

# Economic Development and Consumption Inequality: Evidence and Theory

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## Abstract

We present evidence and a theory on the relationship between economic development and consumption inequality. Based on data from World Income Inequality Database (version 2.0a), our empirical study indicates that economic development has a negative impact on consumption inequality, controlling for inequality in after-tax income. We also find financial development to be an important channel for this effect. To account for these findings, we build a dynamic stochastic general equilibrium model with heterogeneous agents and endogenous market completeness. Our simulation results show that economic development tends to make asset markets more and more complete, which better facilitates consumption smoothing and reduces consumption inequality.

**JEL Classification Codes:** E21, D91, D52, D63, D31, D58, G22.

**Keywords:** Consumption inequality; Economic development; Endogenous market completeness.

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# 1 Introduction

Ever since the seminal contribution of Kuznets (1955), how economic inequality evolves as economies develop has been regarded as an issue of immense importance. As available cross-sectional data are mainly on income, this issue has often been taken to be about the relationship between economic development and income inequality. However, inequality in consumption is arguably a more direct reflection of the dispersion of individual welfare than inequality in income. This observation has led some economists to advocate using measures of consumption inequality in place of measures of income inequality to characterize the distribution of individual well-beings.<sup>1</sup> As Deaton (1998) states, “consumption, rather than income, is the better indicator of household living standards” regardless of which particular consumption theory one subscribes to. The material well-beings of individuals are determined by the goods and services they actually consume, which often differ from their income as they take measures to insulate consumption from fluctuations in income. From this standpoint, it would be ideal to expand the Kuznets program by looking for the relationship between economic development and consumption inequality. To make the first step of this endeavor as focused as possible, we shall not be concerned with how economic development affects income inequality as research work along this line already abounds. Rather, we are interested in finding the impact of economic development on consumption inequality when inequality in income is controlled for.

Although research on consumption inequality has been quite active recently, to the best of our knowledge none of the existing studies attempts to undertake a systematic study of how consumption inequality differs at different stages of economic development, which is precisely the objective of this paper.<sup>2</sup> To this end, we first use a recently available database to study empirically the relationship between economic development and

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<sup>1</sup>Studies along this line include Attanasio and Davis (1996), Blundell and Preston (1998), Cutler *et al.* (1991), Cutler and Katz (1992), Deaton and Paxson (1994), Heathcote, Storesletten, and Violante (2008), Krueger and Perri (2004, 2006), Slesnick (1993, 2001), etc.

<sup>2</sup>Existing studies typically focus on a single country or a small set of countries. For the U.S., see Cutler and Katz (1991, 1992), Slesnick (1993, 2001), and Attanasio, Battistin, and Ichimura (2004), among others; for the U.K., see Blundell and Preston (1998); for Europe, see Zaidi and de Vos (2001); for Canada, see Pendakur (1998) and Crossley and Pendakur (2002); for Australia, see Barrett, Crossley, and Worswick (1999); for Japan, see Ohtake and Saito (1998).

consumption inequality. A particular theory is then advanced to explain the facts established in our empirical investigation. Our empirical results indicate that consumption inequality (measured by the Gini coefficient or the standard deviation of log) decreases as real GDP per capita increases, controlling for inequality in income after tax and transfers. Our dynamic stochastic general equilibrium model, featuring heterogeneous agents and *endogenous* market completeness, reproduces this regularity under reasonable parameterization. It is found that increasingly complete asset market structures that tend to arise with economic development help agents better insulate consumption from fluctuations in income. The improved smoothness of agents' consumption plan translates into a reduction in the dispersion of the cross-agent distribution of consumption. As a result, economic development leads to less and less consumption inequality.

The main source of our data is World Income Inequality Database (version 2.0a) compiled by the United Nations University's World Institute for Development Economic Research (UNU/WIDER). We also assemble data for developed countries from other secondary sources. We then construct our dataset that includes various measures of consumption and income inequality as well as real GDP per capita (from Penn World Tables 6.2). Our regression results indicate a robustly negative impact of economic development on consumption inequality. For example, holding the Gini coefficient of net income (i.e., income after tax and transfer) fixed, a ten-thousand dollar increase in real GDP per capita lowers the Gini coefficient of consumption by 4.66%.<sup>3</sup> In order to arrive at a deeper understanding of the relationship between economic development and consumption inequality, we investigate whether financial development serves as a channel through which increases in real GDP per capita lower consumption inequality for given levels of inequality in net income. We adopt a widely used measure of financial development described in Beck, Demirgüç-Kunt and Levine (2000), namely the value of credit extended by financial intermediaries to the private sector, to construct a proxy for financial development. Following an empirical strategy adopted by, for example, Ramey and Ramey (1995) and Acemoglu *et al.* (2003) in the context of macroeconomic volatility and growth, our analysis indicates

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<sup>3</sup>Real GDP per capita is measured in constant year-2000 U.S. dollar.

that financial development serves as an important channel for the suppressing effect of economic development on consumption inequality. In particular, adding financial development to the regression equation of consumption inequality on real GDP per capita and income inequality renders the coefficient on real GDP per capita statistically insignificant while producing a significantly negative coefficient for financial development.

Our paper also proposes an explanation for these findings. Specifically, we build a dynamic stochastic general equilibrium model with heterogeneous agents, where economic development affects the degree of completeness of asset markets and therefore consumption inequality. We find this modeling strategy particularly appealing in the light of our empirical finding that development of the financial system is an important channel through which economic development reduces consumption inequality. In our model, agents are heterogeneous due to their fixed characteristics as well as income risks that cannot be perfectly insured against.<sup>4</sup> The extent to which the consumption distribution inherits the inequality in the income distribution depends crucially on how well agents share risks. Our analysis involves two major steps. First, holding inequality in income fixed, consumption inequality decreases with the completeness of asset markets which is represented by the number of assets that are generalizations of Arrow securities available for trading. Second, since operation of asset markets is costly, developed economies *choose* to operate more complete asset markets than less developed ones. Here the numbers of assets are chosen optimally by balancing out the marginal cost of operating an additional market with the marginal benefit stemming from more effective consumption smoothing for each agent and more equal distribution of consumption across agents. Taken together, consumption inequality decreases with the process of development, holding income inequality fixed.

The analysis in this paper is closely related to two strands of literature. One is the literature that investigates how consumption inequality changes along with movements in income inequality. Earlier contributions along this line include Cutler *et al.* (1991) and Cutler and Katz (1992), who move beyond comparison of current income and look at the distribution of consumption in their assessment of changes in the distribution of economic

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<sup>4</sup>The presence of such income risks implies that even if agents are *ex ante* identical, they will be *ex post* heterogeneous in consumption.

welfare in the 1960-80s. Interestingly, they document that the distribution of consumption is substantially more equal than the distribution of income, which suggests that there exists mechanisms that reduces the extent to which income inequality is translated into consumption inequality.<sup>5</sup> Recent contributions such as Krueger and Perri (2006) and Heathcote, Storesletten, and Violante (2008) find that the recent increase in the cross-sectional dispersion of consumption was modest compared to the rise in the dispersion of income in the U.S., suggesting that changes in consumption inequality might follow quite different patterns from changes in income inequality.

The literature on the relationship between consumption and income inequality highlights the different roles played by income inequalities between and within demographic groups (such as birth cohorts and gender-education groups). Attanasio and Davis (1996) find that low-frequency movements in the cohort-education structure of hourly wages drove large changes in the distribution of household consumption during the 1980s, pointing to the “spectacular failure” of between-group consumption insurance. To be consistent with this finding, we follow Krueger and Perri (2006) and Heathcote, Storesletten, and Violante (2007) to rule out insurance of between-group risks. We build our analysis of insurance of idiosyncratic income risks on the models of Alvarez and Jermann (2000) and Krueger and Perri (2006), which emphasize enforcement problems of risk-sharing arrangements as studied in Kehoe and Levine (1993). The novelty of our analysis lies in that the degree of market completeness is endogenized in our model while it is exogenously given in models that assume a complete set of asset markets (e.g., Kehoe and Levine (1993), Alvarez and Jermann (2000), and the “DCM” model of Krueger and Perri (2006)) and those that assume a fixed, limited number of assets that can be traded (e.g., Aiyagari (1994), Huggett (1993), Zhang (1997), and the “ZIM” model of Krueger and Perri (2006)). The assumption of a fixed, limited number (usually just one) of assets in the latter type of models have often been criticized as being *ad hoc*.<sup>6</sup>

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<sup>5</sup>In related work, Slesnick (1993) argues that it is more appropriate to evaluate the level of poverty using a consumption-based measure of household welfare. He finds that consumption-based poverty rates are much lower than those based on income.

<sup>6</sup>We notice that some authors call financial systems with (exogenously given) full sets of contingent claims that have borrowing limits that are endogenously determined “endogenous incomplete markets” (for example, Kehoe and Perri (2002) and Abraham and Carceles-Poveda (2006)). We shall, however,

Featuring endogenously determined degree of market completeness, our paper is also related to the literature on financial innovation in risk-sharing contexts, a literature surveyed in, for example, Allen and Gale (1994), Duffie and Rahi (1995), and Tufano (2003). Recognizing that the Arrow-Debreu complete-market benchmark fails to provide a satisfactory account of the reality, in particular that some markets that can otherwise facilitate economic agents to share risks are missing, a series of authors have attempted to analyze the determination of the structure of financial markets.<sup>7</sup> For markets to be (endogenously) incomplete, there must be some costs or frictions that prevent a complete set of markets to emerge in equilibrium.<sup>8</sup> We follow Allen and Gale (1988), Bisin (1998), and Pesendorfer (1995), etc. to assume that it is more costly to adopt sophisticated financial structures. However, instead of modeling market creation by private agents such as firms, financial intermediaries, or exchanges, we postulate a social planner who chooses the number of asset markets that the economy operates by maximizing a certain welfare criterion.<sup>9</sup> The major advantage of this approach is its tractability in our infinite-horizon context, where agents attempt to insure themselves against idiosyncratic income risks through trading of assets in possibly incomplete markets. It seems to us that the alternative approach of allowing the financial structure to emerge as an equilibrium from a decentralized system would entail cumbersome modeling for the question we want to address without offering much more insights than the simpler approach adopted in the present paper. In a parsimonious way, our approach also allows us to study the relationship between economic development and consumption inequality, where highlighted is the role played by the degree of market completeness that usually improves as the economy develops. Our study therefore addresses Duffie and Rahi (1995)’s concern that “the available theory has

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reserve that terminology for economies that fail in an endogenous fashion to have a full set of contingent claims, though for the sake of comparison with the relevant literature our model also features endogenously determined borrowing limits.

<sup>7</sup>See the references cited in the three surveys just mentioned.

<sup>8</sup>Examples of such frictions include externalities associated with financial innovation (e.g., Allen and Gale (1994) and Makowski (1983)), coordination failure due to complementarities between different financial markets (e.g., Heller (1999)), and asymmetric information (e.g., Bhattacharya, Reny, and Spiegel (1995), Demange and Laroque (1995b), and Ōhashi (1995)).

<sup>9</sup>As pointed by Duffie and Rahi (1995), the “social planner” approach is also taken by Cass and Citanna (1998), Demange and Laroque (1995a), Elul (1999), Ōhashi (1997), and Rahi (1995), etc.

relatively few normative or predictive results” by applying the theory of endogenously incomplete markets to a particular substantive area. The idea that countries at higher development stages possess more complete asset markets is also reminiscent of Robinson (1952)’s argument that countries that have better growth performance devote more resources to develop their financial system.

The rest of the paper is organized as follows. Section 2 presents our empirical work. Section 3 lays out our theoretical model that is then quantitatively assessed in Section 4. The last section concludes.

## 2 Evidence

### 2.1 Data

The main source of our data is World Income Inequality Database (version 2.0a, June 2005, hereafter “WIID2a”) compiled by the United Nations University’s World Institute for Development Economic Research (UNU/WIDER).<sup>10</sup> WIID2a is a new database built on its earlier version WIID1 (2000, 2004) which includes the influential inequality dataset of Deininger and Squire (1996). The new data of Deininger and Squire (2004), the unit record data of the Luxembourg Income Study, the Transmonee data and other new estimates are added to the database.

The observations in this secondary database are assembled from a number of different sources varying in definition of basic concepts (income, consumption, or expenditure), scope of population coverage (national, rural, or urban), area coverage, age coverage, and the unit of analysis (household, family, taxation, or person). To avoid the shortcomings of secondary databases pointed out by Atkinson and Brandolini (2001), Pyatt (2003) and Székeley and Hilgert (1999), WIID2a makes effort to document the relevant information as precisely as possible for each observation and provide the users with detailed information about quality constraints either in the survey or the concepts. To maximize comparability of distribution data across and within countries, WIID2a defines a preferred set of features

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<sup>10</sup>The data and documentation are available from WIID’s website: <http://www.wider.unu.edu/wiid/wiid.htm>.

for the conceptual base and the underlying data, the former referring to the definitions of income and consumption/expenditure, the statistical units to be adopted, the use of equivalence scales and weighting. The preferred set of features are applied to original data sources whenever possible. The preferred income definition follows Canberra Group (2001)'s recommendation for international comparisons of income distribution.<sup>11</sup> The preferred consumption concept is that prescribed by Deaton and Zaidi (2002).<sup>12</sup>

Whenever possible, we take WIID2a's "consumption" (instead of "expenditure") data as our measure of consumption. The "consumption" label is given "if there is a strong indication that the use value, rather than the purchase value of durables is included or if durables are completely excluded. In addition, fines and taxes should not be included in the aggregation." The "expenditure" label is given "if we know that durables are included with their purchase value and/or taxes and fines are included. This label is also given if we do not have information about the treatment of durables." We prefer the consumption data to the expenditure data because the use value is a better measure of material welfare than the purchase value. If consumption data is not available in some period for some country, we are forced to use the expenditure data instead. A dummy variable is added to distinguish "consumption" (0) from "expenditure" (1). As for income data, we consider both gross income and net income. Gross income includes tax or other transfers and is dubbed in WIID2a "income, gross", "monetary income, gross", and "earning, gross", etc. Net income is after tax or transfers and corresponds to "income, disposable", "monetary income, disposable", and "earning, net", etc. in WIID2a.<sup>13</sup>

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<sup>11</sup>In that conceptualization, "total income" includes employee income, income from self-employment, income less expenses from rentals, property income, and current transfers received, while "disposable income" equals total income less current transfers paid (employees' social contributions and taxes on income). WIID2a also draws special attention to whether the underlying income concept includes income items such as imputed rents for owner-occupied dwellings, imputed incomes from home production, and in-kind incomes in general.

<sup>12</sup>In that conceptualization, the "consumption" aggregate is composed of food consumption, non-food consumption (including health, education, and transport expenses), the use value (or rental value) of durable goods, and housing (rents paid or imputed rents, plus utilities). If durables are included with their purchase value and/or taxes paid, purchase of assets, repayments of loans, and lumpy expenditures are included, the aggregate is called "expenditure". Again, WIID2a pays attention to the inclusion of non-monetary items.

<sup>13</sup>We do not use observations with ambiguous definition "income...", a label given by WIID2a when there is no information about the income concept from the source.

Since our intention is to construct a country-level dataset, we require the chosen data to have comprehensive coverage of area, population and age within each country. Data from surveys conducted only for urban or rural area, or the employed population are discarded. To make the analysis coherent, we pick up data with the basic statistical unit as “household” or “family” and the unit of analysis as “person”. Moreover, only data that adjust for household size are used. We require the definitions of basic concepts (consumption or expenditure, gross or net income) and the unit of analysis to be same for all observations we use within a country.

The inequality measures in WIID2a include Gini coefficient and quintile, decile, and percentile (5 percent and 95 percent) population group shares. In our work, we focus on Gini coefficient and the standard deviation of log income or consumption (calculated from decile shares). In addition, since data on consumption inequality are documented mainly for developing countries in WIID2a, we assemble data for consumption inequality in developed countries (including Australia, Canada, U.S., Portugal, Italy, Greece, Spain, U.K., France, Germany, Belgium, and Netherlands) from sources other than those utilized by WIID2a,<sup>14</sup> following the three well-known criteria provided in Deininger and Squire (1996).<sup>15</sup> Finally, we proxy countries’ level of economic development by their real GDP per capita (2000 as base year). These data are taken from Penn World Tables 6.2.<sup>16</sup>

We construct a dataset from the data sources described above. As data on inequality measures are not available for all years, we use a 5-year period in our analysis. A 5-year period is not too short to be subject to business cycle fluctuations (Clark, Xu, and Zou, 2006) and would lead to a larger amount of sample points than longer periods. Our calculation splits the sample period 1971-2000 into six 5-year periods. Within each 5-year period, we average available observations to arrive at indicators of the relevant variables in that period. As data (especially those for consumption inequality) in WIID2a might

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<sup>14</sup>These data are from various sources. Australia: Barrett, Crossley and Worswick (1999); Canada: Crossley and Pendakur (2002); U.S.: Cutler and Katz (1992); France, Netherlands, Germany, U.K., Belgium, Italy, Spain, Portugal, Greece: Zaidi and Vos, (2000). In addition, consumption inequality data for Brazil, Colombia, Mexico, and Peru are taken from Goni, Lopez and Serven (2006).

<sup>15</sup>These criteria are: (i) household or individual as the unit of observation, (ii) comprehensive coverage of the population, and (iii) comprehensive measurement of income or expenditure.

<sup>16</sup>See Heston *et al.* (2006).

be missing for all the five years of some periods, the number of observations for a country is often less than six in the our final dataset. Availability of observations over time periods also varies a great deal across countries. We therefore simply pool the data in the regressions we run.

## 2.2 Empirical Results

Table 1 summarizes the correlations among the variables under investigation. It is apparent that real GDP per capita is negatively correlated with all measures of inequality, including the Gini coefficients and standard deviations of log of consumption, gross income, and net income. The Gini coefficient for consumption is positively correlated with the Gini coefficients for both gross and net income. The same thing is true when it comes to the standard deviation of log. Moreover, the Gini coefficients for gross income and net income are positively correlated, so are their standard deviations of log. Finally, the Gini coefficient measure exhibits positive correlation with the standard deviation of log measure, regardless of whether the variable of interest is consumption, gross income, or net income.

[Insert Table 1 here.]

To obtain a visual impression of the relationship between economic development and consumption inequality, we plot measures of consumption inequality against real GDP per capita. Figure 1 uses the Gini coefficient while Figure 2 uses the standard deviation of log. A decreasing relationship between consumption inequality and real GDP per capita is apparent from both figures.

[Insert Figures 1-2 here.]

In our empirical study, we regress measures of consumption inequality on real GDP per capita and measures of income inequality with the method of generalized least squares that takes account of the heteroskedasticity across countries.<sup>17</sup> Our first set of regressions

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<sup>17</sup>We have performed likelihood-ratio tests that reject the null hypothesis of homoskedasticity across countries.

use the Gini coefficient for consumption as the dependent variable. The second set of regressions then use the standard deviation of log consumption.

Table 2 presents the results for the first set of regressions. Three regressions are performed here, depending on whether an inequality measure for income is used as one of the explanatory variables, and if yes, which measure is actually used. First, we run a simple regression where real GDP per capita is the only explanatory variable. The result indicates that this variable has a coefficient of  $-1.047$ , meaning that a one-thousand dollar increase in real GDP per capita would lead to a *reduction* in the Gini coefficient for consumption by about 1 percentage point.<sup>18</sup>

[Insert Table 2 here.]

This effect, however, is obviously too large since inequality in income is not controlled for. Our second regression uses the Gini coefficient for gross income as an additional explanatory variable. The result indicates that holding real GDP per capita fixed, a one-percentage point increase in the gross income Gini will translate into a 0.56 percentage point increase in the consumption Gini. Again, the coefficient on real GDP per capita is negative and significant at all conventional levels. Holding the gross income Gini fixed, a one-thousand dollar increase in real GDP per capita would reduce the consumption Gini by  $-0.49$  percentage point.

There are two ways that economic development, proxied by increases in real GDP per capita, might affect consumption inequality. On one hand, the extent to which gross income inequality passes through to net income inequality might decrease as economies develop, due to increasingly effective income redistribution through taxes and transfers. On the other hand, economic development might also reduce the extent to which inequality in net income (i.e., income after taxes and transfers) passes through to inequality in consumption. We would thus expect the regression using gross income inequality to yield larger slope (in absolute value) for real GDP per capita than the regression using net income inequality as the former regression includes both effects we just described while

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<sup>18</sup>Note that we express real GDP per capita in thousands of constant year-2000 U.S. dollars and Gini coefficients in percentage terms.

the latter reflects only the second effect. We would also expect net income inequality to have a larger slope than gross income inequality as the effect of the latter on consumption inequality might be tempered by redistributive policy. These conjectures are indeed confirmed by our regression results below.

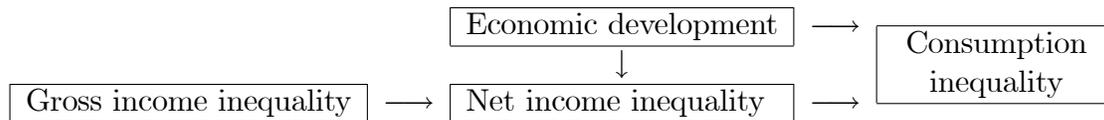
From the comparison of the “Gross” and “Net” columns in Table 2 we see that whether using gross or net income does not make a qualitative difference about the negative relationship between consumption inequality and economic development and the positive relationship between consumption inequality and income inequality. Nevertheless, when net income inequality is used in lieu of gross income inequality, the coefficient on real GDP per capita changes from  $-0.49$  to  $-0.47$ . Still, this is a sizable magnitude: it means that real GDP per capita differential as high as thirty thousand U.S. dollars would be associated with a consumption Gini differential of 14 percentage points. Meanwhile, the coefficient on income inequality changes from  $0.56$  to  $0.65$ , which is not surprising under the presupposition that inequality in net income has a more direct link with consumption inequality. The coefficients on real GDP per capita indicate that even when we partial out the effect of changes in redistributive policies, economic development still exerts a negative influence on consumption inequality. The magnitude of this influence seems to be quite large and statistically significant.

[Insert Tables 3 here.]

In our second set of regressions, we use the standard deviation of log consumption as the dependent variable. Concomitantly, we adopt the standard deviation of log income as our inequality measure for income distribution. The results are displayed in Table 3, where several patterns similar to those in Table 2 stand out. First, the effects of real GDP per capita on consumption inequality are always negative. They get smaller in magnitude when inequality in income is controlled for. Controlling for net income inequality yields smaller coefficient for real GDP per capita than controlling for gross income inequality. Furthermore, the effects of income inequality are always positive. The coefficient on net income inequality is again larger than the coefficient on gross income inequality. The major difference between results in Tables 2 and 3 is that the estimated effect of economic

development becomes statistically insignificant at 5% level when inequality in net income is controlled for, and even less significant we control for inequality in gross income. This is due to the small number of observations that we can assemble when using the standard deviation of log as the inequality measure.

The following schematic summarizes the logic behind the regressions described above.



Inequality in gross income is first translated into inequality in net income, which is in turn translated into inequality in consumption. Economic development reduces the extent to which gross income inequality is passed on to net income inequality through redistributive policy (the downward arrow). It also lowers the magnitude of consumption inequality for given levels of inequality in net income (the top arrow).

### 2.3 Financial Development as a Channel

Why do economies with higher real GDP per capita exhibit lower inequality in consumption? We conjecture that financial development might be an important channel through which economic development affects the distribution of consumption across agents. Our presumption is that *ceteris paribus*, richer countries should have more developed financial system, which in turn should provide agents with better insurance opportunities. It is admittedly difficult, if possible at all, to obtain direct measures of the aspects of financial development that are relevant for providing more and better insurance opportunities for economic agents. The best one can do is to resort to some proxy variable. In particular, we use real private credit per capita (“private credit” hence forth) in the context of our empirical analysis. This variable is constructed from multiplying real GDP per capita and the value of credit extended by financial intermediaries to the private sector as a proportion to GDP, which we take from the well known dataset described in Beck, Demirgüç-Kunt and Levine (2000).<sup>19</sup> In using this proxy we are implicitly assuming that

<sup>19</sup>We use the data they revised in 2006. The variable we take is also the one that best matches our dataset on inequality in terms of the eventual number of observations available for regression. Using other variables that might also be relevant indicators of financial development would give rise to much fewer observations.

economies with more advanced financial systems are usually also the ones that can provide agents with better opportunities for consumption smoothing through trading of ample varieties of assets. Referring again to Table 1, we see that the correlation between “private credit” and real GDP per capita is as high as 0.90, and that the correlations between “private credit” and all measures of inequality are negative.

To assess whether financial development serves as a channel through which economic development lowers consumption inequality, we follow the empirical strategy adopted by, for example, Ramey and Ramey (1995) and Acemoglu *et al.* (2003) in the context of macroeconomic volatility and growth. In particular, we first regress consumption inequality on real GDP per capita and income inequality, without using “private credit” as an explanatory variable. As we have more adequate data on Gini coefficients than on standard deviations of log, we use the former as our inequality measure here. We also aim to control for inequality in net income rather than gross income. Hence this regression is the one corresponding to the “Net” column in Table 2. Its results are reproduced in the column labeled “Without private credit” in Table 4. We then add the variable “private credit” to the right-hand side of the regression equation. If the coefficient on this added variable is significantly negative, and if its addition substantially reduces the magnitude of the coefficient on real GDP per capita, then according to Acemoglu *et al.*’s methodology, financial development can be regarded as a channel variable that stands in between economic development and consumption inequality.<sup>20</sup> The results for the expanded regression are shown in the column labeled “With private credit” in Table 4. We see that the presence of the variable “private credit” renders the coefficient on real GDP per capita insignificant. Importantly, the coefficient on “private credit” is significantly negative, taking the value of  $-0.442$ . The economic significance of this result is that a one-thousand dollar increase in real private credit per capita reduces the consumption Gini by nearly half of a percentage point, holding other things constant.

[Insert Table 4 here.]

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<sup>20</sup>In the regression without “private credit”, the coefficient on real GDP per capita captures not only the direct effect of economic development on consumption inequality, but also its indirect effect channeled by financial development.

We conclude that financial development is an important channel through which increases in real GDP per capita affects consumption inequality. This observation motivates us to focus on the role played by the financial market in shaping the relationship between economic development and consumption inequality in our theoretical work.

### 3 Theory

In the light of our empirical findings, a theory is needed for understanding why and how economic development renders consumption more equally distributed across agents. Given that financial development is an important channel of this effect, our theorization focuses on the development of asset markets along with increases in real per capita income that provides more and better opportunities for agents to insulate their consumption from income fluctuations. In our model, agents are heterogeneous in the amount of consumption they enjoy, due to their fixed characteristics as well as income risks that cannot be perfectly insured against. The extent to which the consumption distribution inherits the inequality in the income distribution depends on how well agents share risks, which in turn depends on how complete asset markets are. There is thus an intimate link between the ability for agents to smooth consumption across states of nature and the extent to which consumption differs across agents.

The main feature of our theoretical framework is that the degree of asset market completeness is *endogenized* and that this endogenous (in)completeness of asset markets bridges economic development on one hand and consumption inequality on the other. The endogeneity of the degree of market completeness is particularly important given that a large body of literature has emphasized the roles played by market incompleteness in explaining observed departures from full risk sharing as predicted by the complete-market paradigm, while models of incomplete markets, which typically assume an exogenously fixed number of assets that agents are allowed to trade, are often criticized as being *ad hoc*.

Our analysis involves two major steps. First, we construct a dynamic stochastic general equilibrium debt-constrained model with an arbitrary (exogenously given) degree of

asset market completeness. Second, we endogenize the degree of market completeness by introducing a tradeoff between the cost of operating additional asset markets and the benefit of better consumption smoothing and less consumption inequality. This tradeoff provides the link between economic development and consumption inequality. Here the level of real GDP per capita serves as an essential determinant of the equilibrium number of assets traded relative to the number of households' idiosyncratic income states.

### 3.1 A Debt-Constrained Economy

We start with describing a model economy with heterogeneous agents and endogenous no-default borrowing constraints. Asset markets in this economy are costless to operate and the number of assets that can be traded is exogenously given. This assumption will be relaxed in the next subsection, where we endogenize the number of assets traded.

#### 3.1.1 The Environment

A representative firm produces a single good to be used as both consumption and investment according to a Cobb-Douglas production function,  $AK_t^\alpha L_t^{1-\alpha}$ ,  $0 < \alpha < 1$ , where  $A$  represents a fixed total factor productivity,  $K_t$  and  $L_t$  are the quantities of capital and labor (in efficiency units) inputs, respectively, in period  $t$ . The firm maximizes its profit by solving

$$\max_{K_t, L_t} AK_t^\alpha L_t^{1-\alpha} - w_t L_t - (r_t + \delta)K_t. \quad (1)$$

where  $w_t$  denotes the real wage rate per efficiency unit of labor,  $r_t$  the real interest rate, and  $\delta$  the depreciation rate of capital. The aggregate resource constraint is

$$C_t + K_{t+1} - (1 - \delta)K_t = AK_t^\alpha L_t^{1-\alpha}. \quad (2)$$

There are a continuum of households of unit mass. These households belong to  $I$  different groups.<sup>21</sup> Let  $p_i$ ,  $i = 1, \dots, I$ , be the fraction of the population in group  $i$ , which has a deterministic, group-specific mean labor endowment,  $\alpha_i$ , for every period. Each household also faces an idiosyncratic labor endowment shock stream  $\{y_i\}_{t=0}^\infty$ . In period

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<sup>21</sup>In reality, these groups can be differentiated by fixed characteristics such as gender, race, and education attainment, etc.

$t$  a household from group  $i$  therefore has a stochastic labor endowment,  $\alpha_i y_t$ , and wage income  $w_t \alpha_i y_t$ . The set of all possible idiosyncratic labor endowments is given by the finite set  $\{\bar{y}_1, \bar{y}_2, \dots, \bar{y}_S\}$ , with  $\bar{y}_1 < \bar{y}_2 < \dots < \bar{y}_S$ . The probability of state  $s$  is given by  $\pi(\bar{y}_s)$ . Let  $y^t \equiv \{y_0, \dots, y_t\}$  denote the history of a household's idiosyncratic endowment shocks. Since we are interested in the stationary equilibrium for the purpose of a long-run analysis, we assume that the idiosyncratic shock that each household faces is independently and identically distributed over time.

Labor is inelastically supplied by the households. As there are infinitely many households and we assume that the law of large numbers applies,  $p_i \pi(\bar{y}_s)$  equals the fraction or the measure of households who belong to group  $i$  and have idiosyncratic labor endowment  $\bar{y}_s$ . Therefore the total supply of labor is given by

$$L_t = \sum_{i=1}^I \sum_{s=1}^S p_i \pi(\bar{y}_s) \alpha_i \bar{y}_s. \quad (3)$$

Each period households trade one-period claims contingent on subsets of their idiosyncratic income states.<sup>22</sup> Let  $c_t$  and  $a_t$  denote period- $t$  consumption and financial wealth at the beginning of that period, respectively. Let  $u(c)$  be an increasing, strictly concave, and twice continuously differentiable utility function, and  $\beta \in (0, 1)$  be a discount factor. The problem for a household in group  $i$  with initial asset holding  $a_0$  and labor endowment  $\alpha_i y_0$  is to maximize

$$u(c_0(i, a_0, y_0)) + \sum_{t=1}^{\infty} \sum_{y^t} \beta^t \pi(y^t) u(c_t(i, a_0, y^t)) \quad (4)$$

subject to a sequence of budget constraints, one for each date  $t$  and history  $y^t$ , in the following form,

$$c_t(i, a_0, y^t) + \sum_{m=1}^M q_t^m a_{t+1}^m(i, a_0, y^t) = w_t \alpha_i y_t + a_t, \quad (5)$$

where  $M$  denotes the number of assets available (the degree of asset spanning),  $a_{t+1}^m$  the quantity purchased of the  $m$ -th asset and  $q_t^m$  the price of this asset in terms of period- $t$

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<sup>22</sup>We recognize that in many economies, especially the developing ones, mutual insurance through networks of family, relatives, and friends are important for insuring against income risks. Our model does not consider this form of insurance. However, this is innocuous as long as such insurance does not enjoy increasing importance in the process of economic development. Quite to the contrary, one would expect its importance relative to insurance through asset trading to decline as economies develop.

consumption.<sup>23</sup> Assets in our model are generalizations of the standard Arrow securities. Each asset represents claims contingent on one or several idiosyncratic income states and each unit of asset will pay out one unit of consumption goods in the corresponding states and zero otherwise. Note that there are  $S$  states and  $M$  assets in this economy, with  $1 \leq M \leq S$ . When  $M = S$ , each possible idiosyncratic income state has its corresponding security. This is the case of complete asset markets. When  $M = 1$ , there is a single asset representing an uncontingent claim that entitles its owner one unit of consumption goods regardless of the realized state in the next period. This corresponds to the standard incomplete-market setup (e.g., Huggett (1993) and Aiyagari (1994)).

For the intermediate situations, i.e.,  $1 < M < S$ , there are more than one asset but the number of assets does not allow for full spanning. Given  $M$ , let the mapping from assets to states be described by the function  $C_M(\cdot)$  that takes an asset index  $m$  to a subset of  $\{1, 2, \dots, S\}$ . That is, for  $m = 1, 2, \dots, M$ ,  $C_M(m)$  gives the set of idiosyncratic income states where the  $m$ -th asset will pay out. Some structures are imposed on the function  $C_M(\cdot)$ : (1) For each  $M$  it entails a partition of the set of states, i.e.,  $\cup_{m=1}^M C_M(m) = \{1, 2, \dots, S\}$  and  $C_M(m) \cap C_M(m') = \emptyset$  for  $m \neq m'$ . (2) The assets are contiguous in the sense that  $C_M(m)$  includes consecutive states for each  $m = 1, 2, \dots, M$ , and that  $C_M(m)$  and  $C_M(m+1)$  cover neighboring states with the state indexes in  $C_M(m+1)$  larger than those in  $C_M(m)$ . (3) The partition is finer and finer with the increase of asset number  $M$ . An example of the assignment of income states to assets is shown in Table 5. In our analysis the function  $C_M(\cdot)$  is taken as given for each given  $M$ .

### 3.1.2 Borrowing Constraints

We incorporate endogenous no-default borrowing constraints a la Kehoe and Levine (1993), Zhang (1997), and Alvarez and Jermann (2000). Essentially, the presence of enforcement problem gives rise to upper bounds on borrowing which guarantee that households would stay in the risk-sharing arrangement rather than default and revert to autarky. Our model generalizes the literature in that we consider a broader range of possible as-

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<sup>23</sup>Note that we do not need to explicitly specify the accumulation of capital since the noncontingent nature of the return to capital allows it to be spanned by the  $M$  assets in households' portfolio. See also Krueger and Perri (2006) for a similar formulation.

set market structures. Imposing similar debt constraints, Kehoe and Levine (1993) and Alvarez and Jermann (2000) postulate a complete set of contingent claims while Zhang (1997) considers a one-asset economy. In this paper we allow the set of contingent claims to vary from a singleton to the complete set. This also contrasts with Krueger and Perri (2006), who consider both the case of complete markets (their “DCM” model) and the case of one-asset incomplete market (their “ZIM” model) but not situations in between these two extremes. As in Krueger and Perri, incorporating the borrowing constraints rules out full risk sharing even in the complete-market setup.

Let  $V_t(i, a_t, y_t)$  be the maximum value of (4) in period  $t$  for a household of group  $i$  with asset holding  $a_t$  and idiosyncratic income realization  $y_t$ . Our no-default borrowing constraints read as follows. For  $m = 1, 2, \dots, M$ ,

$$a_{t+1}^m(i, a_t, y_t) \geq A_{t+1}^i(y_{t+1}) \text{ for } y_{t+1} = \bar{y}_s, \text{ all } s \in C_M(m). \quad (6)$$

Here  $A_{t+1}^i(y_{t+1})$  is what Alvarez and Jermann call solvency constraint that is “not too tight” and satisfies

$$V_{t+1}(i, A_{t+1}^i, y_{t+1}) = U_{t+1}^{aut}(i, y_{t+1}), \quad (7)$$

where  $U_{t+1}^{aut}(i, y_{t+1})$  is the autarky value for an agent of group  $i$  with idiosyncratic income realization  $y_{t+1}$ :

$$U_{t+1}^{aut}(i, y_{t+1}) = u(w_{t+1}\alpha_i y_{t+1}) + \sum_{\tau=1}^{\infty} \sum_{y_{t+1+\tau}} \beta^\tau \pi(y_{t+1+\tau}) u(w_{t+1+\tau}\alpha_i y_{t+1+\tau}). \quad (8)$$

As Alvarez and Jermann point out, these borrowing constraints serve to prevent default while permitting the maximum extent of risk sharing. Note that implicit in the above expression for the autarky value is the assumption that defaulting agents will neither borrow nor save and will simply consume their endowment in the autarkic situation.<sup>24</sup>

Note that the particular form of our borrowing constraints (6) highlights the possibility that an asset covers more than one idiosyncratic income states. For each asset  $m$  the number of constraints is the cardinality of the set  $C_M(m)$ . The constraints say that the

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<sup>24</sup>Krueger and Perri (2006) consider both this simple setup and the more complicated one that allows for risk-free saving in autarkic situations. Their simulations show that these two types of specification do not make a large difference.

holding of the  $m$ -th asset is such that households will continue to participate in the risk-sharing arrangement for all the realizations of the idiosyncratic income risk that this asset covers.

### 3.1.3 Equilibrium

We analyze the stationary recursive equilibrium of the model economy in which the interest rate, wage rate, and asset prices  $\{r_t, w_t, \{q_t^m\}_{m=1}^M\}$ , the aggregate capital stock, labor input, and consumption  $\{K_t, L_t, C_t\}$ , as well as the distributions of assets and consumption are all constant over time. A stationary recursive equilibrium is defined as a set of allocations  $\{c, a\}$  for households, allocations  $\{K, L\}$  for firms, and prices  $\{r, w, \{q^m\}_{m=1}^M\}$  such that

1. (Household optimization) Given prices, the allocations  $\{c, a\}$ , together with the value functions, solve the Bellman equation for each household in group  $i$  with asset holding  $a$  and idiosyncratic income realization  $y$ :

$$V(i, a, y) = \max_{c, \{a^m\}_{m=1}^M} \{u(c(i, a, y)) + \beta \sum_{s=1}^S \pi(\bar{y}_s) V(i, a^{C_M^{-1}(s)}, \bar{y}_s)\}. \quad (9)$$

Note that  $C_M^{-1}(s)$  is the index for the asset that covers state  $s$ . The maximization on the right-hand side of (9) is subject to the budget constraint as in (5) and the no-default borrowing constraints as in (6).

2. (Firm optimization) The wage rate and interest rate are given by

$$w = (1 - \alpha)A\left(\frac{K}{L}\right)^\alpha, \quad (10)$$

and

$$r = \alpha A\left(\frac{K}{L}\right)^{\alpha-1} - \delta. \quad (11)$$

3. (Market clearing) The Labor market clears when

$$L = \sum_{i=1}^I \sum_{s=1}^S p_i \pi(\bar{y}_s) \alpha_i \bar{y}_s. \quad (12)$$

The goods market clears when

$$C + K - (1 - \delta)K = AK^\alpha L^{1-\alpha}, \quad (13)$$

holds, with

$$C = \sum_{i=1}^I \sum_{a,y} \pi(i, a, y) c(i, a, y),$$

where  $\pi(i, a, y)$  is the measure for type- $(i, a, y)$  households. Finally, The asset market clears if

$$K = \frac{1}{1+r} \sum_{i=1}^I \sum_{a,y} \sum_{m=1}^M \pi(i, a, y) \pi(m) a^m(i, a, y) \equiv \frac{B}{1+r}, \quad (14)$$

where  $B$  is the total amount of realized payment in the whole economy.<sup>25</sup>

### 3.2 Endogenous Market Completeness

One of the key features of our model is that we do not take the structure of asset markets as exogenously given. Unlike the complete-market setup of Kehoe and Levine (1993) and Alvarez and Jermann (2000), etc., we allow asset markets to be either complete or incomplete, depending on the choice of an optimizing social planner. Unlike the standard incomplete-market models of Aiyagari (1994), Huggett (1993), and Zhang (1997), etc., which have been criticized as being *ad hoc* in arbitrarily specifying the number of assets that can be traded (typically assumed to be one), we allow the degree of market incompleteness to be chosen in an optimal fashion.

In the previous subsection we have articulated a debt-constrained economy with a given number of asset markets, denoted by  $M$ . We have been abstracting away the cost of maintaining the operation of the asset markets, an element we now introduce. We assume, realistically, that operating one additional asset market entails a positive maintenance cost for the economy. This is captured by the increasing function  $Q(M)$  that we use to represent the total cost that the economy incurs every period for maintaining the operation of  $M$  contingent claim markets.

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<sup>25</sup>There are two ways to interpret the asset market clearing condition. First, note that no arbitrage implies, as in Krueger and Perri (2006), that  $q^m = \pi(m)/(1+r)$ , where  $\pi(m) = \sum_{s \in C_M(m)} \pi(\bar{y}_s)$ ,  $m = 1, 2, \dots, M$ , is the probability with which the claim associated with asset  $m$  will apply. Substituting  $q^m$  for  $\pi(m)/(1+r)$  in (14) yields  $K = \sum_{i=1}^I \sum_{a,y} \sum_{m=1}^M \pi(i, a, y) q^m a^m(i, a, y)$ , which says that the total purchase of asset (the right-hand side) equals the amount of net asset supply  $K$  in the economy. Second, the gross return to capital  $K(1+r)$  that accrues after production (and depreciation) is available for making payments to satisfy claims whose total amount is  $B$ . Note that the probability that  $a^m(i, a, y)$  will be delivered to type- $(i, a, y)$  households is given by  $\pi(m)$ .

We envision a social planner who chooses the optimal number of asset markets to maintain. In making such a choice the social planner respects the private equilibrium that is subject to enforcement frictions, as we described previously. We notice that an alternative approach would be to allow the number of assets traded to emerge as an equilibrium from a purely decentralized system. This approach is not taken here as we expect it to entail cumbersome modeling for the question we want to address without offering much more insights than the simpler approach adopted in the present paper.

The social planner is assumed to possess a utilitarian social welfare function which adds up the utility of all agents in the economy. The optimal degree of market completeness is determined by choosing the social-welfare maximizing number of assets. Intuitively, the effects of adding one more asset are twofold. Other things equal, it will lower aggregate consumption due to the additional cost of maintaining the operation of the extra market. On the other hand, it will at the individual level assist each household to better smooth consumption. At the social level, it reduces the inequality of consumption across households, which is beneficial from the society's perspective since the individual utility functions are strictly concave. The optimal number of asset markets is determined by balancing out these two effects.

The social planner collects lump sum tax  $T(M)$  every period to finance the maintenance cost  $Q(M)$ . For simplicity, we assume period-by-period budget balance so that  $T(M) = Q(M)$ . For given  $M$ , the budget constraint faced by a household of group  $i$ , equation (5), is modified to

$$T(M) + c_t(i, a_0, y^t) + \sum_{m=1}^M q^m(y_{t+1})a_{t+1}^m(i, a_0, y^t) = w_t\alpha_i y_t + a_t. \quad (15)$$

And the resource constraint becomes

$$C_t + K_{t+1} - (1 - \delta)K_t + Q(M) = AK_t^\alpha L_t^{1-\alpha}. \quad (16)$$

The clearing conditions for the labor and asset markets are the same as in the previous subsection.

The social planner's problem is to maximize by choice of  $M$

$$U(M) = \sum_{i=1}^I \sum_{a_0, y_0} \pi(i, a_0, y_0) V(i, a_0, y_0), \quad (17)$$

with

$$V(i, a_0, y_0) = \max_{\{c_s, a_{s+1}\}_{s=0}^{\infty}} \{u(c_0(i, a_0, y_0)) + \sum_{t=1}^{\infty} \sum_{y_t} \beta^t \pi(y_t) u(c_t(i, a_t, y_t))\}, \quad (18)$$

where the maximization on the right-hand side is subject to (15) and the no-default borrowing constraints as in (6). The optimal number of asset markets is therefore

$$M^* = \arg \max_M U(M). \quad (19)$$

We again consider stationary recursive equilibria of the model economy. Therefore for a given  $M$ ,  $U(M)$  corresponds to the social welfare under the stationary equilibrium with  $M$  given assets. Effectively, the social planner is choosing the “best” stationary equilibrium from the class indexed by  $M$ .

We capture economic development in a stylized fashion by varying the productivity parameter  $A$ , which corresponds to a particular level of real GDP per capita and serves as one of the two inputs to our model. The other is an exogenously given level of income inequality (measured by income Gini). For a given combination of productivity and income inequality, our model outputs an optimal asset number  $M^*$  and an associated level of consumption inequality (measured by consumption Gini). Our intuition is that economic development tends to improve the completeness of asset markets as maintenance of a large number of such markets becomes more and more affordable when the economy's output per capita increases along with the productivity level. On the other hand, holding the level of economic development fixed, an increase in income inequality, with which an increase in the idiosyncratic income risk is associated, should render risk-sharing arrangement more attractive and make it desirable to have a larger number of assets that can be traded. Thus, consumption inequality will increase by less than one-for-one with increases in income inequality, consistent with results in Krueger and Perri (2006). Quantitative assessment of our model in the next section confirms these intuitions.

## 4 Quantitative Assessment of the Model

To derive quantitative implications of our model we perform the following kind of numerical experiment. We let a pair of real GDP per capita and Gini coefficient for income be the input to the model. Through simulation the model outputs two numbers, namely, the optimal degree of market completeness and the resulting Gini coefficient for consumption. To perform this experiment, we need to assign values to the model's parameters.

### 4.1 Calibration

A period in the model is specified as one year. The utility function takes the log form, i.e.,  $u(c) = \log(c)$ . The discount factor,  $\beta$ , is set to be 0.96, corresponding to an annual real interest rate of  $r = 4\%$ . We set the capital share to be 0.3. To match the capital-output ratio of 2.6 (the number used in Krueger and Perri (2006)), the depreciation rate of capital  $\delta$  is set to be 0.075, as the condition  $(r + \delta)K = \alpha Y$  that describes the capital share of total income implies

$$\delta = \frac{\alpha}{K/Y} - r. \quad (20)$$

Given the capital-output ratio, a specific value of real GDP per capita corresponds to a value for the technology level  $A$  via the following condition:

$$A = \left(\frac{K}{Y}\right)^{-\alpha} \left(\frac{Y}{L}\right)^{1-\alpha}. \quad (21)$$

We follow the strategy of Krueger and Perri (2006) to decompose the variability of household income into a group-specific component and an idiosyncratic component. They identify the former with between-group income inequality and the latter with within-group income inequality. Write the logarithm of income (normalized by the economy-wide wage rate) as

$$\ln(\alpha_i) + \ln(y_t)$$

where  $\alpha_i$  is a group-specific, time-invariant deterministic part (between-group) and  $y_t$  an idiosyncratic stochastic component (within-group) which is assumed to be i.i.d. across households and over time. In this specification, there are two groups with equal mass  $p_i =$

0.5,  $i = 1, 2$ . Let  $\alpha_1 = e^{-\sigma_1}$  and  $\alpha_2 = e^{\sigma_1}$ . Then the variance of  $\ln(\alpha_i)$  is simply  $\sigma_1^2$ . As for the idiosyncratic income shocks, we assume that there are 7 equal-probability states and that  $\bar{y}_j = e^{\frac{j}{2}\sigma_2}$ ,  $j = 1, 2, \dots, 7$ . Hence the variance of  $\ln(y_i)$  is  $\sigma_2^2$ . Once we have the variance of log total income ( $\sigma^2 = \sigma_1^2 + \sigma_2^2$ ) and the ratio between  $\sigma_1^2$  and  $\sigma_2^2$ , we can compute  $\sigma_1^2$  and  $\sigma_2^2$  separately. We take Krueger and Perri's result for the decomposition of income variability of the United States for the year 1980 as our benchmark, according to which  $\sigma_1^2/\sigma_2^2 = 0.246$ . Thus given  $\sigma^2$ , one can easily compute the Gini coefficient for household income from the distribution associated with the implied  $\sigma_1^2$  and  $\sigma_2^2$ . Alternatively, one can find the value of  $\sigma^2$ , and therefore those of  $\sigma_1^2$  and  $\sigma_2^2$ , that correspond to a given value of the income Gini under our parameterization of the income distribution.

For simplicity we assume that  $Q(M) = qM$  where  $q$  is a positive constant and represents the maintenance cost per asset market. To pin down  $q$  we match the total cost of asset market operation as a percentage of aggregate output in the model with the value added of the finance and insurance sector as a percentage of GDP in the U.S. NIPA account. For the benchmark year of 1980, this percentage equals 4.9%. Keeping in mind that the number of asset markets,  $M^*$ , implied by our model is a function of the cost parameter  $q$ , one can solve for  $q$  using the following condition

$$Q = q \cdot M^*(q), \tag{22}$$

where  $Q$  results from the multiplication of our model's GDP with the relative size of the financial sector, 4.9%. Finally, the assignment rule of income states to assets is given by the one illustrated in Table 5.

[Insert Table 5 here.]

## 4.2 Simulation Results

We use a combination of bisection method and discrete state-space value function iteration to compute the equilibrium of our model.<sup>26</sup> This algorithm allows us to simulate the

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<sup>26</sup>The bisection method is used to find the equilibrium interest rate  $r$  that clears the asset market, which requires  $K(r) = B(r)/(1+r)$ . The value function iteration is used to solve households' problem as in (18).

optimal degree of asset span, the distribution of asset holdings and consumption, as well as social welfare. We cope with the case of exogenous market completeness first, and then turn to the case of endogenous market completeness.

#### 4.2.1 Exogenous Market Completeness

Table 6 shows the simulation results when we fix the income Gini coefficient at 0.30 while varying real GDP per capita and the number of assets.<sup>27</sup> The first thing to notice is that for any given number of assets, the consumption Gini is basically invariant with respect to changes in real GDP per capita. Thus economic development does not reduce inequality in the consumption distribution, if the degree of market completeness is exogenously fixed. This is because our preference specification implies that households' marginal propensity to consume is independent of their wealth levels, so that across-the-board increases in income and wealth do not change their consumption shares.

[Insert Table 6 here.]

The second thing to notice is that for any given level of economic development, increases in the number of asset markets generally reduce inequality in consumption. In addition, the reduction in consumption Gini is far more pronounced at smaller numbers of assets available for trading. The results indicate that improved completeness of asset markets does help to lower consumption inequality.

The result that consumption inequality is invariant with respect to economic development runs at odds with our empirical evidence that consumption inequality declines with increases in real GDP per capita. It therefore underscores the importance to allow asset market completeness to change along with changes in the level of economic development. Before proceeding to present the results with endogenous market completeness it is worthwhile to point out the advantage of our preference specification. Alternative specifications, in particular those exhibiting nonhomotheticity, might render the marginal propensity to consume a decreasing function of income and wealth. Although it might be true that individual propensity to save increases with individual income within a country

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<sup>27</sup>We obtain similar results for other levels of income inequality.

at a point in time, it is not necessarily the case that saving rate increases with income per capita, either across countries (think about the U.S.) or over time. That is, individual propensities to consume do not necessarily fall when a nation gets richer. Hence it would be misleading to conclude that increases in per capita income *per se* would generate declining consumption inequality. This is precisely why we choose to work with our preference specification which implies the invariance of consumption inequality with respect to increases in per capita income. The focus of our theoretical work and simulation exercise is on the role played by financial development in shaping the negative relation between consumption inequality and economic development. Such a channeling role of financial development is found to be of immense importance in our empirical investigation. Our preference specification allows us to isolate this role since changes in asset market completeness become the only way to generate the observed pattern.

#### 4.2.2 Endogenous Market Completeness

We specify a sequence of income Gini and a sequence of real GDP per capita and then form pairs of these two variables as inputs to our simulation. For each pair of income Gini and real GDP per capita, we compute the optimal number of assets, shown in Table 7, and the associated consumption Gini, shown in Table 8.

[Insert Tables 7-8 here.]

First, our simulation shows that holding income inequality fixed, economic development tends to generate increases in the number of assets traded. Consequently, consumption inequality is lowered. However, for low levels of income Gini (e.g., 0.20), increases in real GDP per capita never bring forth departure of asset market structure from the one-asset case within the range of real GDP per capita we experiment. For higher levels of income inequality, departure from the one-asset case does occur, and it sets in earlier and earlier when the income Gini gets larger and larger. This observation leads us to look at the implications of income inequality on market completeness and consumption inequality.

By varying the income Gini while holding real GDP per capita fixed, we find that, conforming to common sense, higher income Gini coefficients lead to higher levels of consumption inequality. When real GDP per capita is not too small, increases in income inequality have the effect of stimulating improvement in the completeness of asset markets (see Table 7), which prevents consumption Gini from rising proportionately with income Gini. As noted by Krueger and Perri, the increase of income volatility associated with an increase in income inequality might cause “a change in the development of financial markets, allowing individual households to better insure against these (now bigger) idiosyncratic income fluctuations.” Although this kind of change is not modeled in Krueger and Perri, it is delivered endogenously in our model. When income inequality is mild, the advantage of better insurance is too small to permit departure from the one-asset structure even at reasonably high levels of real GDP per capita. Finally, note that with increases in either real GDP per capita or income Gini, the chosen number of assets does not necessarily go up.

To gauge how well our model explains the regularities found in the data we perform regressions of consumption Gini on real GDP per capita and income Gini using simulated data. We then compare the regression results to those obtained from the actual data. In particular, we take the regression in Section 2 of consumption Gini on real GDP per capita and net income Gini as the empirical counterpart. Results of the regressions on the actual versus simulated data are reported in Table 9. The two sets of results are broadly similar to each other. The coefficient on real GDP per capita is  $-0.436$  for the simulated data and  $-0.466$  for the actual data. The coefficients on income Gini are  $0.590$  and  $0.655$  for simulated and actual data, respectively. These results indicate that our model provides a reasonable explanation for the observed relationship between consumption inequality and economic development (as well as income inequality).

[Insert Table 9 here.]

## 5 Conclusions

Whether and how economic development affects consumption inequality is an issue of immense importance and has yet largely remained unexplored. We have made two major contributions in this paper. First, we investigate empirically the relationship between economic development and consumption inequality and finds that they are negatively related. Moreover, financial development serves as an important channel through which improvement in nations' overall living standard generates reduction in the inequality of their consumption distributions. Second, we build a dynamic stochastic general equilibrium model with heterogeneous agents participating in risk-sharing arrangements through trading in asset markets. The degree of market completeness is endogenized in our model. The simulation results show that increases in real GDP per capita tend to make asset markets more complete, thereby generating declines in consumption inequality.

As our work constitutes a first-step attempt in the research agenda on economic development and consumption inequality that we propose, there are undoubtedly issues that remain to be resolved. On the empirical side, data on consumption inequality are still quite limited, though thanks to the data assembled by WIID2a we are able to come up with some important findings. On the theoretical side, we recognize that in rationalizing the observed pattern one has to choose a specific model to work with and thus leaves out some potentially important considerations. For example, it is possible that economic development promotes creation of asset markets by lowering the costs of doing so. That is, the technology of asset creation might get more cost-efficient as economies advance, albeit we assume that it is fixed in our model.<sup>28</sup> Incorporating this feature into our model would strengthen our result that economic development reduces consumption inequality through improvement in asset market completeness. It is also possible that the suppressing effect of economic development on consumption inequality works through increased participation of agents in asset markets, a possibility left out by our model. These are surely interesting issues to deal with in future research.

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<sup>28</sup>In fact, there is a technological view of financial innovation articulated in, for example, White (2000), according to which advances in information technology support sophisticated financial innovations in recent decades.

## Appendix: Computation Algorithm

In this appendix we describe our algorithm for computing the equilibrium of the model economy for a given number,  $M$ , of asset markets. The choice of the optimal  $M$  would then be straightforward by comparing the social welfare under different values of  $M$ . Our algorithm is a combination of bisection and value function iteration. The bisection method is used to find the equilibrium interest rate  $r$  that clears the asset market, which requires  $K(r) = B(r)/(1+r)$ . The left-hand side of this condition, representing asset supply, is decreasing in  $r$  while the right-hand side, representing asset demand, is increasing in  $r$  (this is confirmed by our numerical exercise). We first set  $r_1 = 0.0001$  and  $r_2 = 1/\beta$ , the interest rate that would prevail in a frictionless complete-market economy. We then take  $r = (r_1 + r_2)/2$  to be the interest rate and then compute the associated  $K(r_3)$  and  $B(r_3)$ . If  $K(r_3) < B(r_3)/(1+r_3)$ , then we replace  $r_2$  with the existing value of  $r$  and update  $r$  according to  $r = (r_1 + r_2)/2$ , so that  $r$  is lowered. If the opposite is true then we raise the interest rate by replacing  $r_1$  with the existing value of  $r$  and update  $r$  accordingly. The iteration continues until the asset market clearing condition is satisfied.

For a given value of the interest rate  $r$ , we solve the consumer's problem by value function iteration, which we describe as follows. We specify a  $k$ -point grid for each asset, with the lower end being the borrowing limit. Given the interest rate  $r$  (and the implied  $\{q^m\}_{m=1}^M$ ) and a value function  $V^n(i, a, y)$ , we can compute a new value function as

$$V^{n+1}(i, a, y) = \max_{c, \{a^m\}} \{u(c) + \beta \sum_{s=1}^S \pi(\bar{y}_s) V^n(i, a^{C_M^{-1}(s)}, \bar{y}_s)\}, \quad (23)$$

where  $c = w\alpha_i y + a - \sum_{m=1}^M q^m a^m$ . The maximization on the right-hand side of (23) is achieved by choosing an optimal policy  $\{a^m(i, a, y)\}_{m=1}^M$ . We start from an initial guess  $V^0 = 0$  and iterate until  $\{V^n\}$  converges to some value function  $V$ . To improve the efficiency of our computation algorithm, we exploit the fact that the partial derivative of the value function with respect to asset holding,  $V_a^{n+1}$ , which simply equals the marginal utility of consumption, decreases with both  $a$  and  $y$ . We also observe that combining equation (??), the envelope condition, and the first-order conditions (one for each  $m$ )

associated with (23) yields

$$V_a^{n+1}(i, a, y) = \beta(1+r) \sum_{s \in C_M(m)} \frac{\pi(\bar{y}_s)}{\pi(m)} V_{a^m}^n(i, a^m, \bar{y}_s), \quad m = 1, \dots, M. \quad (24)$$

Three restrictions are therefore imposed to accelerate the value function iteration: (1) Given  $a$  and  $y$ , the chosen sequence  $\{a^m\}_{m=1}^M$  satisfies  $a^1 \geq a^2 \geq \dots a^M$ . This is because  $V_{a^m}^n$  decreases with both  $a^m$  and  $\bar{y}_s$ , and assets with larger indices  $m$  cover higher idiosyncratic income states. To guarantee that the right-hand side of (24) equals the same  $V_a^{n+1}(i, a, y)$  for every  $m$ ,  $a^m$  must be smaller for larger  $m$ . Intuitively, this means that the amount of asset that can be used to afford consumption in bad-luck states is larger than in good-luck states. This is exactly the feature of the insurance mechanism embedded in the model. (2) If  $a > a'$ , then  $a^m(i, a, y) \geq a^m(i, a', y)$ ,  $m = 1, \dots, M$ . This is because  $V^{n+1}$  and  $V^n$  on the two sides of (24) are both concave in their respective second arguments. As  $a$  increases, the left-hand side of (24) decreases. Thus  $a^m$  has to increase to maintain the equality of the two sides. (3) If  $y > y'$ , then  $a^m(i, a, y) \geq a^m(i, a, y')$ ,  $m = 1, \dots, M$ . This is because  $V_a^{n+1}$  decreases with  $y$  and  $V_{a^m}^n$  decreases with  $a^m$ .

We compute the probability transition matrix of asset holdings and find its associated stationary distribution. We then compute the aggregate asset demand  $B(r)$ . The aggregate asset supply  $K(r)$  is computed from the condition that the marginal product of capital equals the user cost  $r + \delta$ .

## References

- [1] Abraham, Arpad and Eva Carceles-Poveda (2006), ‘‘Endogenous Incomplete Markets, Enforcement Constraints, and Intermediation,’’ *Theoretical Economics*, 1(4), 439–459.
- [2] Acemoglu, Daron, Simon Johnson, James Robinson, and Yunyong Thaicharoen (2003), ‘‘Institutional Causes, Macroeconomic Symptoms: Volatility, Crises and Growth,’’ *Journal of Monetary Economics*, 50, 49–123.
- [3] Aiyagari, S. Rao, (1994), ‘Uninsured Idiosyncratic Risk and Aggregate Saving’, *Quarterly Journal of Economics*, 109, 659–684
- [4] Allen, Franklin, and Douglas Gale (1988), ‘‘Optimal Security Design,’’ *Review of Financial Studies*, 1(3), 229–263.

- [5] Allen, Franklin, and Douglas Gale (1991), “Arbitrage, Short Sales, and Financial Innovation,” *Econometrica*, 59(4), 1041–1068.
- [6] Allen, Franklin, and Douglas Gale (1994), *Financial Innovation and Risk Sharing*, The MIT Press.
- [7] Alvarez, Fernando, and Urban J. Jermann (2000), “Efficiency, Equilibrium, and Asset Pricing with Risk of Default,” *Econometrica*, 68(4), 775–797.
- [8] Atkinson, Anthony B. and Andrea Brandolini (2001), “Promise and Pitfalls in the Use of ‘Secondary’ Data-Sets: Income Inequality in OECD Countries as a Case Study”, *Journal of Economic Literature*, 39(3), 771–799.
- [9] Attanasio, Orazio, Erich Battistin, and Hidehiko Ichimura (2004), “What Really Happened to Consumption Inequality in the US?”, NBER Working Paper No. 10338.
- [10] Attanasio, Orazio, and Steven J. Davis (1996), “Relative Wage Movements and the Distribution of Consumption”, *Journal of Political Economy*, 104(6), 1227–1262.
- [11] Barrett, Garry F., Thomas F. Crossley, and Christopher Worswick (2000), “Consumption and Income Inequality in Australia”, *The Economic Record*, 76(233), 116–138.
- [12] Beck, Thorsten, Asli Demirgüç-Kunt and Ross Levine (2000), “A New Database on the Structure and Development of the Financial Sector,” *World Bank Economic Review*, 14, 597–605.
- [13] Bhattacharya, Utpal, Philip J. Reny, and Matthew Spiegel (1995), “Destructive Interference in an Imperfectly Competitive Multi-Security Market,” *Journal of Economic Theory*, 65, 136–170.
- [14] Bisin, Alberto (1998), “General Equilibrium with Endogenously Incomplete Financial Markets,” *Journal of Economic Theory*, 82, 19–45.
- [15] Blundell, Richard and Ian Preston (1998), “Consumption Inequality and Income Uncertainty,” *Quarterly Journal of Economics*, 113, 603–640.
- [16] Canberra Group (2001), *Final Report and Recommendations*, Ottawa: Expert Group on Household Income Statistics, The Canberra Group.
- [17] Cass, David and Alessandro Citanna (1998), “Pareto Improving Financial Innovation in Incomplete Markets,” *Economic Theory*, 11, 467–494.
- [18] Clarke, George, Lixin Colin Xu, and Heng-fu Zou (2006), “Finance and Income Inequality: What Do the Data Tell Us?”, *Southern Economic Journal*, 72(3), 578–596.
- [19] Crossley, Thomas and Krishna Pendakur (2002), “Consumption Inequality,” Department of Economics Working Papers 2002-09, McMaster University.

- [20] Cutler, David and Lawrence Katz (1992), “Rising Inequality? Changes in the Distribution of Income and Consumption in the 1980s”, *American Economic Review*, 82, 546–551.
- [21] Cutler, David M., Lawrence F. Katz, David Card, and Robert E. Hall (1991), “Macroeconomic Performance and the Disadvantaged,” *Brookings Papers on Economic Activity*, 1991(2), 1–74.
- [22] Deaton, Angus (1998), “Getting Prices Right: What Should be Done,” *Journal of Economic Perspectives*, 12(1), 37–46.
- [23] Deaton, Angus and Christina Paxson (1994), “Intertemporal Choice and Inequality,” *Journal of Political Economy*, 102, 437–467.
- [24] Deaton, Angus and Salman Zaidi (2002), “Guidelines for Constructing Consumption Aggregates for Welfare Analysis.” LSMS Working Paper No. 135, Washington, D.C.: The World Bank.
- [25] Deininger, Klaus and Lyn Squire (1996), “A New Data Set Measuring Income Inequality”, *World Bank Economic Review*, 10(3), 565–591.
- [26] Deininger, Klaus and Lyn Squire (2004), Unpublished data provided by World Bank based on unit record data.
- [27] Demange, Gabrielle and Guy Laroque (1995a), “Optimality of Incomplete Markets,” *Journal of Economic Theory*, 65, 218–232.
- [28] Demange, Gabrielle and Guy Laroque (1995b), “Private Information and the Design of Securities,” *Journal of Economic Theory*, 65, 233–257.
- [29] Duffie, Darrell and Rohit Rahi (1995), “Financial Market Innovation and Security Design: An Introduction,” *Journal of Economic Theory*, 65, 1–42.
- [30] Duffy, John and Chris Papageorgiou (2000), “A Cross-Country Empirical Investigation of the Aggregate Production Function Specification”, *Journal of Economic Growth*, 5(1), 87–120.
- [31] Elul, Ronel (1999), “Welfare-Improving Financial Innovation with a Single Good,” *Economic Theory*, 13(1), 25–40.
- [32] Goni, Edwin, Humberto Lopez, and Luis Servén (2006), “Getting Real about Inequality: Evidence from Brazil, Colombia, Mexico, and Peru”, World Bank Policy Research Working Paper 3815.
- [33] Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante (2007), “Consumption and Labor Supply with Partial Insurance: An Analytical Framework,” Mimeo.

- [34] Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante (2008), “The Macroeconomic Implications of Rising Wage Inequality in the United States,” NBER Working Paper No. 14052.
- [35] Heller, Walter P. (1999), “Equilibrium Market Formation Causes Missing Markets,” in Chichilnisky, Graciela (eds.), *Markets, Information, and Uncertainty: Essays in Economic Theory in Honor of Kenneth J. Arrow*, Cambridge University Press.
- [36] Heston, Alan, Robert Summers, and Bettina Aten (2006), “Penn World Table Version 6.2,” Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.
- [37] Huggett, Mark (1993), ‘The Risk-Free Rate in Heterogeneous-Agent Incomplete Insurance Economies’, *Journal of Economic Dynamics and Control*, 17(5-6), 953–69.
- [38] Kehoe, Patrick J. and Fabrizio Perri (2002), “International Business Cycles with Endogenous Incomplete Markets,” *Econometrica*, 70(3), 907–928.
- [39] Kehoe, Timothy J. and David K. Levine (1993), “Debt-Constrained Asset Markets,” *Review of Economic Studies*, **60**, 865–888.
- [40] Krueger, Dirk and Fabrizio Perri (2004), “On the Welfare Consequences of the Increase in Inequality in the United States”, *18th NBER Macroeconomics Annual*, 2003, 83–121.
- [41] Krueger, Dirk and Fabrizio Perri (2006), “Does Income Inequality Lead to Consumption Inequality? Evidence and Theory,” *Review of Economic Studies*, 73(1) , 163–93
- [42] Kuznets, Simon (1955), “Economic Growth and Income Inequality,” *American Economic Review*, 45(1), 1–28.
- [43] Li, Hongyi, Lyn Squire, and Heng-fu Zou (1998), “Explaining International and Intertemporal Variations in Income Inequality”, *Economic Journal*, 108, 26–43.
- [44] Makowski, Louis (1983), “Competitive Stock Markets,” *Review of Economic Studies*, 50, 305–330.
- [45] Ōhashi, Kazuhiko (1995), “Endogenous Determination of the Degree of Market-Incompleteness in Futures Innovation,” *Journal of Economic Theory*, 65, 198–217.
- [46] Ōhashi, Kazuhiko (1997), “Optimal Futures Innovation in a Dynamic Economy: The Discrete-Time Case,” *Journal of Economic Theory*, 74, 448–465.
- [47] Ohtake, Fumio and Makoto Saito (1998), “Population Aging and Consumption Inequality in Japan”, *Review of Income and Wealth*, 44(3), 361–81.
- [48] Pendakur, Krishna (1998), “Family Income and Consumption Inequality in Canada over 1978-1992”, *Review of Income and Wealth*, 44(2), 259–283.

- [49] Pesendorfer, Wolfgang (1995), “Financial Innovation in a General Equilibrium Model,” *Journal of Economic Theory*, 65, 79–116.
- [50] Pyatt, Graham (2003), “Development and the Distribution of Living Standards: A Critique of the Evolving Data Base”, *Review of Income and Wealth*, 49(3), 333–358.
- [51] Rahi, Rohit (1995), “Optimal Incomplete Markets with Asymmetric Information,” *Journal of Economic Theory*, 65, 171–197.
- [52] Ramey, Garey and Valerie A. Ramey (1995), “Cross-Country Evidence on the Link between Volatility and Growth,” *American Economic Review*, 85(5), 1138–1151.
- [53] Ravallion, Martin and Shaohua Chen (1997), “What Can New Survey Data Tell Us about Recent Changes in Distribution and Poverty?”, *World Bank Economic Review*, 11(2), 357–382.
- [54] Robinson, Joan (1952), “The Generalization of the General Theory,” in *The Rate of Interest and Other Essays*, London: MacMillan.
- [55] Rodriguez, Francisco and Daniel Ortega (2006), “Are Capital Shares Higher in Poor Countries? Evidence from Industrial Survey,” Wesleyan University, Department of Economics’ Working Paper, 2006–023.
- [56] Slesnick, Daniel T. (1993), “Gaining Ground: Poverty in the Postwar United States,” *Journal of Political Economy*, 101(1), 1–38.
- [57] Slesnick, Daniel T. (2001), *Consumption and Social Welfare: Living Standards and Their Distribution in the United States*, Cambridge: Cambridge University Press.
- [58] Székely, Miguel and Marianne Hilgert (1999), “What’s Behind the Inequality We Measure: An Investigation Using Latin American Data,” Working Paper No. 409. Washington, D.C.: The Inter-American Development Bank.
- [59] Tufano, Peter (2003), “Financial Innovation,” in Constantinides, George M., Milton Harris, and Rene M. Stulz (eds.), *Handbook of the Economics of Finance*, Volume 1A, North Holland.
- [60] United Nations University/World Institute for Development Economics Research (2005), “*World Income Inequality Database*,” version 2.0a.
- [61] United Nations University/World Institute for Development Economics Research (2005), “World Income Inequality Database V2.0a: User Guide and Data Sources.”
- [62] Zaidi, M. Asghar and Klaas de Vos (2001), “Trends in Consumption-Based Poverty and Inequality in the European Union during the 1980s”, *Journal of Population Economics*, 14, 367–390.
- [63] Zhang, Harold H. (1997), “Endogenous Borrowing Constrains with Incomplete Markets,” *Journal of Finance*, 52, 2187–2209.

Table 1. Correlations between Measures of Economic Development, Income and Consumption Inequality, and Financial Development

	GDP	CGini	GIGini	NIGini	CStd	GIStd	NIStd	Private Credit
GDP	1.00							
CGini	-0.54	1.00						
GIGini	-0.39	0.80	1.00					
NIGini	-0.49	0.82	0.77	1.00				
CStd	-0.26	0.95	0.81	0.85	1.00			
GIStd	-0.16	0.73	0.91	0.33	0.73	1.00		
NIStd	-0.59	0.82	0.77	0.96	0.90	0.29	1.00	
Private credit	0.90	-0.52	-0.46	-0.35	-0.20	-0.19	-0.37	1.00

Note: *GDP*: real GDP per capita in constant year-2000 U.S. dollars; *CGini*, *GIGini*, *NIGini*: Gini coefficient for consumption, gross income, and net income, respectively; *CStd*, *GIStd*, *NIStd*: Standard deviation of log for consumption, gross income, and net income, respectively; *Private credit*: Real private per capita, i.e., the per capita value of credit extended by financial intermediaries to the private sector, in constant year-2000 U.S. dollars.

Table 2. Regression Results for Consumption Gini  
*Dependent variable: Consumption Gini (percentage)*

Income measure	None	Gross	Net
Real GDP per capita	-1.047	-0.487	-0.466
P-value	0.000	0.000	0.000
Income Gini (percentage)		0.561	0.655
P-value		0.000	0.000
Consumption dummy	0.877	1.654	2.667
P-value	0.216	0.000	0.000
Constant	45.731	14.806	12.500
P-value	0.000	0.000	0.000
Number of observations	210	117	69

Note: The Gini coefficients for consumption and income are in percentage terms. The unit of real GDP per capita is \$1,000 (constant 2000 U.S. dollars). Consumption dummy equals 0 (resp. 1) if “consumption (resp. expenditure)” data in WIID2a is used.

Table 3. Regression Results for Standard Deviations of Log Consumption  
*Dependent variable: S.t.d. of log consumption (percentage)*

Income measure	None	Gross	Net
Real GDP per capita	-0.604	-0.281	-0.210
P-value	0.000	0.189	0.072
S.t.d. of log income (percentage)		0.450	0.548
P-value		0.000	0.000
Consumption dummy	-1.119	0.329	1.616
P-value	0.008	0.741	0.113
Constant	34.425	12.812	11.491
P-value	0.000	0.000	0.000
Number of observations	139	56	36

Note: The standard deviations of log consumption and income are in percentage terms. The unit of real GDP per capita is \$1,000 (constant 2000 U.S. dollars). Consumption dummy equals 0 (resp. 1) if “consumption (resp. expenditure)” data in WIID2a is used.

Table 4. Regression Results with Private Credit  
*Dependent variable: Consumption Gini (percentage)*

	Without private credit	With private credit
Real GDP per capita	-0.466	0.127
P-value	0.000	0.354
Net income Gini (percentage)	0.655	0.803
P-value	0.000	0.000
Private credit		-0.442
P-value		0.000
Consumption dummy	2.667	3.050
P-value	0.000	0.000
Constant	12.500	2.651
P-value	0.000	0.193
Number of observations	69	69

Note: The Gini coefficients for consumption and income are in percentage terms. The unit of real GDP per capita and real private per capita (“private credit”) is \$1,000 (constant 2000 U.S. dollars). Consumption dummy equals 0 (resp. 1) if “consumption (resp. expenditure)” data in WIID2a is used. The column labeled “Without private credit” corresponds to the last column in Table 2.

Table 5. Assignment of States to Assets

Number of assets	State						
	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	1	2	2	2
3	1	1	2	2	3	3	3
4	1	1	2	2	3	3	4
5	1	2	3	3	4	4	5
6	1	2	3	4	5	5	6
7	1	2	3	4	5	6	7

Note: The total number of idiosyncratic income states is specified to be 7. The first column lists the number of assets (generalizations of Arrow securities) available for trading, ranging from 1 to 7. The row with asset number  $m$  lists the assignment of the 7 states to the  $m$  assets. For example, when the asset number is 2, states 1–4 are assigned to the first asset and states 5–7 to the second asset.

Table 6. Consumption Gini (%) with Exogenous Market Completeness

Real GDP per capita	Asset number						
	1	2	3	4	5	6	7
5,000	24.8	20.8	19.2	19.0	18.2	18.2	17.0
10,000	24.8	20.8	19.2	19.0	18.2	18.3	17.0
15,000	24.8	20.8	19.2	19.0	18.2	18.3	17.0
20,000	25.1	21.3	19.3	19.4	18.3	18.2	16.7
25,000	25.1	21.3	19.3	19.4	18.5	18.2	16.9
30,000	25.1	21.3	19.9	20.3	19.1	19.1	17.8
35,000	25.0	21.2	19.7	19.9	18.9	18.7	17.5

Note: The income Gini coefficient is fixed at 30%. Real GDP per capita is in constant year-2000 U.S. dollars. Each entry gives the equilibrium consumption Gini (in percentage) associated with the corresponding level of real GDP per capita and number of assets available for trading.

Table 7. Optimal Market Completeness

Income Gini (%)	Real GDP per capita						
	5,000	10,000	15,000	20,000	25,000	30,000	35,000
20	1	1	1	1	1	1	1
30	1	1	1	1	2	2	3
40	1	1	1	2	3	3	2
50	1	1	2	5	4	4	5

Note: Real GDP per capita is in constant year-2000 U.S. dollars. Income Gini is in percentage. Each entry gives the optimal number of assets associated with the corresponding level of real GDP per capita and income Gini.

Table 8. Consumption Gini (%) with Endogenous Market Completeness

Income Gini (%)	Real GDP per capita						
	5,000	10,000	15,000	20,000	25,000	30,000	35,000
20	18.3	17.8	17.6	17.5	17.4	17.4	17.4
30	27.2	26.5	26.2	26.2	20.5	19.9	18.5
40	37.0	36.0	35.6	28.2	23.9	22.5	24.2
50	48.7	46.6	38.6	31.5	29.1	26.5	25.9

Note: Real GDP per capita is in constant year-2000 U.S. dollars. Consumption and income Gini's are in percentage. Each entry gives the equilibrium consumption Gini associated with the corresponding level of real GDP per capita and income Gini. The corresponding optimal number of assets is listed in Table 7.

Table 9. Comparison between Regressions on Simulated Data and on Actual Data

<i>Dependent variable: Consumption Gini (percentage)</i>		
Data	Actual	Simulated
Real GDP per capita	-0.466	-0.436
Income Gini (percentage)	0.655	0.590
Constant	12.500	14.59

Note: The Gini coefficients for consumption and income are in percentage terms. The unit of real GDP per capita is \$1,000 (constant 2000 U.S. dollars). The column labeled "Actual" corresponds to the last column in Table 2.

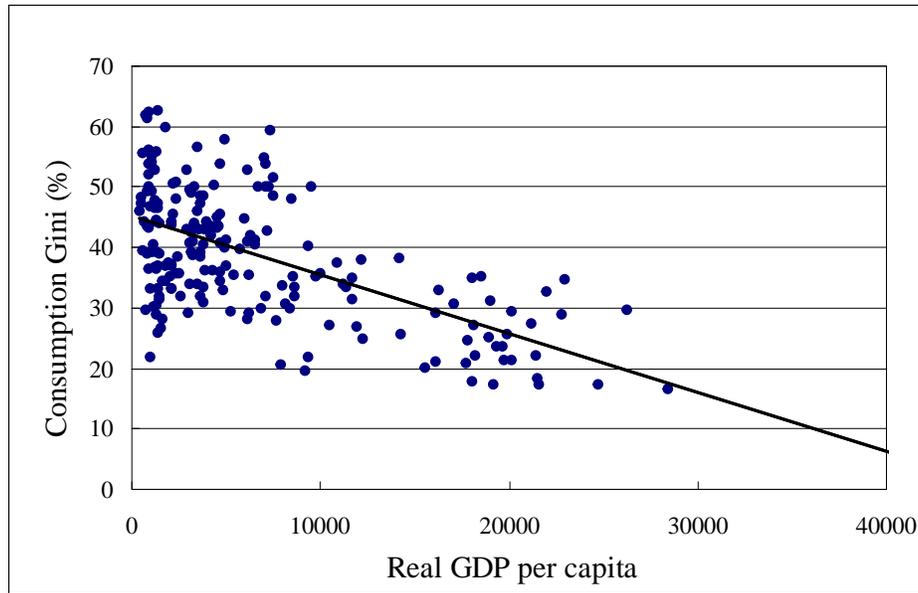


Figure 1: Plot of consumption Gini (in percentage) against real GDP per capita (in constant year-2000 U.S. dollars).

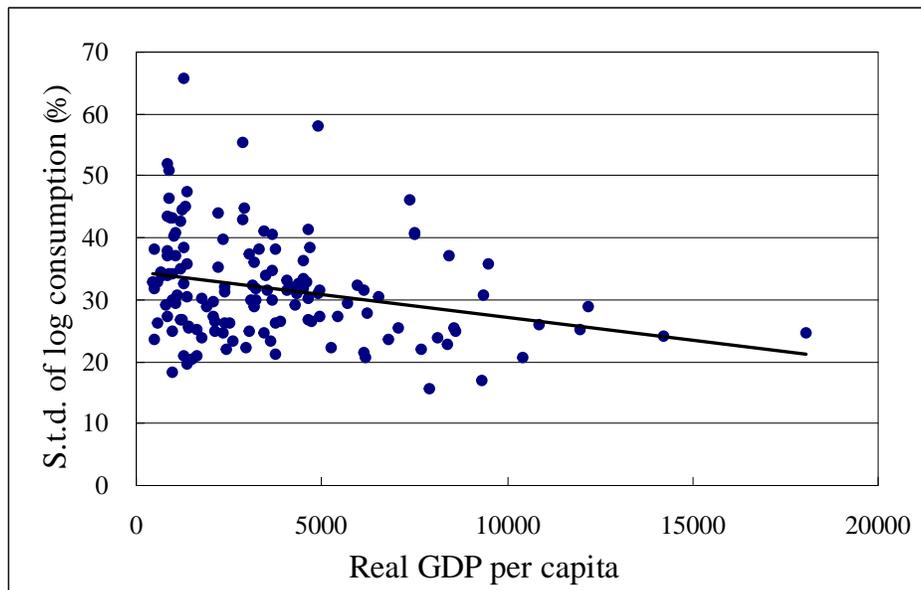


Figure 2: Plot of standard deviations of log consumption (in percentage) against real GDP per capita (in constant year-2000 U.S. dollars).