent. Here ζ^o indicates the economies of scale among the old: if c^o is spent by a household of size γ, then $\frac{c^o}{\zeta^o}$ is enjoyed on a per capita basis. Similarly, parameters $\{\psi^o, \nu^o\}$ take into account the disutility on a per capita basis of having household members work a total amount of h^o hours per period. Given the functional form, ν^o is the Frisch elasticity of labor supply. The additional parameter ζ^y reflects the strain imposed by the young. Notice that there is no pooling of resources when the young invades the old household. The old discount the future at rate β and face the following period budget constraint

$$c^o + a' = w^o\, h^o + (1 + r)\, a, \tag{4}$$

where a are the assets held by the household, w and r are factor prices, and where we have normalized the efficiency units of labor of the old to 1.

The young. There is a measure $1 - \mu$ of young agents. These agents have preferences over consumption, leisure, and the type of household they live in, but are completely impatient (hand-to-mouth). Every period they draw two i.i.d. shocks, $\varepsilon \sim F_\varepsilon$, labor productivity and $\eta \sim F_\eta$, to the disutility of sharing a household with an old agent. They can change their residence status after observing all relevant information within the period: the realization of ε, η, and the aggregate state of the economy that determines prices and allows them to forecast the relevant decisions of the old.

If an agent chooses to live alone alone, denoted A, her utility is

$$u\left(c^{yA}, h^{yA}\right) = \frac{\left(c^{yA}\right)^{1-\phi^y}}{1-\phi^y} - \psi^y \frac{\left(h^{yA}\right)^{1+\frac{1}{\nu^y}}}{1+\frac{1}{\nu^y}} \tag{5}$$

where σ^y controls the curvature in consumption, ψ^y controls the disutility from labor and ν^y is the labor supply elasticity. When a young agent chooses lives together with an old household, denoted T, her utility is given by

$$u\left(c^{yT}, h^{yT}\right) = \frac{\left(c^{yT} + g\left(c^o\right)\right)^{1-\phi^y}}{1-\phi^y} - \psi^y \frac{\left(h^{yT}\right)^{1+\frac{1}{\nu^y}}}{1+\frac{1}{\nu^y}} - \eta. \tag{6}$$

Here $g\left(c^o\right)$ is a transfer function potentially depending on the consumption of the old, which reflects the economies of scale in the old household, or, in effect, how much free riding the young get from the old.

The young living alone choose $\{c^{yA}, h^{yA}\}$ while the young living together choose $\{c^{yT}, h^{yT}\}$. Both choices satisfy the budget constraint of the young:

$$c^{yj} = \varepsilon\, w^y\, h^{yj}, \quad j \in \{A, T\}, \tag{7}$$

where ε^y is the idiosyncratic efficiency units of the young and w^y is the wage of the young.

Production. This structure is integrated into a standard growth model. In all of our analysis, we assume that production is constant returns to scale, and that final goods are produced by perfectly competitive firms. Similarly to Jaimovich et al. (2012), we impose the following CES aggregate production technology

$$F(K, N^y, N^o, z) = \left[\theta\,(zN^y)^\sigma + (1-\theta)\left(\lambda K^\rho + (1-\lambda)\,(zN^o)^\rho\right)^{\sigma/\rho}\right]^{1/\sigma} \tag{8}$$

where N^y and N^o are labor inputs of young and old respectively and K is an aggregate capital stock. The model economy is subject a labor-augmenting, aggregate productivity shock z. θ controls the share of young in production, while λ controls the share of capital in a $K - N^o$ composite. Whenever $\sigma \neq \rho$ the degree of diminishing marginal product differs between young and old. The elasticity of substitution between old workers and capital is given by $(1-\rho)^{-1}$, while the elasticity of substitution between young workers and $K - N^o$ composite is given by $(1-\sigma)^{-1}$. For $\sigma > \rho$ the technology features ***capital-age*** complementarity. Importantly though the production technology specified in (8) ***does not*** depend on living arrangements, thus we do not impose any asymmetries related to this margin on the model.

The resource constraint is standard

$$C + [K' - (1 - \delta K)] = Y, \tag{9}$$

where C is aggregate consumption, K is aggregate capital, Y is output, N is the aggregate labor input (not total hours worked). Investment is also standard then i.e. $I = K' - (1 - \delta K)$.

Aggregation. Despite the fact that our model features multiple types of agents and households, aggregation in this environment is relatively simple. Every period there are three types of households in the economy: old households without young agents (a measure $\frac{\mu}{\gamma} - x(1-\mu)$), old households with young agents (a measure $x(1-\mu)$ of those), and young agents alone (with measure $(1-x)(1-\mu)$).[10] To determine the aggregates, we describe first the indifference condition

$$\eta^*(\varepsilon) = \frac{\left(c^{yT} + g(c^o)\right)^{1-\phi^y}}{1-\phi^y} - \psi^y \frac{\left(h^{yT}\right)^{1+\frac{1}{\nu^y}}}{1+\frac{1}{\nu^y}} - \left[\frac{\left(c^{yA}\right)^{1-\phi^y}}{1-\phi^y} - \psi^y \frac{\left(h^{yA}\right)^{1+\frac{1}{\nu^y}}}{1+\frac{1}{\nu^y}}\right] \tag{10}$$

i.e. it defines a threshold $\eta^*(\varepsilon)$ for each ε in the space of disutility shock realizations above which the agent chooses to live alone at his residence and below which the agent chooses to move into the old household. The fraction of young individuals living with the old households is then given by

$$x = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\underline{\eta}}^{\eta^*(\varepsilon)} dF_\eta \, dF_\varepsilon \tag{11}$$

where $\varepsilon \in (\underline{\varepsilon}, \bar{\varepsilon})$ and $\eta \in \left(\underline{\eta}, \bar{\eta}\right)$. Aggregate labor inputs of young alone and young together are

$$N^{yA} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\eta^*(\varepsilon)}^{\bar{\eta}} \varepsilon h^{yA}(\varepsilon) dF_\eta dF_\varepsilon, \quad N^{yT} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\underline{\eta}}^{\eta^*(\varepsilon)} \varepsilon h^{yT}(\varepsilon) \; dF_\eta dF_\varepsilon. \tag{12}$$

Analogously, the total hours worked by young alone and young together are

$$H^{yA} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\eta^*(\varepsilon)}^{\bar{\eta}} h^{yA}(\varepsilon) dF_\eta dF_\varepsilon, \quad H^{yT} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\underline{\eta}}^{\eta^*(\varepsilon)} h^{yT}(\varepsilon) dF_\eta dF_\varepsilon. \tag{13}$$

Total consumptions of the young alone and young together are

$$C^{yA} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\eta^*(\varepsilon)}^{\bar{\eta}} w^y \varepsilon h^{yA}(\varepsilon) dF_\eta dF_\varepsilon, \quad C^{yT} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\underline{\eta}}^{\eta^*(\varepsilon)} w^y \varepsilon h^{yT}(\varepsilon) \; dF_\eta dF_\varepsilon. \tag{14}$$

---

[10] The relative sizes of the young and the old as well as the nature of the processes for η and ε guarantee that there are not more young agents moving in with the old than the number of old households.

Using the aggregates for the young agents we have that the aggregate values for consumption (C), labor input (N), and hours (H), are given by

$$
\begin{aligned}
C &= \frac{\mu}{\gamma} c^o + (1-\mu) \ \ [C^{yT} + C^{yA}], && (15)\\
N^o &= \frac{\mu}{\gamma} h^o && (16)\\
N^y &= (1-\mu)[N^{yT} + N^{yA}] && (17)\\
N &= N^o + N^y, && (18)\\
H &= \frac{\mu}{\gamma} h^o + (1-\mu) \ \ [H^{yT} + H^{yA}], && (19)
\end{aligned}
$$

Capital is owned by the old, so wealth is equal to total capital: $K = a\frac{\mu}{\gamma}$.

Equilibrium. Our model is simple enough such that the objects required to define an equilibrium are the same as in a standard representative agent model. The aggregate state of the economy is $s = \{z, K\}$, since these are sufficient statistics for wealth and prices.

Definition 1. *A recursive equilibrium is a set of functions for capital,* $K'(s)$*; consumption* $\left\{C^{yA}(s), C^{yT}(s), c^o(s)\right\}$*; hours worked* $\left\{H^{yA}(s), H^{yT}(s), H^o(s)\right\}$*; the threshold* $\eta^*(\varepsilon)$*; the fraction of young that move in with the old* $x(s)$*; and competitive factor prices* $\{r(s), w(s)\}$*, such that*

1. *The young maximize given the choice of the old. This includes the choices of consumption, hours worked when together, hours worked when alone, and household type.*

2. *The fraction of the young moving in with the old satisfies (11), and the marginal young are indifferent, i.e.,* $\eta^*(\varepsilon)$ *satisfies (10) for each* ε.

3. *The old maximize given the expected choices of the young, and when imposing the representative agent condition, their choices yield* $\{K'(s), c^o(s), h^o(s)\}$.

4 Mapping the Model to the Data

In this section we take the model to the data. We discipline the model parameters using a combination of first and second moments associated with macroeconomic variables, labor market statistics and living arrangements data. There are two sets of parameters in our model. The first set contains the parameters that can be assigned without solving the model. We discipline them by using their direct data counterparts or by relying on the existing micro estimate. There are 7 parameters like that in our baseline model. The parameters in the second set have to be identified jointly and the procedure requires solving the model. Importantly, given the structure of the model, we can not separately discipline parameters based on first and second moments and we have to solve for the stochastic equilibrium, rather than the steady-state only, every time in the calibration procedure. We have 18 parameters in the second set and we use 18 moments to discipline them.

4.1 Targeted Moments

The model period is a quarter and the sample period is 1978-2022. We discipline model parameters by demanding that the model matches a combination of first and second moments from the data, which are presented in Table 5 together with their model counterparts. The set of targets we use can be divided into three categories: (i) macroeconomic aggregates (ii) labor market statistics (iii) living arrangements statistics. For the macroeconomic variables we target the quarterly interest rate of 1 percent, investment output ratio of 26 percent and share of labor income of the old agents in the GDP equal to 0.53 in the CPS data. Furthermore, we impose on the model that the volatility of the Solow residual matches the data counterepart. Unlike in a standard, growth model in our framework a total factor productivity (TFP) is not equivalent to aggregate, labor-augmenting productivity z. Thus, following Ríos-Rull and Santaeulalia-Llopis (2010) we deine Solow residual as:

$$s_t = \hat{y}_t - \alpha \hat{k}_t - (1-\alpha)\hat{h}_t \tag{20}$$

where case-hat variables are the log deviations from the steady state and α controls the share of capital in output. Then, we exploit the estimates provided by Ríos-Rull and Santaeulalia-Llopis (2010), who report the persistence of the AR(1) process for the Solow residual to be 0.958 and the standard deviation of the innovation to be 0.0067 in the post-war US data. We estimate the AR(1) process for the Solow residual on the model simulated data and demand in our calibration procedure that the estimates match their real-world data counterparts.

The second set of targeted statistics consists of the labor market variables. In the CPS data young adults, who live within the old households work on average 30 percent less and earn 40 percent less than their peers living alone. At the same time their hours worked are 1.6 times more volatile than of their peers living separately (measured in terms of relative standard deviations), while their wages vary similarly over the business cycle (both vary more than the wages of the old though). We impose these regularities on our model by targeting several first moments: the average hours worked and relative (to the old) wages both conditional on living arrangements. We also target several second moments: (i) relative standard deviation of hours of the young agents, $\sigma(h^y)/\sigma(h^o)$ (ii) relative standard deviation of hours of the young agents living with old, $\sigma(h^{yT})/\sigma(h^o)$ (iii) relative standard deviation of hours of the young agents living alone, $\sigma(h^{yA})/\sigma(h^o)$ (iv) relative standard deviation of wages of the young agents, $\sigma(w^y)/\sigma(w^o)$ (v) relative standard deviation of wages of the young agents living with old, $\sigma(w^{yT})/\sigma(w^o)$ and (vi) relative standard deviation of wages of the young agents living alone, $\sigma(w^{yA})/\sigma(w^o)$.[11]

The third set of targeted moments is related to the living arrangements of young adults and their variation over the business cycle. First, we make sure that the model replicates the average fraction of the young living with the old in the CPS data, which is 52 percent. Second, as we document in the empirical section, the living arrangements of young adults are volatile and the fraction of young adults living within the old household is countercyclical. To capture these regularities in our model economy, we target the relative standard deviation of fraction of young living with old, $\sigma(x)/\sigma(h^o)$, and it's negative correlation with the aggregate hours worked, $Corr(x,h)$.

It is important to highlight that we chose to match relative rather than absolute values of the standard deviations. An alternative to proceed would be to choose parameters so that the model generates the same volatility of hours of the young people, and the same volatility of living arrangements, as in the data. We think that such a procedure would give a misleading answer because it would implicitly assume that *all* movements in these variables are due to technology shocks. Though only a small fraction of the volatility of hours of the old are due to technology shocks in the model. Instead, we choose parameters so that the technology shock accounts for the same fraction of the variances of all types of hours worked and the variance of living arrangements.

4.2 Parametrization

In what follows, we discuss model parameters, choices of the functional forms imposed on the model economy, and the identifying assumptions that we make in the process of bringing the model to the data. The parameters, their symbols and their values are presented in Table 19.

Demographics. In our baseline calibration we identify the unstable young as those aged below 30, and the stable old as those aged 30 to 65. Unless stated otherwise, the calibration and findings that we report in the main text refer to this definition. The fraction of old agents is 0.69, which is the average fraction of people aged 18 to 65 that are 30 and above, over the sample period in our CPS data. Most of these people are married, generating an average household size of 2.33.

Technology. We pose a nested CES technology, as in equation (8), with both young and old labor, where the labor input of the old is complementary with the capital stock and the old labor-capital composite is an imperfect substitute for the labor input of the young, following Jaimovich

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[11] It is important to notice that matching relative standard deviations of young living alone and with the old does not guarantee that the model match correctly the relative standard deviations of the overall population of the young to old. The latter is affected by the movements in composition and crucially by the covariance terms.

Table 5: Targeted Moments: Baseline Model

Moment	**Data**	**Model**
First Moments		
Investment/Output	0.26	0.26
Mean Hours Old	0.62	0.60
Mean Hours Young Together	0.21	0.20
Mean Hours Young Alone	0.30	0.30
Fraction of Young living with Old	0.52	0.52
Wage of young alone/Wage Old	0.72	0.64
Wage of young together/Wage Old	0.41	0.44
Share of Old Labor Income in GDP	0.53	0.51
Second Moments		
$\sigma(h^y)/\sigma(h^o)$	1.73	1.72
$\sigma(h^{yT})/\sigma(h^o)$	2.08	1.96
$\sigma(h^{yA})/\sigma(h^o)$	1.28	1.48
$\sigma(x)/\sigma(h^o)$	0.71	0.35
$\sigma(w^y)/\sigma(w^o)$	1.19	1.20
$\sigma(w^{yT})/\sigma(w^{yA})$	1.00	0.92
Corr(x, h)	-0.72	-0.74

et al. (2012). We assume that the aggregate shock follows the standard AR(1) process i.e.

$$\log z' = \rho_z \log z + \vartheta_z \tag{21}$$

where $\vartheta_z \sim N\left(0, \sigma^i\right)$. In the calibration process we estimate the AR(1) process for the Solow residual on the model simulated data and we make sure it matches the data (see Table 5) to enforce that our model replicates the contribution of the technology shocks to the overall volatility. In order to discipline the shocks governing productivity of the young, ε , we rely on following identifying assumption. We impose that this idiosyncratic productivity is drawn from the log-normal distribution i.e. $\varepsilon \sim \ln N\left(\mu_\varepsilon, \sigma_\varepsilon^2\right)$, where μ_ε controls the mean and σ_ε controls the standard deviation of the shock. Parameters governing the aggregate shock, individual young productivity and other technology parameters, i.e. the shares of young in production, θ, the share of capital in production λ, and the parameters governing elasticities in production, σ and

ρ are jointly identified by targeting moments reported in Table 5.

Preferences of the Old. We impose preferences of the old, which are separable in consumption and hours worked and potentially take into account the probability of the arrival of the young - see (3). In our baseline calibration we consider log utility in consumption ($\phi^o = 1$). Parameters governing the economies of scale ζ^o and ζ^y are directly set using OECD estimates. For the Frisch elasticity of labor supply for the old, ν^o, we use the estimate which captures both the extensive margin and the typical existence of a couple in an old household. Our baseline value of 0.72 is based on Heathcote, Storesletten, and Violante (2010), which is also close to the value 0.82 reported by Chetty et al. (2011a) in their meta-analysis of estimates for the Frisch elasticity using micro data.[12] Disutility of working parameter, ψ^o, and discount factor, β are disciplined jointly by targeting moments reported in Table 5.

Preferences of the Young. Preferences of the young are summarized by equations (5) and (6) and depend on: (i) three standard parameters of the utility function, i.e. curvature in consumption, ϕ^y, weight on hours worked, ψ^y, elasticity of labor supply, ν^y (ii) disutility of living with the old household η and (iii) transfers received by young living with the old $g(c^o)$. The degree of risk aversion, ϕ^y, is particularly important. With log utility and no patience, hours are constant, irrespective of the wage rate. When risk aversion is greater than unity, hours move countercyclically, since the income effect of wage changes dominates the substitution effect. This means that in our calibrated economy, the risk aversion of the young is less than 1. Weight on hours worked and elasticity of labor supply are mostly pinned down by the levels and volatilities of hours worked of the young relative to the old. We assume that, the distaste of living with the old η is drawn from a flexible, two-parameter distribution. We chose type 1 extreme value distribution (Gumbel distribution), with location parameter μ_η and scale parameter σ_η, i.e. $\eta \sim Gumbel\left(\mu_\eta, \sigma_\eta\right)$. It is crucial that we allow these idiosyncratic shocks to be drawn from the two-parameter distribution. If there is only one parameter, it would be pinned down by the mean fraction of the young living with the old. However, what matters for our question is the slope of the cumulative distribution function (CDF) at this value, since this is what determines the mass of young agents that are induced to change their living arrangements in response to small changes in the wage rate. Another identifying assumption that we impose on the model is the functional form of the implicit transfers from the old household to the young agents living together with the old. In our baseline calibration we pose an affine transfer function $g(c^o) = \zeta_0 + \zeta_1 c^o$, which depends linearly on the consumption of the old. This feature generates procyclical transfers slowing down the movements of the young in the model in and out of the old household. All the parameters related to preferences of the young are disciplined jointly by targeting moments reported in Table 5.

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[12] We also note that with one possible exception (the 1987 Iceland zero tax year studied by Bianchi, Gudmundsson, and Zoega (2001)), none of the studies analyzed by Chetty et al. (2011a) or Chetty, Guren, Manoli, and Weber (2011b) are based on data that include the type of unstable marginal workers that we are emphasizing in this paper.

5 Findings

In this section, we present the main findings from our quantitative analysis. We begin by discussing the model's performance relative to targeted and untargeted moments. We then discuss the endogenous selection of the young into various living arrangements in the model's equilibrium. Next, we illustrate the dynamic properties of the model by inspecting impulse function responses following an aggregate shock. Finally, we discuss two measurements based on model simulations: (i) wedge in labor elasticities across living arrangements and (ii) size of implicit transfers from the old to the young living with them.

5.1 Model vis-a-vis the data.

Table 5 presents the model's performance vis-a-vis targeted moments. Our model matches them relatively well. First, we account for labor market differences across living arrangements. We replicate the wedge between the mean hours of young together and young alone. The former work 30 percent less than the latter. We also account for most of the wage difference between young with different living arrangements observed in the data. In the steady state of our model, those living alone earn 40 percent more relative to their peers living with the old. In our quantitative model, the hours of young living with old are twice as volatile as the old, while their peers living alone have a relative volatility of around 1.5 in the model (around 1.3 in the data). The calibrated model replicates the relative volatility of wages between the young and the old (1.2 in both data and the model) and across the young with different living arrangements (1.0 in the data and 0.9 in the model). We also account correctly for the composition of the young agents, its volatility over the business cycle, and covariance with aggregate economic conditions. In line with the data, our model generates 52 percent of young agents living with the old in the steady state. Our calibration comes short in replicating the volatility of the living arrangement margin relative to the hours of the old, and we account for half of the variance of x observed in the data. Our interpretation of this finding is that aggregate technology shock is insufficient to generate enough movements in the living arrangements of the young at the business cycle frequency, at least through the lens of our model. Finally, in our model, young move into the old households in recessions and move out in expansions, implying a negative correlation of -0.74 between x and aggregate hours worked, in line with its data counterpart of -0.72.

Table 6 presents the model's performance against non-targeted moments. The first statistic, reported as "Contribution H/F" in the table, is a model counterpart of the contribution of household per person and covariance terms to the volatility of total hours worked, as defined in (2) and reported in Table 4. Our model accounts for 75 percent of the contribution reported in the empirical section. Thus, our quantitative theory of living arrangments accounts for a bulk of movements in the household size over the business cycle and their contribution to the variability of the hours worked. As we argue in Section 2.4, there are two channels through which variation in living arrangements among the young contributes to their high hours' volatility. The first

Table 6: Non-Targeted Moments: Baseline Model

Moment	**Data**	**Model**
Contribution H/F	0.19	0.14
Moment M	0.15	0.09
Correlation of hours of old and hhs size	-0.58	-0.59
Correlation of hours of young and hhs size	-0.63	-0.82
Correlation of total hours and hhs size	-0.62	-0.74

channel arises because the volatility of hours worked by the young living together with the old is larger than that of their peers living alone. We directly discipline this margin by imposing targets reported in Table 5. The second channel through which living arrangements matter for hours volatility is that the fraction of young living with the old, x, varies by itself over the cycle. In the empirical section, we construct the measure, which quantifies the size of this channel, see (1). The moment M in the data is 0.15, whereas its non-targeted model counterpart is 0.09. Thus, our quantitative theory accounts for 60 percent of the size of this channel, which we read as a success given the parsimonious nature of our model. Finally, the last three rows of table 6 report correlations of hours of the old, hours of the young, and total hours with the household size. The model reflects qualitatively the differences between these correlations. Quantitatively, the model correctly gets the negative correlation between the hours of the old and household size but overshoots the one with the hours of the young, implying an overshoot in the correlation of total hours with the household size. Overall, we view a model's performance against the non-targeted business cycle moments related to living arrangements as corroboration of our mechanism and its quantitative relevance.

5.2 Selection into the living arrangements.

Young individuals in the model are heterogeneous with respect to living arrangements, hours worked, and wages. Thus, there is a cross-sectional distribution of labor market variables conditional on the living arrangements in the model. Young individuals endogenously self-select into living alone and with the old after observing the realization of the two idiosyncratic shocks: (i) productivity shock ε (ii) disutility shock η. The key equilibrium condition for this choice is equation (10), which defines threshold $\eta^*(\varepsilon)$ in the domain of the disutility shock. This threshold is illustrated in the left panel of Figure 3.

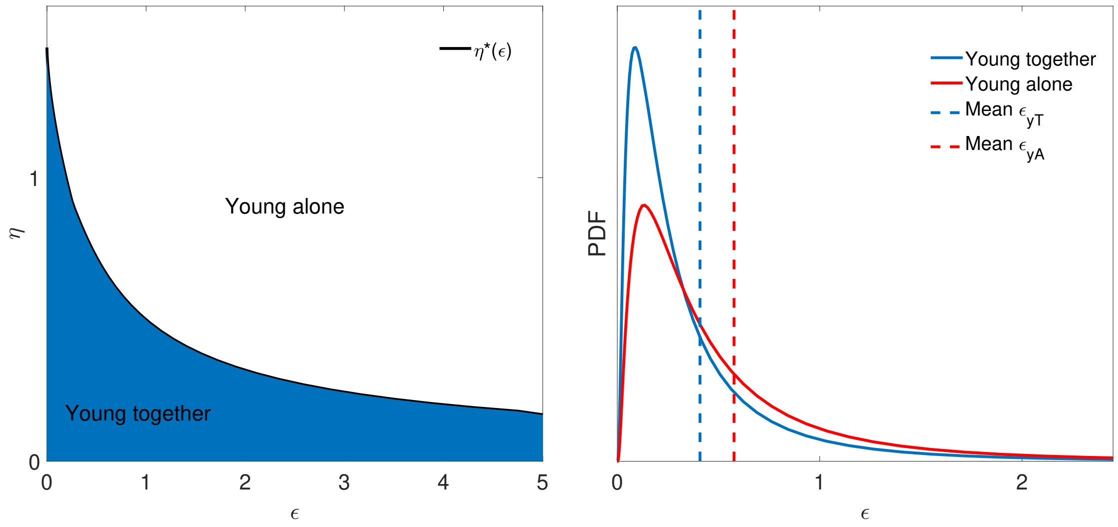
A young individual who enters the period moves into the old household if only for every productivity shock ε, the disutility shock falls below the $\eta^*(\varepsilon)$. For any realization above this threshold, the young individual lives alone. The independence of the shocks over time induces that the previous living arrangement of the young individual is irrelevant to the choice in the current period.

Table 7: Parameter Values: Baseline Model

Parameter description	**Symbol**	**Value**	**Discipline**
Params set without solving the model			
Fraction of the old in the Population	μ	0.693	CPS data
Frisch elasticity for the Old	ν^o	0.720	Heathcote et al. (2010)
Equivalence scale within the Old	ζ^o	1.700	OECD data
Equivalence scale for Old with Young	ζ^y	0.500	OECD data
Size of the Old household	γ	2.224	CPS data
Params requiring solving the model			
Discount factor	β	0.990	$r = 0.01$
Depreciation Rate	δ	0.042	Targeted Moments
Disutilty of labor for the Old	ψ^o	3.069	Targeted Moments
Disutilty of labor for the Young	ψ^y	4.293	Targeted Moments
Curvature in consumption of the Young	ϕ^y	0.535	Targeted Moments
Labor elasticity of the Young	ν^y	1.279	Targeted Moments
Mean of the prod. of the Young	μ_ε	2.676	Targeted Moments
Std of the prod. of the Young	σ_ε	1.022	Targeted Moments
Mean of the disutility of living with Old	μ_η	0.696	Targeted Moments
Std of the disutility for living with Old	σ_η	0.707	Targeted Moments
Share of Young in production	θ	0.062	Targeted Moments
Share of Old in capital-labor CES	λ	0.291	Targeted Moments
Production technology elasticity	ρ	0.146	Targeted Moments
Production technology elasticity	σ	0.660	Targeted Moments
Constant in the transfer function	ζ_0	0.062	Targeted Moments
Slope of the transfer function	ζ_1	0.119	Targeted Moments

The downward-sloping threshold implies a sharp selection pattern emerging from our model. On average, young, unproductive agents will live within the old household almost independently upon realizing their disutility shock. As the productivity increases, and we move to the right on the horizontal axis of Figure 3a, it takes a lower value of the disutility shock for the young agent to move out and live alone. This selection mechanism gives rise to a pattern of productivity distributions conditional on living arrangements (Figure 3b). The average productivity of the young agents living alone is higher than their peers living with the old, and the distribution mass is shifted to the right of the productivity domain. Note that the distribution of wages of the young in the model is isomorphic to the productivity distribution. Therefore, young living alone have, on average, higher wages than their peers living in larger households.[13]

Figure 3: Selection of the young agents into living arrangements.



(a) Indifference curve $\eta^*(\varepsilon)$. (b) Productivity distribution among young.

Notes: Units on the horizontal and vertical axes are normalized by means of ε and η accordingly. Both the indifference curve and the pdfs are truncated at 5 times the average of ε.

5.3 The dynamics of the model.

Figure 4 presents impulse responses of the baseline model to the aggregate technology shock, which help illustrate our model's mechanics. As the labor-augmenting productivity rises (Figure 4a), the marginal products of the young and the old increase, which is clear from our production specification in equation (8). Recall that the production function features age-capital complementarity. Since capital, a state variable, is inelastic in the short run, the demand for labor rises disproportionally across age groups; the demand for labor of the young increases more. To see this more sharply, suppose that old labor is a perfect complement to capital (i.e., $\rho \to -\infty$, while young labor is an imperfect substitute ($\sigma > \rho$). Then, with capital being fixed in the short run, productivity shock generates no response in the quantity of old labor hired; the only variation is in the quantity of young labor. As a result, the hours of the young respond stronger (Figure 4d). The more pronounced response of hours of the young can be further decomposed into responses conditional on living arrangements and changes in the composition (Figure 4g). On impact, following an increase in demand for young labor and associated marginal products, both groups of the young increased their hours worked. Higher Marshallian elasticity of labor supply

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[13] The wage rate is simply the product of the w^y and ε.

for the young together (see Section 5.4) implies that they respond stronger than their peers living alone. At the same time, the composition of young households changes as more young agents move out of the old households to live by themselves; see short-run drop in x in Figure 4g. The dynamics of x translates into the changes in the average household size (Figure 4i), which declines on impact and is negatively correlated with the aggregate hours, in line with the data. As for the old households, on the impact, they invest more following the rise in the marginal product of capital and the rise of their consumption is backloaded and hump-shaped (Figure 4c). As this rise in consumption of the old kicks in in the medium run and the impact of technology shock dies out, the incentives for the marginal young agents living alone to move back are increasing due to the implicit transfers $g(c^o)$. It is reflected in the reversal of the household size in the medium run. Finally, the impulse responses reveal how, in our model, the number of households margin interacts with the movements in the aggregates hours worked (Figure 4h).

5.4 Model implied labor supply elasticities.

Our joint theory of living arrangements and labor market outcomes over the business cycle has sharp predictions for the differences in variance of hours worked across age and living arrangements dimensions, as documented in the previous sections. The implicit transfers from the old to the young living with them are key to capturing these regularities we observe in the data and match in the model. To see this, notice that the labor supply of young individuals living alone, who received ε labor productivity shock, in our economy is

$$h^{yA} = \left(\frac{(w^y \varepsilon)^{1-\phi^y}}{\psi} \right)^{\frac{\nu^y}{1+\phi^y \nu^y}}.$$

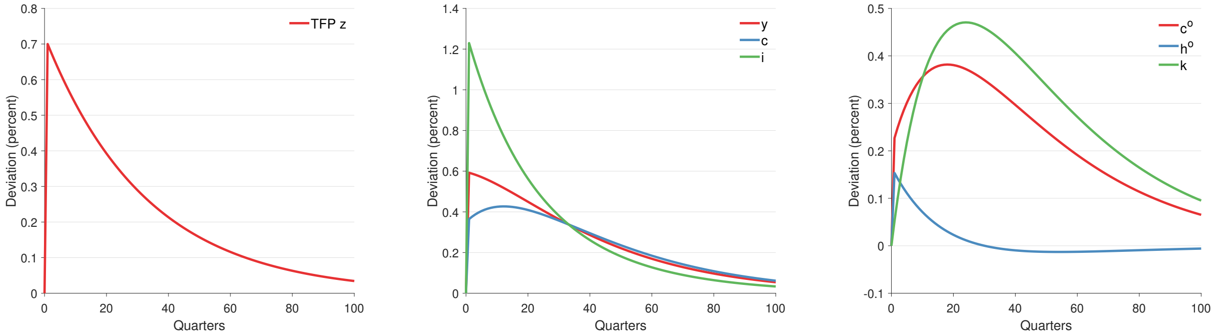
The Marshalian elasticity of labor supply is independent on the realization of any idiosyncratic shocks and is given by (see Appendix A for the details of derivation):

$$\epsilon_{w^y}^{h^{yA}} = \frac{(1-\phi^y)\,\nu^y}{1+\phi^y \nu^y}. \tag{22}$$

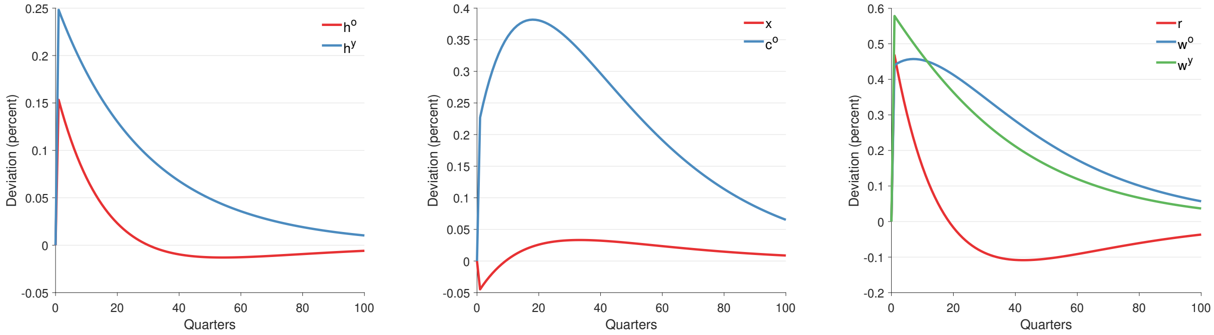
At the same time labor supply of young individual living with the old, who received ε labor productivity shock, does not exhibit closed-form solution, due to the presence of the implicit transfers $g(c^o)$. However, one can derive the following formula for the Marshallian elasticity of labor supply:

$$\epsilon_{w^y}^{h^{yT}}(\varepsilon) = \frac{\nu^y (1-\sigma^y)}{1+\sigma^y \nu^y} \frac{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1-\sigma^y}\right)\right]}{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1+\sigma^y \nu^y}\right)\right]} = \epsilon_{w^y}^{h^{yA}} \frac{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1-\sigma^y}\right)\right]}{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1+\sigma^y \nu^y}\right)\right]}. \tag{23}$$

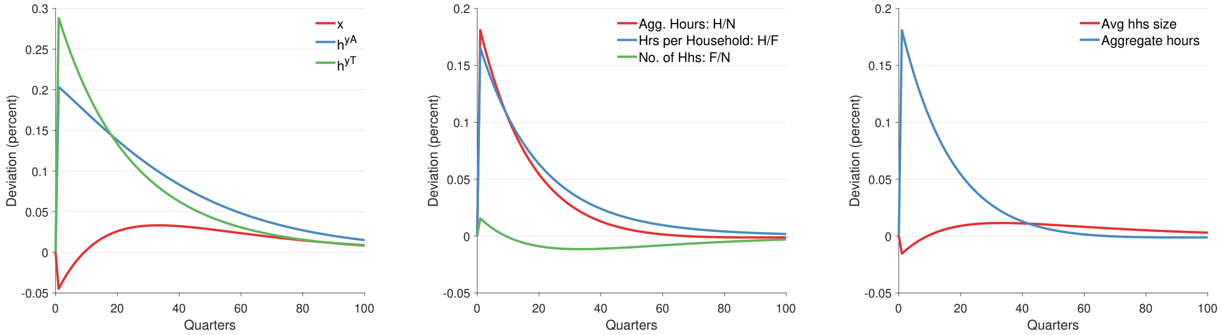
Figure 4: Impulse Response Functions to Aggregate Technology Shock



(a) Input (b) Aggregates (c) Allocations of the old



(d) Hours of young and old (e) Young living with old (f) Prices



(g) Young alone and together (h) Hours vs. households (i) Size of the hhs

In the absence of the intertemporal concerns these two Marshallian elasticities, rather than Frisch elasticity, control the response of the hours of young alone and young together to the aggregate fluctuations. Our theory predicts that hours of young together respond stronger than hours of young alone over the business cycle as long as $g(c^o) > 0$ (i.e. implicit transfers are strictly positive), whereas our calibration quantifies that difference. Observe first that, if only $\sigma^y < 1$, which we argued is the case, for any $g(c^o) > 0$ we have

$$\epsilon_{w^y}^{h^{yA}} < \epsilon_{w^y}^{h^{yT}}(\varepsilon) = \epsilon_{w^y}^{h^{yA}} \frac{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1-\sigma^y}\right)\right]}{\left[1 + \left(\frac{g(c^o)}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1+\sigma^y \nu^y}\right)\right]} \quad \forall \varepsilon$$

thus the presence of the positive implicit transfers induces that labor supply elasticity of young together is ***strictly*** larger relative to the young alone. Moreover, observe that elasticity of young together $\eta_{w^y}^{h^{yT}}(\varepsilon)$ is an increasing function of the fraction of the consumption of the young receive from the old. The larger are the transfers the more strongly hours of the young together respond to changes in the wage rate and also the larger, ceteris paribus, is the gap relative to the young alone. Also, observe that as $g(c^o) \to 0$ then $\epsilon_{w^y}^{h^{yT}}(\varepsilon) \to \epsilon_{w^y}^{h^{yA}}$ and $\epsilon_{w^y}^{h^{yT}}(\varepsilon) = \epsilon_{w^y}^{h^{yA}}$ for $g(c^o) = 0$, i.e. as transfers disappear the two elasticities and hence the response to the aggregate fluctuations become identical. Our theory of living arrangements builds upon the idea of economies of scale in the old household, which implies free-riding consumption for young together, and predicts that precisely this force accounts for the differences in the variance of hours worked over the business cycle across different living arrangements of the young. The calibration strategy we follow allows us to match exactly the relative variances of hours, and hence we can back out the difference in the elasticities driven by economies of scale. The implied values of the elasticity of the young alone in our baseline calibration is $\epsilon_{w^y}^{h^{yA}} = 0.35$. The mean elasticity of young together is given by:

$$\bar{\epsilon}_{w^y}^{h^{yT}} = \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \int_{\underline{\eta}}^{\eta^*(\varepsilon)} \epsilon_{w^y}^{h^{yT}}(\varepsilon)\, dF_\eta dF_\varepsilon \tag{24}$$

and in our baseline calibration it is equal to 0.52. Both numbers are comfortably within the range of existing empirical estimates.

These numbers contrast sharply with results by Jaimovich et al. (2012), who require Frisch elasticity of the young to be 25 to match relative variances of the hours of young and old or Frisch of 7 to match the relative variance of wages of these two groups. In both exercises, they keep the Frisch elasticity of the old ***infinite***, which is in stark contrast with existing estimates from the microeconometric literature - see Chetty et al. (2011a), Chetty et al. (2011b), Keane (2010).[14] Our model closely matches the relative variance of hours and wages of young and old and delivers reasonable Marshallian elasticities of labor supply for the young, as discussed above. At the same time, we tie our hands by respecting the micro measurement of the Frisch elasticity of the stable, old households and set it to 0.72.

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[14] See Table 5 in the Jaimovich et al. (2012).

5.5 The size of implicit transfers.

The analysis of the labor supply elasticities in the previous section highlights the crucial role of the implicit transfers, $g(c^o)$, for the transmission of the aggregate productivity shock. These transfers are not directly observable; hence, one can not measure them in the data. However, we can estimate their magnitude through the lens of our model, given that we discipline it with the macroeconomic aggregates, labor market statistics, and living arrangements moments. In what follows, we introduce five measures of the transfers.

1. Fraction of the consumption of the old: $g(c^o)/c^o$. This measure informs us how large are implicit transfers as fraction of old household's consumption.

2. Fraction of the market consumption of the young together: $\frac{g(c^o)}{\bar{c}^{yT}}$. This measure compares implicit transfers and average, market consumption of the young together.

3. Fraction of the market consumption of the young alone: $\frac{g(c^o)}{c^{yA}}$. This compares implicit transfers and market consumption of the young alone.

4. Additional average hours worked young together would have to spend on the market to achieve the same utility as with the implicit transfers. We define the measure as follows

$$\Delta_h = \left(\frac{\hat{h}^{yT} - \bar{h}^{yT}}{\bar{h}^{yT}} \right)$$

   where $\bar{h}^{yT}$ is the mean hours of the young together under the baseline calibration, and $\hat{h}^{yT}$ is the hours required to keep the utility unchanged absent transfers (see Appendix B.1 for derivation).

5. Additional productivity young together would have to have on the market to obtain the same utility as with the implicit transfers

$$\Delta_\varepsilon = \left(\frac{\hat{\varepsilon} - \bar{\varepsilon}}{\bar{\varepsilon}} \right)$$

   where $\bar{\varepsilon}$ is the mean productivity of the young together in the baseline calibration, and $\hat{\varepsilon}$ is the mean productivity required to keep the utility unchanged absent transfers (see Appendix B.2 for derivation).

In terms of all five measures implicit transfers induced by our model are sizeable, ranging from 13.9 percent when measured as fraction of additional hours that young living with the old would have to work, up to 155.3 percent when measured in terms of additional productivity required to make young individual indifferent. Very large additional productivity required to account for the

Table 8: Measures of the implicit transfers (%)

	Measures of implicit transfers (%)				
	$\frac{g(c^o)}{c^o}$	$\frac{g(c^o)}{c^{yT}}$	$\frac{g(c^o)}{c^{yA}}$	Δ_h	Δ_ε
Baseline model	16.6	80.0	41.4	13.9	155.3

implicit transfers is a result of the fact that there is a significant fraction of the young individuals living within the old household, who work very little. While computing the measure we keep hours worked fixed so that this fraction contributes disproportionally to the average, additional productivity required to compensate for the implicit transfers.

6 Implications for the "macro" Frisch elasticity

The objective of this paper is, in part, to show that the macro labor elasticity is indeed different from its micro counterpart, even while remaining scrupulously respectful of the measurements of the micro elasticity that are based on direct empirical evidence. Consequently, we now ask the question of how much higher the macro elasticity is when we are explicit about both the existence of young people and the existence of movements in household size. To answer this question, we calibrate a standard representative agent business cycle model by choosing the Frisch elasticity so that the representative agent model generates the same volatility of total hours as the model economies that we study in this paper.

Table 9 reports these findings. For our baseline definition of the young, we find that the implied macro Frisch elasticity is 1.23. Since the elasticity of the old in our baseline economy was 0.72; our findings suggest an increase in the Frisch elasticity of 70.8 percent, which we find quite sizable.

Table 9 also provides the implied macro elasticity of the alternative calibration strategies. The values of these other macro elasticities move consistently to the models' predictions for the total volatility of hours.

Alternative assumptions for micro Frisch elasticity. A concern that one might have is whether the increase in the Frisch elasticity when moving from a representative agent economy to an economy with unstable agents is affected by the level of the actual micro Frisch elasticity.[15] The reason for this concern is the non-linearity of the underlying model. To explore this issue, we

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[15] Chetty et al. (2011a) and Chetty et al. (2011b) conduct a meta-analysis of micro estimates of the Frisch elasticity. Of all the studies they examined, only one could be argued to include the type of individuals with unstable living arrangements that we focus on in this paper: this is the study of Iceland's temporary tax holiday by Bianchi et al. (2001). The remaining studies should be interpreted as estimates of the Frisch elasticity for stable or old individuals.

Table 9: Macro elasticity comparable to a micro elasticity of 0.72

Economy	**Implied Frisch in RA RBC**	**Proportional Increase**
Baseline economy	1.23	70.8%
Alternative definitions of young		
Never married	1.18	63.8%
Never married, 18-30	1.03	43.1%
Implicit definition	1.43	98.6%

Notes: The implicit definition of the young is chosen so that the size of the young generates a contribution of the variance of households per person to total hours volatility that is the same as in the data.

Table 10: Macro elasticity for alternative micro elasticities

Frisch elasticity for the old	**Standard deviation of the aggregate hours**	**Implied Frisch in RA RBC**	**Proportional Increase**
$\nu = 0.72$ (Baseline)	0.36	1.23	70.8%
$\nu = 0.3$	0.28	0.82	173.3%
$\nu = 1.0$	0.41	1.48	48.1%
$\nu = 2.0$	0.55	2.85	42.5%

Notes: Results are based on baseline definition of the unstable: individuals aged 18 to 30.

replicated the analysis above for an economy where all the targets are the same as in the Baseline, except for the Frisch elasticity of the stable old agents. We consider values of {.3,1.0,2.0}. Table 10 reports the representative agent counterpart of our economies with young agents. Interestingly, we find that the level matters, exacerbating the role of the young in shaping the macro elasticity: for all the alternative values of the Frisch elasticity in the multiple agent economies that we tried, the implied Frisch elasticity of its representative agent counterpart is proportionally higher than in the Baseline.

7 Conclusions

In this paper, we have first documented countercyclical movements in household size over the business cycles. We found that these cyclical movements are large: changes in the average number of households per person account for around 20 percent of the cyclical variation in hours worked per person. A large part of these changes in household composition is due to young or unstable individuals moving in and out of the homes of older, stable individuals. We document that labor market outcomes of young individuals living with the old differ largely from their peers. They work and earn less and have higher volatility of hours worked.

We then posed a model with both stable and unstable individuals where household composition is chosen optimally by the unstable agents. Our model features endogenous selection into living arrangements by young individuals, which is consistent with the patterns we document in the data. Further, we use the model model to assess the role of the household attachment channel for various issues. We estimate that implicit transfers received by the young living with the old are sizeable. They also imply the wedge between elasticities of labor supply between the young with different living arrangements. Those living with the old have a significantly larger elasticity than their peers living alone.

We then calculated what size of Frisch elasticity a representative agent model would need to display the same volatility of total hours as our model (with old agents having a Frisch elasticity of labor of 0.72). We found that its implied value is 1.23, an increase of 70.8% details of the calibration.

We conclude that macroeconomists now have a powerful argument to claim that the macro labor elasticity is larger than that yielded by micro studies based on young agents having both a more volatile behavior of wages and a variable (both across time and in the cross-section) household structure.

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Appendix

A Labor supply elasticities

Start with the labor supply of young alone, which is independent on the living arrangement at the beginning of a period, given by

$$h^{yA} = \left(\frac{(w^y\varepsilon)^{1-\sigma^y}}{\psi^y}\right)^{\left(\frac{\nu^y}{1+\sigma^y\nu^y}\right)}. \tag{25}$$

Taking derivative of (25) with respect to wage w^y yields

$$\begin{aligned}
\frac{dh^{yA}}{dw^y} &= \left(\frac{\nu^y}{1+\sigma^y\nu^y}\right)\left(\frac{(w^y)^{1-\sigma^y}\,\varepsilon^{1-\sigma^y}}{\psi^y}\right)^{\left(\frac{\nu^y}{1+\sigma^y\nu^y}-1\right)}(1-\sigma^y)\left(\frac{(w^y)^{-\sigma^y}\,\varepsilon^{1-\sigma^y}}{\psi^y}\right)\\
&= \left(\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y}\right)\left(\frac{\varepsilon^{1-\sigma^y}}{\psi^y}\right)^{\left(\frac{\nu^y-1-\sigma^y\nu^y}{1+\sigma^y\nu^y}+1\right)}(w^y)^{-\sigma^y}\left((w^y)^{1-\sigma^y}\right)^{\left(\frac{\nu^y-1-\sigma^y\nu^y}{1+\sigma^y\nu^y}\right)}.
\end{aligned}$$

By the fact that

$$\begin{aligned}
\left(\frac{\nu^y-1-\sigma^y\nu^y}{1+\sigma^y\nu^y}+1\right) &= \frac{\nu^y}{1+\sigma^y\nu^y}\\
(1-\sigma^y)\left(\frac{\nu^y-1-\sigma^y\nu^y}{1+\sigma^y\nu^y}\right) &= \frac{\nu^y-1-2\sigma^y\nu^y}{1+\sigma^y\nu^y}
\end{aligned}$$

we get

$$\frac{dh^{yA}}{dw^y} = \left(\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y}\right)\left(\frac{\varepsilon^{1-\sigma^y}}{\psi^y}\right)^{\left(\frac{\nu^y}{1+\sigma^y\nu^y}\right)}(w^y)^{\frac{\nu^y-1-2\sigma^y\nu^y}{1+\sigma^y\nu^y}}.$$

Hence the uncompensated, Marshallian elasticity of labor supply for young alone is

$$\begin{aligned}
\eta_{w^y}^{h^{yA}} &= \left(\frac{w^y}{h^{yA}}\right)\frac{dh^{yA}}{dw^y} \\
&= \frac{1}{h^{yA}}\left(\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y}\right)\left(\frac{\varepsilon^{1-\sigma^y}}{\psi^y}\right)^{\left(\frac{\nu^y}{1+\sigma^y\nu^y}\right)}\left(w^y\right)^{\frac{\nu^y-1-2\sigma^y\nu^y+1+\sigma^y\nu^y}{1+\sigma^y\nu^y}} \\
&= \left(\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y}\right)\left(\left(w^y\right)^{1-\sigma^y}\right)^{-\left(\frac{\nu^y}{1+\sigma^y\nu^y}\right)}\left(w^y\right)^{\frac{\nu^y-\sigma^y\nu^y}{1+\sigma^y\nu^y}}.
\end{aligned}$$

Notice that

$$-\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y}+\frac{\nu^y-\sigma^y\nu^y}{1+\sigma^y\nu^y}=0$$

implying

$$\eta_{w^y}^{h^{yA}}=\frac{(1-\sigma^y)\,\nu^y}{1+\sigma^y\nu^y} \tag{26}$$

which is the formula 22 in the main body of the paper. The labor supply of the young together is implicitly defined by the following first order condition

$$\left(w^y h^{yT}\varepsilon+g\left(c^o\right)\right)^{-\sigma^y}w^y\varepsilon-\left(\psi^y\right)\left(h^{yT}\right)^{\frac{1}{\nu^y}}=0. \tag{27}$$

Define

$$G\left(w^y,h^{yT}\right)=\left(\frac{w^y\varepsilon}{\psi^y}\right)^{-\frac{1}{\sigma^y}}\left(w^y h^{yT}\varepsilon+g\left(c^o\right)\right)-\left(h^{yT}\right)^{-\frac{1}{\sigma^y\nu^y}}=0$$

then the Marshallian elasticity of labor supply is given by

$$\eta_{w^y}^{h^{yT}}=\left(\frac{w^y}{h^{yT}}\right)\frac{dh^{yT}}{dw^y}=\left(\frac{w^y}{h^{yT}}\right)\left(-\frac{\partial G/\partial w^y}{\partial G/\partial h^{yT}}\right)$$

where the second equality comes from the implicit function theorem. After some algebra we get

$$\frac{\partial G\left(h^{yT},w^y\right)}{\partial w^y} = \left(\frac{\sigma^y-1}{\sigma^y}\right)\left(\frac{w^y\varepsilon}{\psi^y}\right)^{-\frac{1}{\sigma^y}}\left[\varepsilon h^{yT}-\frac{\zeta c^o}{(\sigma^y-1)\,w^y}\right] \tag{28}$$

$$\frac{\partial G\left(h^{yT},w^y\right)}{\partial h^{yT}} = \left(\frac{\left(w^y\right)^{1-\sigma^y}\varepsilon^{1-\sigma^y}}{\psi^y}\right)^{-\frac{1}{\sigma^y}}+\left(\frac{1}{\sigma^y\nu^y}\right)\left(h^{yT}\right)^{-\frac{1}{\sigma^y\nu^y}-1}. \tag{29}$$

The optimality condition (27) implies

$$\left(h^{yT}\right)^{-\frac{1}{\sigma^y \nu^y}} = \left(\frac{w^y \varepsilon}{\psi^y}\right)^{-\frac{1}{\sigma^y}} \left(w^y h^{yT} \varepsilon + \zeta c^o\right),$$

which plugged into the (29) after rearranging yields

$$\frac{\partial G\left(h^{yT}, w^y\right)}{\partial h^{yT}} = \left(\frac{w^y \varepsilon}{\psi^y}\right)^{-\frac{1}{\sigma^y}} \left[w^y \varepsilon \left(\frac{1 + \sigma^y \nu^y}{\sigma^y \nu^y}\right) + \frac{\zeta c^o}{h^{yT} \sigma^y \nu^y}\right].$$

Combining all elements the elasticity of interest becomes

$$\begin{aligned} \eta_{w^y}^{h^{yT}} &= \left(\frac{w^y}{h^{yT}}\right) \frac{\left(\frac{\sigma^y - 1}{\sigma^y}\right)\left[\varepsilon h^{yT} - \frac{\zeta c^o}{(\sigma^y - 1) w^y}\right]}{\left[w^y \varepsilon \left(\frac{1 + \sigma^y \nu^y}{\sigma^y \nu^y}\right) + \frac{\zeta c^o}{h^{yT} \sigma^y \nu^y}\right]} \\ &= \frac{\nu^y (1 - \sigma^y)}{1 + \sigma^y \nu^y} \frac{\left[1 + \left(\frac{\zeta c^o}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1 - \sigma^y}\right)\right]}{\left[1 + \left(\frac{\zeta c^o}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1 + \sigma^y \nu^y}\right)\right]}, \end{aligned}$$

where second inequality follows after some algebra. As a result we get

$$\eta_{w^y}^{h^{yT}} = \eta_{w^y}^{h^{yA}} \frac{\left[1 + \left(\frac{\zeta c^o}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1 - \sigma^y}\right)\right]}{\left[1 + \left(\frac{\zeta c^o}{\varepsilon w^y h^{yT}}\right)\left(\frac{1}{1 + \sigma^y \nu^y}\right)\right]} \tag{30}$$

which is the formula 23 in the main body of the paper.

B Measures of implicit transfers

B.1 Hours measure

This measure is developed as follows. Consider the utilities of the young with transfers and no transfers for an individual who enters the period living together or alone and chooses to live with the old in the current period. Fix productivity ε and threshold $\eta^*(\varepsilon)$ defined by 10 and let $\widehat{h}_\varepsilon^{yT}$

be hours worked which would make the individual indifferent, i.e.

$$\begin{aligned}&\left[\frac{\left(\varepsilon w^{y}h^{yT}+\zeta c^{o}\right)^{1-\sigma^{y}}}{1-\sigma^{y}}-\varphi^{y}\frac{\left(h^{yT}\right)^{1+\frac{1}{\nu^{y}}}}{1+\frac{1}{\nu^{y}}}-\eta^{*}\left(\varepsilon\right)-\right]\\&\left[\frac{\left(\varepsilon w^{y}\widehat{h}_{\varepsilon}^{yT}\right)^{1-\sigma^{y}}}{1-\sigma^{y}}-\varphi^{y}\frac{\left(\widehat{h}_{\varepsilon}^{yT}\right)^{1+\frac{1}{\nu^{y}}}}{1+\frac{1}{\nu^{y}}}-\eta^{*}\left(\varepsilon\right)\right]=0\end{aligned}$$

therefore averaging across young individuals living together we yield at

$$\widehat{h}^{yT}=\int_{0}^{\infty}\int_{0}^{\eta^{*}(\varepsilon)}\widehat{h}_{\varepsilon}^{yT}\,dF_{\eta}dF_{\varepsilon}$$

and hence the measure

$$\Delta_{h}=\left(\frac{\widehat{h}^{yT}-\overline{h}^{yT}}{\overline{h}^{yT}}\right)\times 100$$

where $\overline{h}^{yT}$ is the mean hours worked of the young together in the baseline calibration.

B.2 Productivity measure

This measure is developed as follows. This measure is developed as follows. Consider the utilities of the young with transfers and no transfers for an individual who enters the period living together or alone and chooses to live with the old in the current period. Fix hours worked h^{yT} and the threshold $\eta^{*}(\varepsilon)$ defined by 10 and let $\overline{\varepsilon}_{T}$ be the productivity which would make the individual indifferent, leading to

which yields

$$\widehat{\varepsilon}_{T}=\frac{\varepsilon w^{y}h^{yT}+\zeta c^{o}}{w^{y}h^{yT}}.$$

therefore averaging across young individuals living together we yield at

$$\widehat{\varepsilon}=\int_{0}^{\infty}\int_{0}^{\eta^{*}(\varepsilon)}\widehat{\varepsilon}_{T}\;dF_{\eta}dF_{\varepsilon}$$

and hence the measure is

$$\Delta_{\varepsilon} = \left(\frac{\widehat{\varepsilon} - \overline{\varepsilon}}{\overline{\varepsilon}} \right) \times 100.$$

where $\overline{\varepsilon}$ is the mean productivity of the young together in the baseline calibration.

C Additional tables

Table 11: Targeted Moments: Frisch for Old = 0.3

Moment	**Data**	**Model**
First Moments		
Investment/Output	0.26	0.30
Mean Hours Old	0.62	0.63
Mean Hours Young Together	0.21	0.19
Mean Hours Young Alone	0.30	0.30
Fraction of Young living with Old	0.52	0.51
Wage of young alone/Wage Old	0.72	0.63
Wage of young together/Wage Old	0.41	0.43
Share of Old Labor Income in GDP	0.53	0.48
Second Moments		
$\sigma(h^y)/\sigma(h^o)$	1.73	1.54
$\sigma(h^{yT})/\sigma(h^o)$	2.08	1.77
$\sigma(h^{yA})/\sigma(h^o)$	1.28	1.32
$\sigma(x)/\sigma(h^o)$	0.71	0.34
$\sigma(w^y)/\sigma(w^o)$	1.19	1.16
$\sigma(w^{yT})/\sigma(w^{yA})$	1.00	0.93
Corr(x, h)	-0.72	-0.78

Table 12: Non-Targeted Moments: Frisch for Old = 0.3

Moment	**Data**	**Model**
Contribution H/F	0.19	0.15
Moment M	0.15	0.10
Correlation of hours of old and hhs size	-0.58	-0.63
Correlation of hours of young and hhs size	-0.63	-0.85
Correlation of total hours and hhs size	-0.62	-0.78

Table 13: Parameter Values: Frisch for Old = 0.3

Parameter description	**Symbol**	**Value**	**Discipline**
Params set without solving the model			
Fraction of the old in the Population	μ	0.693	CPS data
Frisch elasticity for the Old	ν^o	0.720	Heathcote et al. (2010)
Equivalence scale within the Old	ζ^o	1.700	OECD data
Equivalence scale for Old with Young	ζ^y	0.500	OECD data
Size of the Old household	γ	2.224	CPS data
Params requiring solving the model			
Discount factor	β	0.990	$r = 0.01$
Depreciation Rate	δ	0.043	Targeted Moments
Disutilty of labor for the Old	ψ^o	2.627	Targeted Moments
Disutilty of labor for the Young	ψ^y	4.341	Targeted Moments
Curvature in consumption of the Young	ϕ^y	0.540	Targeted Moments
Labor elasticity of the Young	ν^y	1.302	Targeted Moments
Mean of the prod. of the Young	μ_ε	2.438	Targeted Moments
Std of the prod. of the Young	σ_ε	1.017	Targeted Moments
Mean of the disutility of living with Old	μ_η	0.705	Targeted Moments
Std of the disutility for living with Old	σ_η	0.690	Targeted Moments
Share of Young in production	θ	0.079	Targeted Moments
Share of Old in capital-labor CES	λ	0.293	Targeted Moments
Production technology elasticity	ρ	0.193	Targeted Moments
Production technology elasticity	σ	0.568	Targeted Moments
Constant in the transfer function	ζ_0	0.062	Targeted Moments
Slope of the transfer function	ζ_1	0.104	Targeted Moments

Table 14: Targeted Moments: Frisch for Old = 1.0

Moment	**Data**	**Model**
First Moments		
Investment/Output	0.26	0.27
Mean Hours Old	0.62	0.58
Mean Hours Young Together	0.21	0.20
Mean Hours Young Alone	0.30	0.30
Fraction of Young living with Old	0.52	0.52
Wage of young alone/Wage Old	0.72	0.66
Wage of young together/Wage Old	0.41	0.46
Share of Old Labor Income in GDP	0.53	0.50
Second Moments		
$\sigma(h^y)/\sigma(h^o)$	1.73	1.68
$\sigma(h^{yT})/\sigma(h^o)$	2.08	1.93
$\sigma(h^{yA})/\sigma(h^o)$	1.28	1.44
$\sigma(x)/\sigma(h^o)$	0.71	0.33
$\sigma(w^y)/\sigma(w^o)$	1.19	1.19
$\sigma(w^{yT})/\sigma(w^{yA})$	1.00	0.90
Corr(x, h)	-0.72	-0.73

Table 15: Non-Targeted Moments: Frisch for Old = 1.0

Moment	**Data**	**Model**
Contribution H/F	0.19	0.13
Moment M	0.15	0.09
Correlation of hours of old and hhs size	-0.58	-0.54
Correlation of hours of young and hhs size	-0.63	-0.84
Correlation of total hours and hhs size	-0.62	-0.73

Table 16: Parameter Values: Frisch for Old = 1.0

Parameter description	**Symbol**	**Value**	**Discipline**
Params set without solving the model			
Fraction of the old in the Population	μ	0.693	CPS data
Frisch elasticity for the Old	ν^o	1.000	Heathcote et al. (2010)
Equivalence scale within the Old	ζ^o	1.700	OECD data
Equivalence scale for Old with Young	ζ^y	0.500	OECD data
Size of the Old household	γ	2.224	CPS data
Params requiring solving the model			
Discount factor	β	0.990	$r = 0.01$
Depreciation Rate	δ	0.057	Targeted Moments
Disutilty of labor for the Old	ψ^o	2.741	Targeted Moments
Disutilty of labor for the Young	ψ^y	3.819	Targeted Moments
Curvature in consumption of the Young	ϕ^y	0.535	Targeted Moments
Labor elasticity of the Young	ν^y	1.456	Targeted Moments
Mean of the prod. of the Young	μ_ε	2.676	Targeted Moments
Std of the prod. of the Young	σ_ε	1.022	Targeted Moments
Mean of the disutility of living with Old	μ_η	0.684	Targeted Moments
Std of the disutility for living with Old	σ_η	0.700	Targeted Moments
Share of Young in production	θ	0.059	Targeted Moments
Share of Old in capital-labor CES	λ	0.298	Targeted Moments
Production technology elasticity	ρ	0.157	Targeted Moments
Production technology elasticity	σ	0.683	Targeted Moments
Constant in the transfer function	ζ_0	0.062	Targeted Moments
Slope of the transfer function	ζ_1	0.130	Targeted Moments

Table 17: Targeted Moments: Frisch for Old = 2.0

Moment	**Data**	**Model**
First Moments		
Investment/Output	0.26	0.25
Mean Hours Old	0.62	0.51
Mean Hours Young Together	0.21	0.21
Mean Hours Young Alone	0.30	0.29
Fraction of Young living with Old	0.52	0.51
Wage of young alone/Wage Old	0.72	0.63
Wage of young together/Wage Old	0.41	0.47
Share of Old Labor Income in GDP	0.53	0.51
Second Moments		
$\sigma(h^y)/\sigma(h^o)$	1.73	1.30
$\sigma(h^{yT})/\sigma(h^o)$	2.08	1.49
$\sigma(h^{yA})/\sigma(h^o)$	1.28	1.14
$\sigma(x)/\sigma(h^o)$	0.71	0.22
$\sigma(w^y)/\sigma(w^o)$	1.19	1.16
$\sigma(w^{yT})/\sigma(w^{yA})$	1.00	0.88
Corr(x, h)	-0.72	-0.73

Table 18: Non-Targeted Moments: Frisch for Old = 2.0

Moment	**Data**	**Model**
Contribution H/F	0.19	0.10
Moment M	0.15	0.07
Correlation of hours of old and hhs size	-0.58	-0.48
Correlation of hours of young and hhs size	-0.63	-0.85
Correlation of total hours and hhs size	-0.62	-0.73

Table 19: Parameter Values: Frisch for Old = 2.0

Parameter description	**Symbol**	**Value**	**Discipline**
	Params set without solving the model		
Fraction of the old in the Population	μ	0.693	CPS data
Frisch elasticity for the Old	ν^o	2.000	Heathcote et al. (2010)
Equivalence scale within the Old	ζ^o	1.700	OECD data
Equivalence scale for Old with Young	ζ^y	0.500	OECD data
Size of the Old household	γ	2.224	CPS data
	Params requiring solving the model		
Discount factor	β	0.990	$r = 0.01$
Depreciation Rate	δ	0.064	Targeted Moments
Disutilty of labor for the Old	ψ^o	2.565	Targeted Moments
Disutilty of labor for the Young	ψ^y	3.658	Targeted Moments
Curvature in consumption of the Young	ϕ^y	0.535	Targeted Moments
Labor elasticity of the Young	ν^y	1.574	Targeted Moments
Mean of the prod. of the Young	μ_ε	2.603	Targeted Moments
Std of the prod. of the Young	σ_ε	1.023	Targeted Moments
Mean of the disutility of living with Old	μ_η	0.665	Targeted Moments
Std of the disutility for living with Old	σ_η	0.689	Targeted Moments
Share of Young in production	θ	0.064	Targeted Moments
Share of Old in capital-labor CES	λ	0.297	Targeted Moments
Production technology elasticity	ρ	0.126	Targeted Moments
Production technology elasticity	σ	0.654	Targeted Moments
Constant in the transfer function	ζ_0	0.064	Targeted Moments
Slope of the transfer function	ζ_1	0.129	Targeted Moments