Measuring Cross-Country Material Wellbeing and Inequality Using Consumer Durables

Arthur Grimes
(Motu Economic & Public Policy Research, New Zealand)

Sean Hyland
(Motu Economic & Public Policy Research, New Zealand)

Paper prepared for the 35th IARIW General Conference

Copenhagen, Denmark, August 20-25, 2018

Session 7E-2: Measuring Capital and Wealth II

Time: Friday, August 24, 2018 [14:00-17:30]

Measuring Cross-Country Material Wellbeing and Inequality Using Consumer Durables#

Arthur Grimes and Sean Hyland*

Abstract

We advance a framework for defining a country's material wellbeing based on an (imperfectly observed set of) households' consumer durables, and apply the framework to household-level data from the OECD PISA surveys. We construct household and national material wellbeing metrics plus national inequality metrics consistently for 40 countries over 2000-2012. Comparisons with income-based alternatives (GNI per capita and the Gini coefficient of household incomes) indicate that our consumption-based measures capture aspects of material wellbeing that are not captured fully by income-based measures. The PISA consumption-based metrics are more closely associated with some (but not all) of a set of objective mortality-related national outcomes than are income-based measures. The results imply that consumption-based measures should be used in conjunction with income-based measures as indicators of the mean and variation in country material living standards.

Keywords: Material wellbeing; inequality; consumer durables; gross domestic product

JEL Nos.: E01, I31, I32

Acknowledgements

This research was funded by Royal Society of New Zealand Marsden Fund grant MEP1201. The authors gratefully acknowledge this assistance. We thank Gemma Wills, David Bloom, Michael Wolfson and Motu colleagues for helpful comments and contributions. Any errors or omissions are the sole responsibility of the authors.

 # IARIW Conference, Copenhagen, August 2018. Programme Title:

A Consistent Cross-Country Measure of Household Durable Consumption Wealth and Inequality

* Arthur Grimes (corresponding author): Motu Economic and Public Policy Research, PO Box 24390 Wellington 6142, New Zealand; and Victoria University of Wellington; arthur.grimes@motu.org.nz.

Sean Hyland: Motu Economic and Public Policy Research; and Columbia University.

1. Introduction

Almost a quarter of a millenium ago, Adam Smith (1776) argued that "consumption is the sole end and purpose of production." This principle is often forgotten; macroeconomic indicators of production and income enjoy wide use as inter- and intra-country welfare metrics in spite of well-documented limitations in this respect (Slesnick, 2001; Meyer and Sullivan, 2003; Stiglitz, Sen and Fitoussi [SSF], 2009). There remains a need to accurately quantify the consumption aspects of material wellbeing, especially in cross-country contexts. Without downplaying the importance of non-market wellbeing factors such as health, education and environmental outcomes (included, for example, in the UNDP's Human Development Index and the OECD's Better Life Index), our focus is on the cross-country measurement of material wellbeing.

We derive a (mean) material wellbeing index (MWI), plus distributional measures, based on (imperfectly observed) *durables consumption* for 40 countries over the period 2000-2012. In this respect, our paper can be seen as a complement to the work of Jones and Klenow (2016) who base their micro-data cross-country analysis on consumption of *non-durables and services*.[1] Our framework is influenced by the recommendations of SSF for the measurement of wellbeing. These include placing a greater focus on consumption and wealth (including consumer durables) whilst concentrating less on production, and accounting for their respective distributions. Our measures bear expected relationships with other material wellbeing measures, such as GNI per capita and the Gini coefficient of income, but there are also some substantive differences.[2]

We test how closely our consumption-based measures relate to a range of objective mortality measures in comparison with more typically used income-related variables (GNI per capita and the Gini coefficient of income). In cross-sectional terms, our mean and distributional consumption-based measures have closer associations with the mortality outcomes than do the conventional income-based measures; for changes (over twelve years), each of MWI and per capita GNI are preferred for certain mortality-related outcomes. Thus, while not completely replacing income-based measures, a consumption-based approach does contribute new information at a cross-country level over and above that provided by income measures.

A key difficulty for any cross-country consumption-based approach is to obtain comparable data across countries, especially on an inter-temporal basis. For our empirical

[1] Atkinson (2015) highlights the importance of including services from durables consumption if using a consumption-based material wellbeing measure.

[2] Similarly, Jones and Klenow (2016) find that while GDP per capita is a useful overall proxy for consumption-equivalent welfare, there are some material differences in the two measures across countries.

application of the framework, we utilise household possession data from the OECD's PISA (Programme for International Student Assessment) surveys. The primary aim of these surveys is to analyse the abilities and attitudes of 15 year old students across 75 economies, with surveys conducted triennially beginning in 2000. Supplementary questions on the home environment were included to consider the determinants of educational achievement; questions refer to the presence of an array of cultural, educational and status goods. These questions cover only a subset of all household consumption items and so we have an imperfectly observed set of consumption goods. Applying our theoretical framework to these data, we derive a measure of Household Material Wellbeing (HMW). We then map HMW into three aggregate series: the Material Wellbeing Index (MWI), which represents the country-year mean of HMW; and two measures of inequality: the Gini coefficient of HMW, and the Atkinson Inequality Measure (AIM), which describes the degree of inequality in the country-year-specific HMW distribution (Atkinson, 1970).[3]

The constructed measures have a number of strengths. First, in accordance with SSF, MWI is both consumption-based and wealth-focused, whilst the related Gini and AIM statistics describe distributional properties. Second, the data we employ is freely-available, independent, representative data managed by the OECD. Third, the PISA sampling design provides a strong element of demographic control – all units are a household with a 15 year old student – which improves comparability over time and across countries. This demographic control is a desirable, but unusual, feature for cross-country comparisons. Fourth, we directly observe important housing characteristics rather than having to impute housing production indirectly as in the national accounts, and so we can more easily compare housing assets across countries than is possible in purchasing power parity (PPP) calculations. Deaton (2010) discusses the difficulties that housing poses for cross-country PPP calculations, an issue that we circumvent by using a quantity-based housing measure.

Of course there are drawbacks to our measures, including imperfect coverage of consumption items (especially of non-durables and services) and the assumption of interpersonal comparability in utility functions. The latter is true for all aggregate indices, and our construction of the AIM statistic at least enables differing interpersonal value judgements to be accommodated.

This is not the first study to proxy material wellbeing through the use of household consumption data. A series of studies compares consumption-based and income-based measures

[3] In related work, we also construct an inequality adjusted measure of national material wellbeing using the MWI and AIM measures – see Grimes and Hyland (2015) [G&H].

for a single country.[4] Due to data limitations, cross-country studies are much less common. Main et al. (2017) derive a "material resources scale" for school-aged children across fifteen countries, based on access to a set of eight items. To derive the measure, the authors add the number of items that can be accessed by the student. Thus (unlike our price-based approach) a book is given equal weight to a bedroom in their measure. Smits and Steendijk (2014) compile a wealth index to evaluate the relative positions of households across 97 low and middle income countries. Their index, which uses principal components analysis (rather than prices) to weight items, is based on data for access to seven consumer durables, three housing characteristics and two public services.

Our study is also not the first to use PISA possession data to infer the socio-economic status of respondents: both the Family Wealth Index and the Index of Economic, Social and Cultural Status are constructed from PISA data. However, again the common approach to defining relative positions within this literature uses principal components analysis - a data driven approach which produces an index devoid of absolute meaning and which precludes inter-temporal comparisons. In contrast, our theoretical approach shows that through the use of market-based rental prices to weight items, we can construct a proxy for material welfare and construct consistent inequality measures both across countries and across time.

Micro-level analysis shows that our measure of household material wellbeing is positively associated with household income. This relationship also holds at the national level, demonstrated by a strong association between our aggregate measure and Gross National Income per capita (GNIpc) in both levels and changes. However, we observe some substantive differences between income and consumption-based results, which may reflect factors such as credit institutions and existing wealth that are important for lifetime consumption-smoothing. Our measures of household possession inequality are positively correlated with the Gini coefficient of national income distributions, but again, there are divergences, potentially reflecting demographic differences, and the role of government social programmes and transfers. At the national level, our consumption-based measures are (cross-sectionally) more closely associated with objective mortality outcomes than are income-based measures, while each set of measures is preferred over the other for certain mortality outcomes when associations are analysed for changes over time.

[4] For studies relating to USA see: Aguiar and Bils (2015) Attanasio et al. (2007), Attanasio et al. (2015), Fisher et al. (2014), Heathcote et al. (2010), Krueger and Perri (2006), Meyer and Sullivan (2003, 2011, 2012a, 2012b, 2017) and Slesnick (2001). For New Zealand, see Carver and Grimes (2016).

Section 2 of the paper outlines the theoretical framework for our wellbeing metrics. Section 3 details our data and the construction of our alternative indices. Section 4 presents the cross-country levels and rankings of MWI and AIM across the sample while section 5 presents validation tests for these metrics. In section 6, we test how closely our consumption-based MWI and AIM indices are associated with a range of objective national mortality-related outcomes relative to standard income-based measures (GNI per capita and the Gini coefficient of household incomes). Section 7 concludes.

2. Framework

The permanent income hypothesis posits that consumption is determined by contemporaneous wealth and income, and by expectations of future income flows. As such, in the absence of credit constraints, a household's current consumption summarises its expected lifetime material wellbeing. If a household is credit constrained, current consumption is still a valid indicator of current material wellbeing. Our material wellbeing framework, based on a selection of consumer durables, incorporates both consumption flows and wealth at the household level.

For the purposes of constructing a wellbeing metric, the weight on each household possession should reflect its relative benefit. Whilst such information is not observed, standard theory establishes that, in well-functioning markets, prices reflect the relative benefit to the marginal consumer. Consistent with Graham and Oswald (2006), we treat welfare as a function of the annual flow of consumption services, thus we focus on the rental cost of consumer durables. The use of market prices to weight items is consistent with national income estimates and the rental approach is consistent with inclusion of imputed rents of owner occupied dwellings in GDP.

To highlight the relationship between observed rental costs and utility consider the consumer optimisation problem corresponding to an infinite period model with two observed durable goods, A and B, and a composite unobserved non-durable good, C.[5] Suppose the consumer derives utility from both non-durables consumption and the flow of consumption services from durable goods, $U(\theta_A x_{At}, \theta_B x_{Bt}, x_{Ct})$, where x_{jt} is the stock of good j held in period t and θ_j is the ratio of consumption services to the stock of durable good j. Further suppose the individual begins each period with wealth w_t and earns income y_t, the sum of which can be allocated across consumption of durables (with prices P_{At}, P_{Bt}), nondurables (with

[5] With only minor changes in notation, C can also include unobserved durable goods, but the exposition is simpler when we refer to C as non-durables consumption.

price P_{Ct}), or financial assets, f_t (with return r_t).[6] All variables are measured in real terms so that prices are expressed relative to the aggregate price level and r_t is a real rate of return.

$$w_t + y_t = P_{At}x_{At} + P_{Bt}x_{Bt} + P_{Ct}x_{Ct} + f_t \qquad \text{(Error! Bookmark not defined.)}$$

The real return on durables is the expected real rate of capital gain, $\dot{P_{jt}}$ less the rate of depreciation, δ_j. The intertemporal wealth constraint is then:

$$(1 + r_t)(w_t + y_t - P_{Ct}x_{Ct}) + (\dot{P_{At}} - r_t - \delta_A)P_{At}x_{At} + (\dot{P_{Bt}} - r_t - \qquad \text{(Error! Bookmark not defined.)}$$

Due to the recursivity of this problem we can write the consumer's problem as:

$$V_t = \max_{x_{At}, x_{Bt}, x_{Ct}} \{U(\theta_A x_{At}, \theta_B x_{Bt}, x_{Ct}) + \rho V_{t+1}(w_{t+1})\} \qquad \text{(Error! Bookmark not defined.)}$$

The optimal solution requires substituting (2) into (3), then differentiating with respect to the three choice variables, $x_{jt}, \forall\, j \in \{A, B, C\}$ yielding the following first order conditions:

$$\frac{\partial U}{\partial x_{At}} = \frac{\partial U}{\partial(\theta_A x_{At})}\frac{\partial(\theta_A x_{At})}{\partial x_{At}} = \rho V_{t+1}{}'(w_{t+1})(r_t + \delta_A - \dot{P_{At}})P_{At}$$

$$\frac{\partial U}{\partial x_{Bt}} = \frac{\partial U}{\partial(\theta_B x_{Bt})}\frac{\partial(\theta_B x_{Bt})}{\partial x_{Bt}} = \rho V_{t+1}{}'(w_{t+1})(r_t + \delta_B - \dot{P_{Bt}})P_{Bt}$$

$$\frac{\partial U}{\partial x_{Ct}} = \rho V_{t+1}{}'(w_{t+1})(1 + r_t)P_{ct}$$

The individual allocates expenditure such that the benefit of an extra unit of any good, relative to its net costs, is equal to the shadow price (the present value of holding an additional dollar in the next period, which we denote as λ), that is:

$$\frac{\theta_A . \partial U/\partial(\theta_A x_{At})}{(r_t + \delta_A - \dot{P_{At}})P_{At}} = \frac{\theta_B . \partial U/\partial(\theta_B x_{Bt})}{(r_t + \delta_B - \dot{P_{Bt}})P_{Bt}} = \frac{\partial U/\partial x_{Ct}}{(1 + r_t)P_{Ct}} = \lambda = \rho V_{t+1}{}'(w_{t+1}) \qquad \text{(Error! Bookmark not defined.)}$$

Now suppose we observe an individual's stock of durable goods at levels x_{At} and x_{Bt}, but do not observe their level of nondurables consumption, x_{Ct}, or the separable utility function, $U(\theta_A x_{At}, \theta_B x_{Bt}, x_{Ct})$. To make inferences about wellbeing, consider the first-order Taylor series approximation of the utility function U at the point $(0,0,x_{Ct})$, i.e. where the (unobserved)

[6] We impose a no-Ponzi scheme condition on borrowing, stating that in the limit assets must be non-negative: $E_t \lim_{s\to\infty} \left[\prod_{s=0}^{\infty} \left(\frac{1}{1+r_{t+s}}\right)\right] f_{t+s} \geq 0,$

consumption of nondurables is nonzero but the stock of each durable good is zero, about the partially observed point ($\theta_A x_{At}$, $\theta_B x_{Bt}, x_{Ct}$).

$$U(0,0,x_{Ct}) \approx U(\theta_A x_{At}\,,\theta_B x_{Bt},x_{Ct}) + \frac{\partial U}{\partial \theta_A x_{At}}(0-\theta_A x_{At}) + \frac{\partial U}{\partial \theta_B x_{Bt}}(0-\theta_B x_{Bt}) + \frac{\partial U}{\partial x_{ct}}(x_{Ct}-x_{Ct})$$

This expression can be rearranged, with substitution from equation (3), as:

$$U(\theta_A x_{At}\,,\theta_B x_{Bt},x_{Ct}) - U(0\,,0,x_{Ct}) \approx \frac{\partial U}{\partial \theta_A x_{At}}\theta_A x_{At} + \frac{\partial U}{\partial \theta_B x_{Bt}}\theta_B x_{Bt}$$

$$= \left(\frac{\partial U}{\partial(\theta_B x_{Bt})}\frac{\theta_B\left(r_t+\delta_A-\dot{P_{At}}\right)P_{At}}{\theta_A\left(r_t+\delta_B-\dot{P_{Bt}}\right)P_{Bt}}\right)\theta_A x_{At} + \frac{\partial U}{\partial \theta_B x_{Bt}}\theta_B x_{Bt}$$

$$= \left(\left(r_t+\delta_A-\dot{P_{At}}\right)P_{At}x_{At} + \left(\left(r_t+\delta_B-\dot{P_{Bt}}\right)\right)P_{Bt}x_{Bt}\right)\frac{\theta_B.\partial U/\partial(\theta_B x_{Bt})}{\left(r_t+\delta_B-\dot{P_{Bt}}\right)P_{Bt}}$$

$$= \left(\left(r_t+\delta_A-\dot{P_{At}}\right)P_{At}x_{At} + \left(\left(r_t+\delta_B-\dot{P_{Bt}}\right)\right)P_{Bt}x_{Bt}\right)\lambda$$

The main result follows in (5): the sum of the annual rental cost (R_{jt}) of durables expressed in monetary terms approximates the increased utility over the zero-durables bundle, holding unobserved non-durables constant.

$$R_{At}x_{At} + R_{Bt}x_{Bt} \equiv \left(r_t+\delta_A-\dot{P_{At}}\right)P_{At}x_{At} + \left(\left(r_t+\delta_B-\dot{P_{Bt}}\right)\right)P_{Bt}x_{Bt} = \frac{U(\,\theta_A x_{At},\,\theta_B x_{Bt},x_{ct}) - U(0,0,x_{ct})}{\lambda} \qquad \text{(Error! Bookmark not defined.)}$$

Thus, even though we do not observe the consumption of some goods, we can still infer that the sum of rental values of observed consumption is related directly to an individual's utility. In the end, whether wellbeing measures based on incompletely observed consumption data are preferable to measures based on (potentially) completely observed income data is an empirical matter which we test subsequently in the paper.

While our approach is grounded in individuals' utility functions, it is still susceptible to a number of the common critiques of GDP (and GNI) discussed in SSF: only goods for which prices exist can be included, prices may not reflect social value, and there are difficulties in capturing quality changes. Furthermore, as Dowrick and Quiggin (1993) and Deaton (2010) discuss, there are difficulties incurred when ranking consumption bundles by international prices when local prices and/or preferences differ. This research does not attempt to make progress along these dimensions; our focus instead is to promote a cross-country framework capable of comparing household material wellbeing distributions based on possessions data, acknowledging these caveats.

3. Data and Index Construction

We apply our framework to household-level data. The primary data source is the OECD's triennial PISA survey established in 2000. The aim of these surveys is to examine the attitudes and abilities of 15-year-old students across countries. Supplementary questions are included to assess the relationship between educational achievement and the home environment. From the responses to these questions we construct a consistent unit record database of household possessions, covering three time periods and 40 countries, to which we apply our material wellbeing framework. Because the PISA surveys are completed by a 15-year-old student, our framework features a strong element of demographic control for comparisons across countries and time, unlike national accounts data.

The set of possessions for which questions were asked consistently in the 2000, 2009 and 2012 waves defines the subset of resources that contribute towards material wellbeing in this analysis.[7] The questions are split between binary and multiple responses: binary response questions consider whether or not a good is present in the student's home, with goods ranging from the inexpensive (such as books) to more valuable attributes (such as whether the student has their own bedroom, henceforth referred to as 'own room'[8]); multiple response questions consider how many units of a stated possession are present in a student's home (with admissible responses: 0, 1, 2, and '3 or more').[9] We restrict our attention to the household-level data from the 40 countries for which all possession questions were asked in all three years.[10]

Supplementary data relates to the prices and lifespans of the PISA possessions used to weight the possessions for aggregation; these data are reported in Table 1. Column 1 lists the question type for each possession, whilst column 2 lists the data source used to obtain possession prices. The third column indicates the lifetime benefit of a possession, as implied by

[7] We ignore the intervening waves as they include only a subset of the possession questions. We report all three years' values of our measures in the Appendix, while concentrating on 2000 and 2012 in the main text.

[8] We derive the total number of bedrooms in the house under the assumption that homes are not crowded (according to Canadian National Occupancy Standards; see Canadian Mortgage and Housing Corporation, 1991) along with some other minor assumptions.

[9] Appendix Table A2 details missing response rates across goods (which ranged from 1.7% to 3.9%) and reports the mean and distributions for holdings of each good.

[10] Appendix Table A1 details the participation of each country by wave. Some countries are reported as having participated in 2000 whilst their surveys were actually conducted in 2002. We account for this discrepancy when computing growth rates and consider 2002 realisations of alternative metrics where relevant.

price, which varies widely across our set. Note that the prices used in this paper are both time and country invariant (using US 2014Q2 prices as the reference). We do so to reflect the objective benefit that an asset is capable of delivering, abstracting from variation around this reference point (e.g. due to quality differences across time and across countries). This approach, driven by data limitations, could be motivated by the capabilities approach of Sen (1985) or by assuming that utility is determined relative to country-year norms as postulated, for instance, by Duesenberry (1949). We use the estimated useful life of a possession (column 3) to calculate annualised prices (column 4). Noting that the assumptions reported in Table 1 are inevitably approximations, in section 5.4 we report sensitivity tests of our measures to changes in key assumptions with respect to inclusion of certain possessions and the weights accorded to each possession.

[Table 1 about here]

Our principal household level measure - household material wellbeing (HMW) – is defined as the rental price-weighted sum of the household's observed possession counts, where the weights are the associated 2012 US rental costs, equivalised by household size for all rivalrous goods.[11,12,13] The quantity of the binary response possessions is equal to one if the student declares the asset is present in their home, and zero otherwise. The quantity of multiple response possessions is as given for responses "zero", "one" and "two". We treat the response "three or more" as though the household has four of these possessions; three must be an underestimate of the conditional average within that group, and we choose the next integer in the sequence.[14,15]

We describe cross-country material wellbeing levels through the Material Wellbeing Index (MWI), defined as the country-year mean of the household measure (HMW). The mean is an appropriate measure of central tendency since possession counts are capped, thereby reducing the impact of outliers.

---

[11] A student's household size was not directly asked in PISA surveys. We construct an informative lower bound by aggregating a student's responses to questions regarding the presence of relations and use the square root of household size to equivalise household material wellbeing. G&H derive beneficial properties of using this equivalisation method in the presence of imperfect information.

[12] We treat artwork as non-rivalrous and all other possessions as rivalrous.

[13] In calculating the rental price we assume zero real capital gains expectations and assume a zero real interest rate (as was approximately the case for the USA in 2012).

[14] If the distribution of (unobserved) non-truncated '3 or more' possession responses is triangular and the maximum non-truncated response is 6 then the conditional mean would be exactly four; if the maximum non-truncated response were five or seven then the mean would be 3.66 and 4.33, respectively, implying that 4 is a reasonable estimate to use.

[15] There exists an upper bound to our calculated measure; household MW cannot exceed $13,350.08 (which corresponds to a one-person household with the maximum observed possession counts across all binary and multiple response possessions). We do not observe any household with all possession counts at the maximum possible level.

Whilst comparisons of means are informative, a major focus of this study is to describe distributional differences, which we summarise both by the Gini coefficient (of consumption) and by the Atkinson Inequality Measure (AIM) of HMW (Atkinson, 1970; Foster et al, 2005).[16] There are four reasons why these calculated inequality metrics could mis-state 'true' inequality: (i) we cannot consider value (quality) differences within a possession category, (a Corolla is considered equal to a Ferrari); (ii) the list of possessions does not include expenditure on categories for which the rich spend more, such as air travel; (iii) the number of each possession within the household is truncated; and (iv) we do not observe expenditure on goods with low income-elasticity of demand (e.g. food or petrol). The fourth factor could lead to our distribution statistics over-stating inequality, while the other three factors could lead to an under-statement of inequality.

4. MWI and AIM Rankings

Table 2 provides MWI values for all countries in 2000 and 2012,[17] while Figure 1 depicts the level of MWI for each country in 2012. USA had the highest level of MWI across all countries, ahead of the other Anglo-Saxon settler economies (Canada, New Zealand and Australia). Also near the top of the distribution are rich European economies (Liechtenstein, Luxembourg, Norway, Sweden), whilst other western European economies are concentrated between rankings of 10 and 20 (Italy, Austria, Germany, Portugal, France, Spain). Below the median value we find a grouping of former Eastern Bloc countries (Poland, Czech Republic, Bulgaria, Hungary, Latvia, Russia, Romania, Albania) as well as some Latin American economies (Chile, Brazil, Argentina and Mexico) and East Asian economies (Korea, Thailand, Hong Kong and Indonesia).

[Table 2 and Figure 1 about here]

Table 3 presents the AIM(1) values for all countries in 2000 and 2012.[18] It also shows the country's AIM(1) rank plus its inequality rank according to the Gini coefficient calculated for HMW. The rank correlation coefficients between AIM(1) and the HMW Gini for 2000 and 2012 are 0.99 and 0.92 respectively. Given this high degree of consistency across the two measures, we use AIM(1) as our sole measure of consumption inequality for the remainder of the paper. Figure 2 portrays the AIM(1) metric for within-country inequality in 2012.

[16] For the calculations of AIM reported in the main text, we use an inequality parameter of $\varepsilon=1$; hence we refer to the measure as AIM(1). We report additional AIM measures using $\varepsilon=2$ and $\varepsilon=3$ in the Appendix; we note that there is a high degree of consistency of country rankings across the different ε values.
[17] Appendix Table A3 presents levels and growth rates for MWI for each country across each period.
[18] Appendix Tables A4a-A4c detail levels and changes in AIM values corresponding to alternative inequality aversion parameters.

[Table 3 and Figure 2 about here]

The results show that the Netherlands was the most equal country within our sample in 2012, whilst Mexico was the most unequal. Again we note some broad groupings: the Netherlands plus the Scandinavian countries (Denmark, Norway and Sweden) are relatively equal, while the Anglo-Saxon countries have moderate levels of inequality. Eastern European countries display moderate to high levels of inequality, while the Latin American countries feature with relatively high levels of inequality. Countries within Asia show highly divergent distributional outcomes; Korea, Japan and Hong Kong have low to moderate inequality, while Thailand and Indonesia display high inequality.

The broad groupings of countries for both MWI and AIM(1) suggest that national institutions may play a role in explaining cross-country differences in material wellbeing and its distribution. Figure 3 plots the two metrics simultaneously for 2012. Panel (a) depicts the relationship between the two metrics across all countries; only some observations are labelled by country code to enhance legibility. We find a convex decreasing relationship between MWI and AIM; countries with high (low) levels of MWI tend to enjoy low (high) levels of inequality, however there is a flattening out of this relationship as MWI increases.

Panel (b) restricts attention to the cluster of countries in the dashed box of panel (a), so that we can better observe the more developed countries. Within this subset we find a quadratic relationship between MWI and AIM(1). The countries with the lowest levels of inequality tend to lie in the middle of this set of countries by MWI, while the high-MWI Anglo-Saxon settler countries are concentrated around a moderate level of inequality.

[Figure 3 about here]

5. Validation of Material Wellbeing Metrics

5.1. Household-level Analysis

Initially, we examine the household-level consistency between our consumption-based measure and household income. Income data in PISA is imperfect. It is available only through the parental questionnaire, a supplementary questionnaire which was first introduced in 2006 and which relatively few countries have chosen to administer subsequently. Household income is expressed as a categorical variable, with bins defined relative to the national median, and it is therefore imprecisely observed.[19] Nevertheless, the normalisation of income around the country-year specific median allows us to pool household-level observations from across countries with different median incomes and consider the relationship between the distribution of HMW (normalised relative to country-year specific MWI) and relative income positions.

This relationship is shown in box plots of relative HMW by relative income categories in Appendix Figure A1. With just one exception, all parts of the distribution of relative HMW are increasing in relative income.[20] Thus, households with higher income levels tend to have higher levels of durables consumption. We also observe a considerable overlap in the relative HMW distribution across relative income categories. This indicates that we have not simply constructed a linear transformation of income. This outcome is what we would expect from theory since consumption should be smoother than income over the life-cycle; for instance, low income early or late in life may still be accompanied by high consumption if lifetime income is high.

5.2. Cross-country Comparison with GNI

Appendix Figure A2 plots an analogous relationship at the aggregate level for the cross-country relationship between the natural logarithms of MWI (lnMWI) and per capita GNI (lnGNIpc). There is a strong positive nonlinear relationship between the two measures across both years. The observed nonlinearity of MWI in relation to income is consistent with cross-country analysis of alternative wellbeing measures and income (Grimes et al., 2014), although it may, in part, also reflect the existence of an upper bound on MWI. A quadratic regression of lnMWI on lnGNIpc (excluding Hong Kong[21]) explains more than 80% of the cross-country variation in lnMWI in each year - the fitted line from each regression is overlaid in the figure. There is, however, variation around the relationship. For example, in 2012, Korea enjoys a similar level of GNIpc to New Zealand, but its MWI is only 70% of that in New Zealand. Appendix Figure A3 demonstrates a strong dynamic relationship between MWI and GNIpc, but again shows variation around this relationship. For instance, each of Indonesia, Hong Kong and Korea had lower MWI growth over 2000-2012 than would be predicted by the linear relationship. (These findings for Korea are consistent with that country's low growth of household disposable income relative to GDP between 1996 and 2006, as documented in SSF.)

[19] Households report whether their combined income is (i) less than 50% of the national median, (ii) between 50% and 75% of the national median, (iii) between 75% and 100% of the national median, (iv) between 100% and 125% of the national median, (v) between 125% and 150% of the national median, or (vi) greater than 150% of the national median.

[20] The sole exception is the upper adjacent value of HMW for the lowest relative income category in 2012.

[21] Hong Kong (HKG) is a clear outlier in this relationship across all years. This is almost entirely driven by the very low car ownership rates (at just 0.076 cars per equivalised household) among respondents, in spite of moderate national income. This low car ownership rate is similar to World Bank national estimates, adding credibility to the representativeness of the PISA survey.

The cross-country variations in both levels and growth rates for MWI relative to GNIpc indicate that additional information is being captured by our framework.

5.3. Distributional Estimates

The material wellbeing framework presented in this paper draws on household-level data, which enables analysis of within-country distributions. Appendix Figure A4 plots the relationship between our AIM(1) and a conventional distributional alternative, the Gini coefficient of household incomes, where the latter is reported for each country by the OECD and the World Bank.[22] We find a strong positive relationship between the two aggregate measures, implying that countries which have higher levels of income inequality also tend to have higher levels of inequality in household durables; an observation which supports the distributional inference of our material wellbeing framework. However, as was the case with the comparison of means, there exists considerable variation around this simple relationship. For instance, the Netherlands, Albania and Romania have similar Gini coefficients of incomes in each year, but the Netherlands displays low consumption inequality while the latter two countries each display high consumption inequality. This suggests that rather than replicating existing estimates, our measure captures important additional distributional information.

5.4. Sensitivity analysis

While based on a solid theoretical foundation, any consumption-based metric is necessarily determined by imperfect data on household possessions as well as by judgements over appropriate weights. We test the sensitivity of our results to alternative datasets and assumptions. This includes testing for the impacts of variations in the possession bundle and sensitivity to variations in the possession weights.

We test sensitivity to specific possessions by creating a set of pseudo-MWI metrics, each of which omits a different PISA survey possession when defining material wellbeing.[23] For most possessions, exclusion has a minimal effect on rankings. The exclusion of cars (and, to a lesser extent, bathrooms) has a somewhat greater effect though, in each case, the modal change in ranking is zero. The minor impact of excluding the number of bedrooms from MWI is comforting, given that this is a derived variable; 78% of country-year rankings are unaffected by this exclusion, whilst no country-year observation changes rank by more than 2 places.

---

[22] There is a considerable number of missing observations in the Gini coefficient of income, especially for 2000. For Figure A4, missing observations are linearly interpolated.

[23] The distributions of the difference in country-year rankings, by possession, pooling across all years, is depicted in Appendix Figure A5.

We test sensitivity to the weights used for each possession by augmenting each weight by a random multiplicative term. For each good we take an independent random draw from the symmetric triangular distribution on the interval [0.8, 1.2], construct a pseudo-MWI for each country based on the augmented prices and then compare the consequent rankings with those associated with our central measure, evaluating the deviations from 1000 repetitions.[24] The weighting shock is country-invariant (since we are using country-invariant prices), but is independent across goods.[25] We find no difference between the augmented-price MWI rankings and our central MWI rankings in more than 75% of simulations, with no deviations in rankings greater than 4 (in absolute value) observed; 95% of cases have a deviation in rank no greater than 1 in absolute value. A more dramatic reweighting (see Appendix Figure A7) rescales the weights such that the contributions to HMW are equivalent to contributions to aggregate expenditure (using Australian expenditure weights). In this case, MWI rankings between weighting systems do not differ by more than 3 places for two-thirds of our country-year observations whilst inequality rankings (shown in Appendix Figure A8) are even less sensitive.

6. Applications

We examine whether our MWI and AIM consumption-based measures have content for policy and research purposes by testing the strength of their associations relative to income-based measures with four mortality-related objective wellbeing outcomes: female and male life expectancy,[26] the maternal mortality ratio and the infant mortality rate.[27] The mortality data are as reported in the World Bank Health, Nutrition and Population Statistics, with descriptions given in Table 4. We test whether these mortality measures are most closely related to: log(GNI per capita) [LGNIpc][28] or MWI[29] (as competing measures of the mean wealth of a country's residents), and the Gini coefficient of household incomes (YGINI)[30] or the AIM(1) measure of

---

[24] We adopt the symmetric triangular distribution because (i) the probability of an observation is decreasing in its distance from the mean, (our best estimate of the appropriate weight), and (ii) the domain of the probability distribution function is bounded, as prices cannot be negative or infinitely positive.

[25] Appendix Figure A6 displays the distribution of ranking deviations, pooling over all country-year observations as well as repetitions.

[26] The cross-country relationship between life expectancy and a national income variable such as GNI per capita is known as the Preston Curve (Preston, 1975). Thus our test (modified by the influence of inequality) can be seen as a test of whether an income-based or consumption-based variable is superior in a Preston Curve setting.

[27] We obtain very similar results using the infant, neo-natal and under-5 year mortality rates, so report only the first of these variables.

[28] LGNIpc data for 2000 and 2012 are in PPP terms (constant 2011 $s) sourced from UNDP International Human Development Indicators, http://hdr.undp.org, downloaded 3 July 2017.

[29] We use the level (rather than the log) of MWI since the relationship between MWI and GNIpc is approximately logarithmic – see Appendix Figure A2.

[30] YGINI data for 2012 is for GINI index (World Bank estimate), World Bank Development Research Group. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. Source: http://data.worldbank.org/indicator/SI.POV.GINI. (downloaded 26 May 2017). This source

consumption derived in this paper (as competing measures of household inequality).[31] The required data are not available for Hong Kong and Lichtenstein; hence they are dropped from the analysis, leaving 38 countries. While this is a small sample, it still enables us to provide an indication of whether the consumption-based MWI and AIM statistics have value relative to income-based measures as national wellbeing indicators.

[Table 4 about here]

We estimate our equations both for 2012 and 2000 (levels), and for changes from 2000-2012 (referred to as 'delta' below). YGINI data is not sufficiently comprehensive across countries for 2000 so is used only for the 2012 levels tests. For the 2012 levels specification, we estimate four equations for each dependent variable ($DepVar$) as follows:

$$DepVar = \alpha_0 + \alpha_1 LGNIpc + \alpha_2 AIM + \mu \quad (6)$$

$$DepVar = \alpha_0 + \alpha_1 MWI + \alpha_2 AIM + \mu \quad (7)$$

$$DepVar = \alpha_0 + \alpha_1 LGNIpc + \alpha_2 YGINI + \mu \quad (8)$$

$$DepVar = \alpha_0 + \alpha_1 MWI + \alpha_2 YGINI + \mu \quad (9)$$

For the 2000 levels equation and for the delta equation (2012-2000), we estimate equations (6) and (7) for each dependent variable, given the unavailability of 2000 data for YGINI. We hypothesise that the two mean living standard variables (LGNIpc and MWI) will have a positive relationship with life expectancy and a negative relationship with the mortality rate variables, while the two inequality variables (YGINI and AIM) will have a negative relationship with life expectancy and a positive relationship with mortality rates.

Results for the 2012 levels specification are shown in Table 5, where the four blocks of the table correspond to equations (6)-(9) respectively (labelled in the table as models M1 – M4).

[Table 5 about here]

In all cases, both LGNIpc and MWI are each positive and significant for the two life expectancy variables (as hypothesised) while each is negative for the two mortality rate variables; LGNIpc is not significantly different from zero in Model 1 for the maternal mortality ratio (but

---

did not provide Gini data for Japan, Korea or New Zealand, for which OECD data were sourced from: https://data.oecd.org/inequality/income-inequality.htm (downloaded 26 May 2017). Where 2012 data were not available from World Bank closest year data were used as follows: Australia (2010), Canada (2010), Chile (average of 2011 and 2013), Germany (2011), Indonesia (2013), USA (2013).

[31] For discussion of the association between inequality and health, see Wilkinson and Pickett (2009) and Wolfson and Beall (2017). Atkinson (2015) notes that consumption-based inequality measures may be superior to income-based measures for considering issues that relate to standard of living, including poverty (which could include health-related outcomes). Alternative distributional measures could potentially be calculated from our data relating specifically to poverty and to polarisation (Wolfson, 1994), but we leave this to future investigation.

is significant for the other three variables) while MWI is significant in all cases. In each case where AIM and YGINI are significantly different from zero, their signs are as expected (i.e. negative for life expectancy and positive for mortality rates. The inequality variables are consistently significant for the infant mortality rate.

We test competing specifications using the Davidson-MacKinnon J-test for non-nested models, with results reported in the final block of Table 5. Each test (e.g. of models M1 and M2) is conducted in both directions (i.e. H_0: M1, H_A: M2; and H_0: M2, H_A: M1). We indicate (using a 5% significance level) where one model rejects the other and is itself not rejected, and also show where neither model rejects the other ('-') and where both models are rejected by each other ('both').

For 5 of the 8 tests that involve both LGNIpc and MWI, the consumption-based measure rejects the income-based measure (uni-directionally), while GNIpc does not reject MWI in any case (other than where both models are rejected by each other). For the 8 cases that involve both YGINI and AIM, the consumption-based measure rejects the income-based measure (uni-directionally) on 3 occasions and is itself not rejected in any case. For 2012, therefore, the PISA consumption-based measures are more closely related to mortality outcomes than are the more conventionally used income-based measures.[32]

Table 6 presents results of estimating equations (6) and (7) for the same four dependent variables. The top two blocks show results for the 2000 levels specification while the third and fourth blocks show results for the delta (2012-2000) specification. The final block details J-tests for each specification (again noting that the models with YGINI are excluded owing to a lack of appropriate data).

[Table 6 about here]

For 2000, based on the J-tests, each of LGNIpc and MWI is preferred over the other on one occasion while neither rejects the other on two occasions. For the delta (2012-2000) specification, MWI is preferred for the two life expectancy variables while LGNIpc is preferred for the mortality rate variables.[33]

---

[32] An alternative approach nests all four variables in the same equation for each dependent variable and then tests, using a Wald test: (a) whether we can exclude the two income-based terms (LGNIpc and YGINI), and (b) whether we can exclude the two consumption-based terms (MWI and AIM). When we do so (using a 5% significance level), we can never reject that the LGNIpc and YGINI coefficients equal zero, but we do reject that the MWI and AIM coefficients equal zero for the two mortality rate variables.

[33] If all three variables are nested in the same equation, we can reject that the MWI coefficient equals zero for male life expectancy (in both the 2000 and the delta specifications) and can reject that the LGNIpc coefficient equals zero for the infant mortality rate (both specifications) and for the maternal mortality rate in 2000. We reject that the AIM coefficient equals zero on only once occasion (the delta specification for maternal mortality).

Overall, each of LGNIpc and MWI is preferred in certain contexts. From the levels equations, MWI appears to have become increasingly preferred to LGNIpc over time. This result may indicate that average per capita GNI growth is not feeding through as strongly to objective mortality outcomes as it did prior to 2000. If this were the case – for instance if households with children (i.e. our sample) are not sharing commensurately in national income growth – then a household consumption-based metric may contain greater information about objective health outcomes, as we observe for 2012.

For the inequality measures, our PISA consumption-based metric out-performs the more standard household income-based inequality measure on some occasions (in 2012) but for other comparisons neither measure substantially out-performs the other. These results indicate that a consumption-based inequality measure is at least as useful (in explaining life expectancy and mortality outcomes) as an income-based inequality measure.

7. Conclusions

We progress the literature on measurement of material wellbeing by developing a consumption-based framework for measuring household material wellbeing where consumption is imperfectly observed. Our household measure accounts for the annual flow of consumption services from a set of consumer durables within the home using market rental prices to weight items. The approach satisfies key recommendations of SSF for constructing a material wellbeing metric – specifically, focusing on consumption and wealth rather than production, and emphasising the household perspective. Both means and distributions of material wellbeing within countries are derived.

We apply our methodology to a repeated cross-sectional dataset, drawn from the OECD's PISA surveys, incorporating the responses of households from 40 countries in three separate years. Use of this dataset enables us to control substantially for demographic differences across countries since all households in our sample include a 15 year old child. We define a household's material wellbeing (HMW) as the annual rental value corresponding to an observed set of household durables. We then map HMW into two series: the Material Wellbeing Index (MWI) representing the country-year mean of HMW, and the Atkinson Inequality Measure (AIM) capturing the degree of inequality in the country-year-specific HMW distribution.

Our measures capture important aspects of material wellbeing. Firstly, micro-level analysis shows our measure of household material wellbeing is positively associated with household income. Secondly, we find a strong positive relationship between our aggregate measure and Gross National Income per capita, demonstrating that the household-level correlation is preserved under aggregation. Thirdly, our AIM(1) measure of material wellbeing dispersion produces country-year rankings that are broadly consistent with measures of household income inequality.

The usefulness of a new metric requires that it does not simply replicate other metrics; rather we require the presence of additional information. At the aggregate level, we show that some countries (such as Korea) have a lower than expected mean level of consumption given their national income while others (such as New Zealand) have a higher than expected consumption level. Similarly, some countries (such as Albania and Romania) have higher degrees of consumption-based inequality than is indicated by their Gini coefficient of household income.

We test whether the PISA consumption-based measures contain extra information over and above standard income-based measures (GNI per capita and the Gini coefficient of household incomes) by conducting a series of comparative tests of the consumption versus income-based measures in terms of their relationship with four national mortality-related outcomes (female and male life expectancy, the maternal mortality ratio and infant mortality). For 2012, the consumption-based metrics dominate the income metrics in all cases where one set is preferred statistically to the other, whereas for 2000 and for changes between 2000 and 2012 each set of metrics is preferred in at least one case.

Overall, our results show that consumption-based measures of the level and distribution of material wellbeing add some confirmatory and some new insights for understanding the wellbeing of households and populations. Future research can apply this framework to new consumption-based datasets, potentially with a wider range of goods and services. They can also be used to test relationships of consumption-based national material wellbeing indicators with other (objective and subjective) wellbeing outcomes. Such applications should produce added insights into material wellbeing levels and distributions at multiple levels, potentially ranging from households to the global economy.

References

Aguiar M, Bils M. 2015. "Has Consumption Inequality Mirrored Income Inequality", *American Economic Review* 105(9), 2725-2756.

Atkinson A. 1970. On the Measurement of Inequality. *Journal of Economic Theory*, 2(3), 244-263.

Atkinson A. 2015. *Inequality. What Can Be Done?* Cambridge MA: Harvard University Press.

Attanasio O, Battistin R, Ichimura H. 2007. "What Really Happened to Consumption Inequality in the United States?," in E E Berndt and C R Hulten (eds), *Hard-to-Measure Goods and Services: Essays in Honor of Zvi Griliches,* National Bureau of Economic Research.

Attanasio O, Hurst E, Pistaferri L. 2015. "The Evolution of Income, Consumption and Leisure Inequality in the US, 1980-2010", in C Carroll, T Crossley and J Sabelhaus (eds), *Improving the Measurement of Consumer Expenditures,* University of Chicago Press.

Canadian Mortgage and Housing Corporation. 1991. *Core Housing Need in Canada*, Canadian Mortgage and Housing Corporation, Ottawa.

Carver T, Grimes A. 2016. "Income or Consumption: Which Better Predicts Subjective Wellbeing?" *Motu Working Papers*, 16-12, Motu Economic and Public Policy Research.

Deaton A. 2010. Price Indexes, Inequality, and the Measurement of World Poverty. *American Economic Review*, 100(1), 5-34.

Dowrick S, Quiggin J. 1993. "Australia, Japan and the OECD: GDP Rankings and Revealed Preference," *Australian Economic Review*, 26(1), 21-34.

Duesenberry J. 1949. *Income, Saving and the Theory of Consumer Behavior.* Cambridge, Mass.: Harvard University Press.

Fisher J, Johnson D, Smeeding T. 2014. "Inequality of Income and Consumption in the U.S.: Measuring the Trends in Inequality from 1984 to 2011 for the Same Individuals", *Review of Income and Wealth* 61(4), 630-650.

Foster J, Lopez-Calva L, Szekely M. 2005. "Measuring the Distribution of Human Development: Methodology and an Application to Mexico," *Journal of Human Development and Capabilities*, 6(1), 5-25.

Graham L, Oswald J. 2006. "Hedonic Capital," IZA Discussion Papers, No. 2079, Institute for the Study of Labor (IZA).

Grimes A, Oxley L, Tarrant N. 2014 "Does Money Buy Me Love? Testing Alternative Measures of National Wellbeing". In: D McDaid & C Cooper (eds.) *Economics of Wellbeing*, Volume 5 of *Wellbeing: A Complete Reference Guide*, 49-82. Wiley-Blackwell, Oxford UK.

Grimes A, Hyland S. 2015. A New Cross-Country Measure of Material Wellbeing and Inequality: Methodology, Construction and Results. *Motu Working Papers*, 15-09, Motu Economic and Public Policy Research.

Heathcote J, Perri F, Violante G. 2010. "Unequal we stand: An empirical analysis of economic inequality in the United States, 1967–2006," *Review of Economic Dynamics* 13(1), 15-51.

Krueger D, Perri F. 2006. "Does Income Inequality Lead To Consumption Inequality? Evidence and Theory", *Review of Economic Studies* 73(1), 163-193.

Main G, Montserrat C, Andresen S, Bradshaw J, Lee BJ. 2017. "Inequality, material well-being, and subjective well-being: Exploring associations for children across 15 diverse countries", *Children and Youth Services Review*, in press.

Meyer B, Sullivan J. 2003. "Measuring the Well-Being of the Poor Using Income and Consumption", *Journal of Human Resources* 38(S), 1180-1220.

Meyer B, Sullivan J. 2011. "Further Results on Measuring the Well-Being of the Poor Using Income and Consumption," *Canadian Journal of Economics* 44(1), 52-87.

Meyer B, Sullivan J. 2012a. "Identifying the Disadvantaged: Official Poverty, Consumption Poverty, and the New Supplemental Poverty Measure," *Journal of Economic Perspectives* 26(3), 111-136.

Meyer B, Sullivan J. 2012b. "Winning the War: Poverty from the Great Society to the Great Recession," *Brookings Papers on Economic Activity*, Fall, 133-183.

Meyer B, Sullivan J. 2017. "Consumption and Income Inequality in the U.S. Since the 1960s", NBER Working Paper No. 23655.

Preston S. 1975. "The Changing Relation between Mortality and Level of Economic Development," *Population Studies* 29(2), 231-248.

Sen A. 1985. *Commodities and Capabilities,* Amsterdam: North-Holland.

Sirmans G, MacDonald L, Macpherson D, Zietz E.. 2006. "The Value of Housing Characteristics: A Meta Analysis," *The Journal of Real Estate Finance and Economics*, 33(3), 215-240.

Slesnick D. 2001. *Consumption and Social Welfare,* Cambridge: Cambridge University Press.

Smith A. 1776. *The Wealth of Nations*. Edited by Edwin Cannan, 1904. Reprint edition 1937. New York, Modern Library

Smits J, Steendijk R. 2015. "The International Wealth Index (IWI)," *Social Indicators Research,* 122(1), 65-85.

Stiglitz J, Sen A, Fitoussi J-P. 2009. Report by the Commission on the Measurement of Economic Performance and Social Progress. Available at http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf.

Wilkinson R, Pickett K. 2009. *The Spirit Level: Why Greater Equality Makes Societies Stronger*. New York, NY: Bloomsbury Press; 2009.

Wolfson M. 1994. "When Inequalities Diverge", *American Economic Review* 84(2), 353-358.

Wolfson M, Beall R. 2017. "On the determinants of health inequalities – Explorations using the Theoretical Health Inequality Model", In: G Kaplan, A Roux, C Simon, S Galea (eds) *Growing Inequality: Bridging Complex Systems, Population Health and Health Disparities*. Westphalia Press: Washington, DC.

Table 1: Data Sources, Prices, Lifespans and Annual Rental Flows

Item	Question Type	Price Data Source	Price (USD)	Useful Life (Years)	Annual Rent
Artwork	Binary	Amazon.com	2,550	13.3	191.73
Classic Lit	Binary	Amazon.com	30	2.0	15.00
Desk	Binary	Amazon.com	400	15.5	25.81
Dictionary	Binary	Amazon.com	31	2.0	15.34
Dishwasher	Binary	Amazon.com	700	6.7	105.11
Educ Software	Binary	Amazon.com	30	4.0	7.50
Internet	Binary	CES PUMD	700	1.0	700.00
Own Room	Binary	Sirmans et al (2006), FRED	20,945	50.0	418.90
Poetry	Binary	Amazon.com	30	2.0	15.00
Study Place	Binary	Sirmans et al (2006), FRED	10,473	50.0	209.45
Textbooks	Binary	Amazon.com	30	2.0	15.00
Bathroom	Multiple	Sirmans et al (2006), FRED	19,033	25.0	761.31
Cars	Multiple	Cars.com	6,315	4.0	1,578.75
Computer	Multiple	NPD Group	671	4.0	167.75
(Cell) Phone	Multiple	J.D. Power and Associates	852	3.0	284.00
TV	Multiple	Amazon.com	580	5.0	116.00

Estimated median prices for artwork, desks, dictionaries, dishwashers, educational software and televisions and all books were obtained from Amazon.com.

Given internet charges are already rental payments, we consider the average household expenditure per year directly from 2012 Consumer Expenditure Survey public-use microdata (CES PUMD), obtained from http://www.bls.gov/cex/pumdhome.htm.

The car price reported is the annualised estimated 4 year depreciation on a brand new Toyota Corolla, which uses median price by year data from http://www.cars.com/toyota/corolla/ and predicts the decline in resale value by age.

The value of housing characteristics (bathrooms, bedrooms) is informed by the meta-analysis of Sirmans et al (2006) and the 2014Q1 median US house price obtained from the Federal Reserve Economic Data (FRED). Specifically, we use the average parameter value from hedonic regressions which do not control for size, as we seek the total benefit of a bedroom or bathroom. The value of a study place we assume is one half the value of a bedroom.

Lifespan is defined by the New Zealand Inland Revenue (IR265) as the estimated useful life (years) for depreciation purposes.

To infer the price of a computer we use the average sales price of Windows computers in the United States in 2013, as reported by NPD Group on https://www.npd.com/wps/portal/npd/us/news/press-releases/windows-touch-and-chromebooks-boost-us-back-to-school-computer-sales-but-not-enough-to-stop-overall-declines-according-to-the-npd-group/ .

The annual price of a cell phone is informed by the average individual's cell phone bill of $71 monthly, as reported by J.D. Power and Associates in 2011 (see http://business.time.com/2012/10/18/47-a-month-why-youre-probably-paying-double-the-average-cell-phone-bill/).

Table 2: MWI Values and Rankings

ISO Code	Country Name	2000 MWI	2000 Rank	2012 MWI	2012 Rank
ALB	Albania	1891	38	2766	38
ARG	Argentina	2381	30	2903	36
AUS	Australia	4194	2	4864	4
AUT	Austria	3688	11	4383	11
BEL	Belgium	3283	22	4214	20
BGR	Bulgaria	2498	28	3709	27
BRA	Brazil	2081	37	2905	35
CAN	Canada	4168	3	4911	2
CHE	Switzerland	3479	17	4257	18
CHL	Chile	2230	33	3565	29
CZE	Czech Republic	2622	26	3955	25
DEU	Germany	3648	13	4300	15
DNK	Denmark	3613	14	4142	22
ESP	Spain	3369	19	4238	19
FIN	Finland	3669	12	4364	13
FRA	France	3301	21	4271	17
GBR	United Kingdom	3595	15	4380	12
GRC	Greece	3008	24	4028	23
HKG	Hong Kong-China	2324	31	2659	39
HUN	Hungary	2470	29	3605	28
IDN	Indonesia	1402	40	1741	40
IRL	Ireland	3358	20	4601	7
ISL	Iceland	3965	7	4342	14
ITA	Italy	3827	9	4475	10
JPN	Japan	3567	16	3915	26
KOR	Korea	2768	25	3468	30
LIE	Liechtenstein	3735	10	4760	5
LUX	Luxembourg	3890	8	4659	6
LVA	Latvia	2203	34	3441	31
MEX	Mexico	2231	32	2791	37
NLD	Netherlands	3269	23	4155	21
NOR	Norway	4000	5	4596	8
NZL	New Zealand	4034	4	4907	3
POL	Poland	2536	27	3993	24
PRT	Portugal	3443	18	4281	16
ROU	Romania	2096	36	3104	34
RUS	Russia	1825	39	3233	33
SWE	Sweden	3976	6	4543	9
THA	Thailand	2188	35	3318	32
USA	United States of America	4588	1	5075	1

Columns (1) and (3) present the MWI value for the relevant country-year, whilst the associated rankings are displayed in the column to the right (note, lower ranking values indicate higher levels of MWI).

Table 3: AIM(1) Values, plus AIM(1) and Gini Rankings

ISO Code	Country Name	2000 AIM	2000 AIM Rank	2000 Gini Rank	2012 AIM	2012 AIM Rank	2012 Gini Rank
ALB	Albania	0.071	28	29	0.082	36	36
ARG	Argentina	0.097	36	36	0.068	33	33
AUS	Australia	0.047	13	11	0.03	13	11
AUT	Austria	0.044	9	9	0.031	14	14
BEL	Belgium	0.046	10	12	0.03	10	10
BGR	Bulgaria	0.066	26	26	0.055	32	32
BRA	Brazil	0.114	39	39	0.09	37	37
CAN	Canada	0.05	18	16	0.034	18	19
CHE	Switzerland	0.049	15	17	0.029	7	9
CHL	Chile	0.095	34	35	0.077	35	35
CZE	Czech Republic	0.067	27	27	0.037	25	25
DEU	Germany	0.05	17	18	0.032	15	15
DNK	Denmark	0.04	6	6	0.028	4	4
ESP	Spain	0.059	25	25	0.035	22	22
FIN	Finland	0.041	7	7	0.03	11	13
FRA	France	0.049	16	14	0.033	17	17
GBR	United Kingdom	0.053	20	21	0.034	21	23
GRC	Greece	0.055	23	24	0.037	26	26
HKG	Hong Kong-China	0.047	12	10	0.036	24	24
HUN	Hungary	0.084	32	33	0.041	27	27
IDN	Indonesia	0.08	30	30	0.108	39	39
IRL	Ireland	0.054	22	23	0.028	5	7
ISL	Iceland	0.035	1	2	0.029	8	8
ITA	Italy	0.046	11	13	0.03	12	12
JPN	Japan	0.047	14	15	0.033	16	18
KOR	Korea	0.043	8	8	0.026	3	2
LIE	Liechtenstein	0.035	3	3	0.025	2	3
LUX	Luxembourg	0.052	19	19	0.035	23	20
LVA	Latvia	0.084	33	32	0.045	29	30
MEX	Mexico	0.138	40	40	0.129	40	40
NLD	Netherlands	0.036	4	4	0.021	1	1
NOR	Norway	0.035	2	1	0.029	9	5
NZL	New Zealand	0.053	21	20	0.034	20	21
POL	Poland	0.096	35	34	0.047	31	31
PRT	Portugal	0.075	29	28	0.042	28	28
ROU	Romania	0.108	38	37	0.076	34	34
RUS	Russia	0.081	31	31	0.045	30	29
SWE	Sweden	0.037	5	5	0.028	6	6
THA	Thailand	0.108	37	38	0.107	38	38
USA	United States of America	0.056	24	22	0.034	19	16

Atkinson Inequality Measures (AIM) reflect the inequality of the HMW distribution, and are computed for coefficient $\varepsilon = 1$. Columns (1) and (4) present AIM(1) for the country-year; associated rankings are displayed in columns (2) and (5). Columns (3) and (6) display the inequality ranking using the Gini coefficient. NB: lower rankings indicate lower levels of inequality.

Table 4: Mortality Variables

Short description	World Bank data code	Description
Life expectancy female	SP.DYN.LE00.FE.IN	Life expectancy at birth (female) indicates the number of years a female newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Life expectancy male	SP.DYN.LE00.MA.IN	Life expectancy at birth (male) indicates the number of years a male newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Maternal mortality ratio	SH.STA.MMRT	Maternal mortality ratio is the number of women who die from pregnancy-related causes while pregnant or within 42 days of pregnancy termination per 100,000 live births. The data are estimated with a regression model using information on the proportion of maternal deaths among non-AIDS deaths in women ages 15-49, fertility, birth attendants, and GDP.
Infant mortality rate	SP.DYN.IMRT.IN	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.

Source: World Bank Health, Nutrition and Population Statistics http://data.worldbank.org/data-catalog/health-nutrition-and-population-statistics (downloaded 1 May 2017).

Table 5: Income versus consumption based associations with mortality (2012)

Model	VARIABLES	Life expectancy Female	Life expectancy Male	Maternal mortality ratio	Infant mortality rate
M1	LGNIpc	3.438***	6.298***	-12.49	-4.129***
		(1.238)	(1.680)	(10.61)	(1.308)
	AIM	-32.85	-3.977	499.1**	95.70***
		(23.34)	(31.66)	(200.0)	(24.65)
	R-squared	0.587	0.567	0.523	0.799
M2	MWI	0.00245***	0.00427***	-0.0209***	-0.00313***
		(0.000787)	(0.00107)	(0.00607)	(0.000804)
	AIM	-32.23	-7.524	231.4	90.72***
		(21.65)	(29.49)	(167.2)	(22.14)
	R-squared	0.605	0.583	0.630	0.820
M3	LGNIpc	4.695***	5.956***	-28.47***	-7.270***
		(0.828)	(1.081)	(7.238)	(0.955)
	YGINI	-0.0277	-0.0813	0.915	0.163**
		(0.0638)	(0.0833)	(0.558)	(0.0736)
	R-squared	0.566	0.578	0.478	0.748
M4	MWI	0.00323***	0.00411***	-0.0248***	-0.00505***
		(0.000544)	(0.000709)	(0.00406)	(0.000603)
	YGINI	-0.0387	-0.0947	0.715	0.178**
		(0.0612)	(0.0798)	(0.458)	(0.0679)
	R-squared	0.585	0.598	0.635	0.777
	Davidson-MacKinnon J-tests (preferred model)				
	M1 v M2	-	M2	M2	M2
	M1 v M3	M1	-	-	M1
	M1 v M4	-	M4	M4	both
	M2 v M3	M2	M3	M2	M2
	M2 v M4	-	-	-	M2
	M3 v M4	M4	-	M4	both

N=38 for all regressions. Constant included in all regressions but not reported.

Standard errors in parentheses; significant at: *** p<0.01, ** p<0.05, * p<0.1.

J-tests: An alternative hypothesis that rejects the null at p<0.05 (and that is not itself rejected) is listed; '-' indicates neither rejects the other; 'both' indicates that each rejects the other.

Table 6: Income versus consumption based associations with mortality (2000 and Delta)

Model	Variables	Life expectancy Female	Life expectancy Male	Maternal mortality ratio	Infant mortality rate
			2000		
M1	LGNIpc	3.549***	3.967***	-42.13***	-9.460***
		(0.750)	(1.017)	(13.18)	(1.646)
	AIM	-23.62	-42.17	-21.40	65.59
		(19.13)	(25.95)	(336.3)	(42.00)
	R-squared	0.664	0.623	0.377	0.747
M2	MWI	0.00302***	0.00401***	-0.0354***	-0.00683***
		(0.000631)	(0.000775)	(0.0112)	(0.00156)
	AIM	-17.52	-20.30	-82.67	78.78
		(19.89)	(24.45)	(352.1)	(49.20)
	R-squared	0.667	0.693	0.375	0.682
			Delta (2012-2000)		
M1	LGNIpc	1.085*	0.180	-42.08***	-13.40***
		(0.565)	(0.710)	(12.88)	(2.472)
	AIM	-14.00*	-20.63*	-701.8***	-54.23
		(8.115)	(10.18)	(184.9)	(35.48)
	R-squared	0.161	0.107	0.415	0.474
M2	MWI	0.00105**	0.00114**	-0.0100	-0.00463*
		(0.000438)	(0.000531)	(0.0116)	(0.00255)
	AIM	-1.447	-6.864	-817.1***	-108.2*
		(9.503)	(11.52)	(251.3)	(55.31)
	R-squared	0.204	0.210	0.253	0.116
			Davidson-MacKinnon J-tests (preferred model)		
2000	M1 v M2	-	M2	-	M1
Delta	M1 v M2	M2	M2	M1	M1

N=38 for all regressions. Constant included in all regressions but not reported.

Standard errors in parentheses; significant at: *** p<0.01, ** p<0.05, * p<0.1.

J-tests: An alternative hypothesis that rejects the null at p<0.05 (and that is not itself rejected) is listed; '-' indicates neither rejects the other; 'both' indicates that each rejects the other.

Figure 1: MWI Levels by Country, 2012

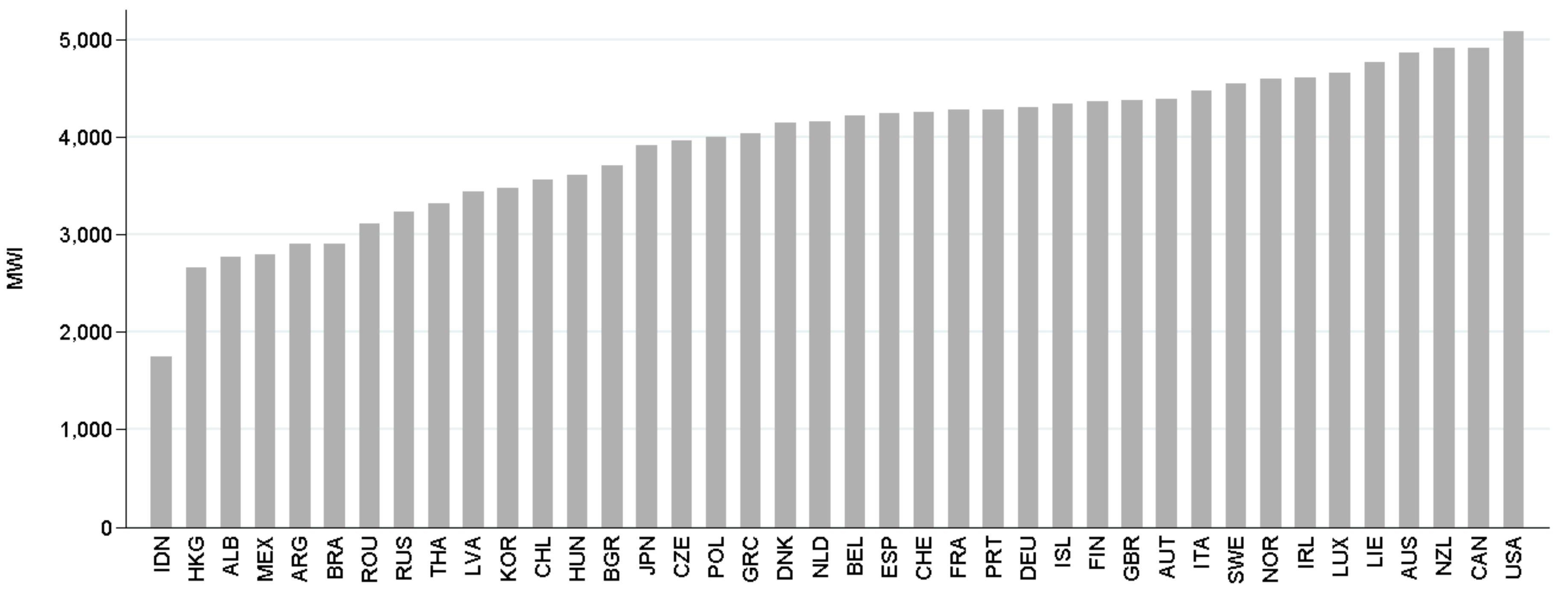


Figure 2: AIM(1) Levels by Country, 2012

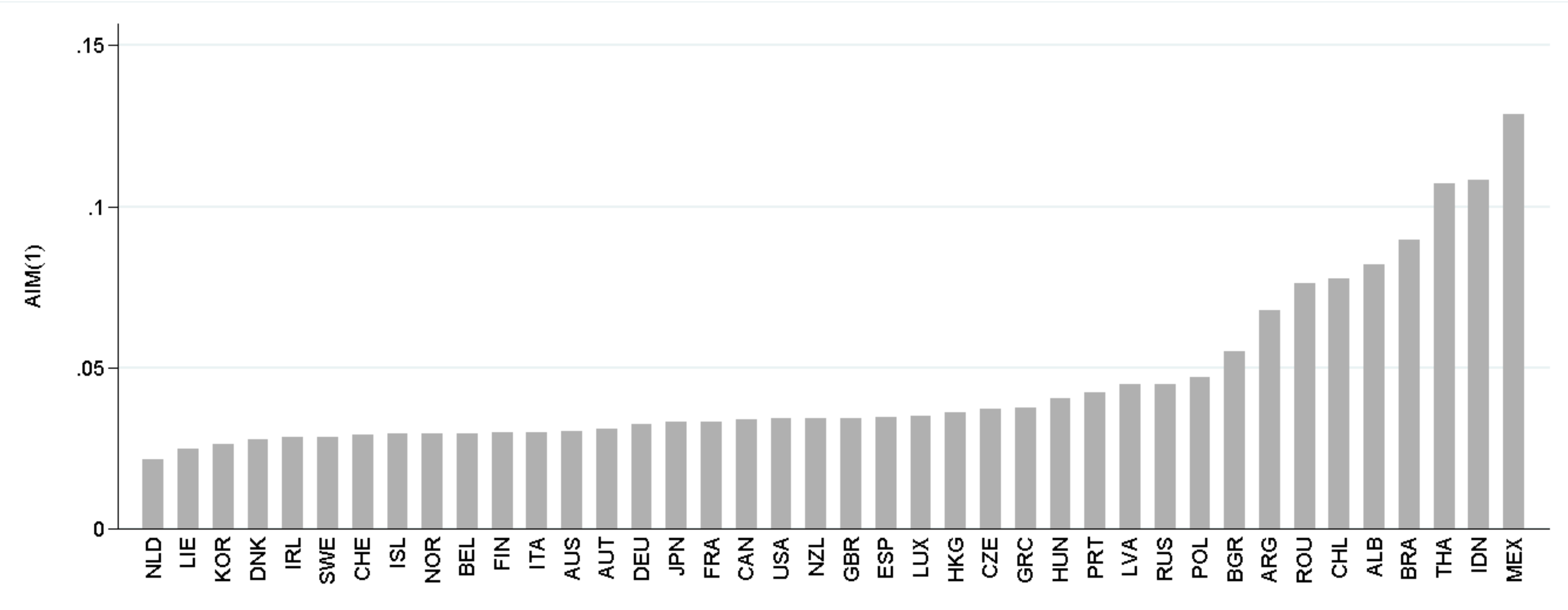
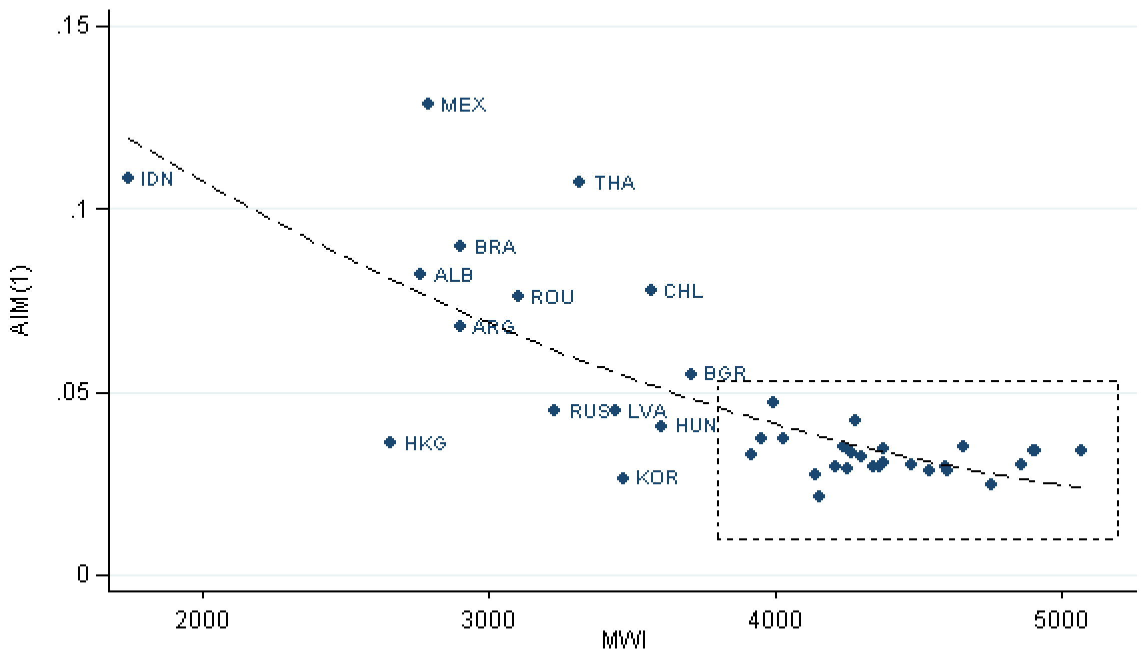
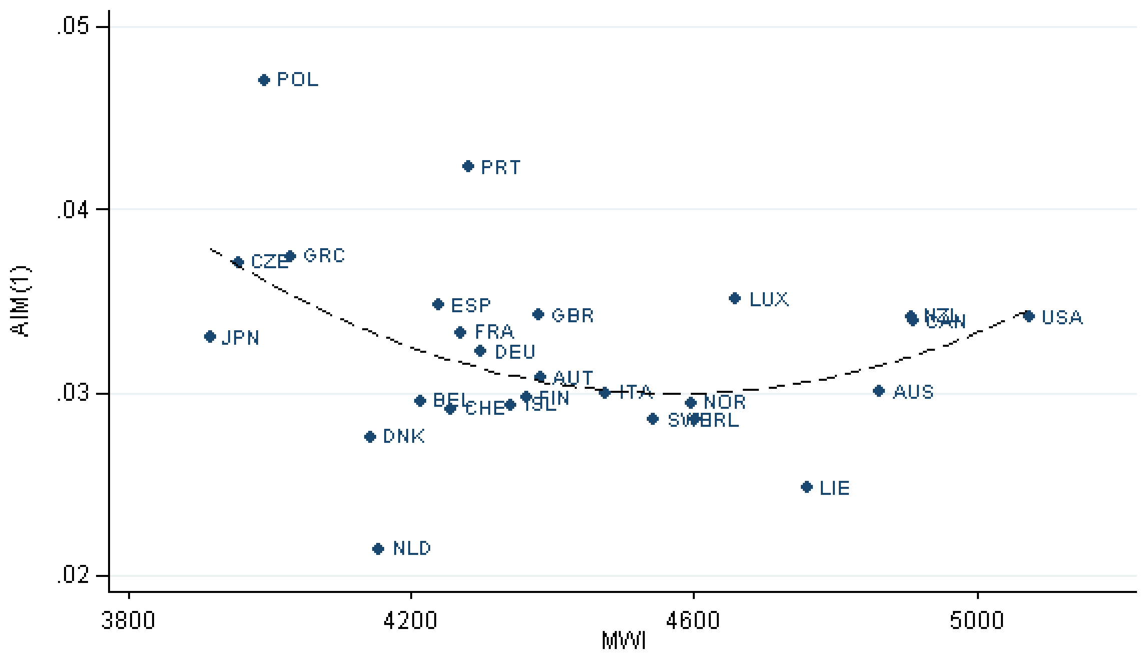


Figure 3: MWI v AIM(1), 2012

(a)



(b)



Panel (a) features all 2012 cross-country observations, overlaid with a quadratic line of best fit. This is repeated in panel (b) for the subset of countries for which MWI in 2012 exceeded 3800.

Appendix Table A1: PISA Responding Student Counts, By Country and Year

ISO Code	Country Name	Number of Student Respondents 2000	2009	2012
ALB	Albania	2783	4596	4743
ARG	Argentina	2230	4774	5908
AUS	Australia	2859	14251	14481
AUT	Austria	2640	6590	4755
BEL	Belgium	3784	8501	8597
BGR	Bulgaria	2615	4507	5282
BRA	Brazil	2717	20127	19204
CAN	Canada	16489	23207	21544
CHE	Switzerland	3396	11812	11229
CHL	Chile	2721	5669	6856
CZE	Czech Republic	3066	6064	5327
DEU	Germany	2830	4979	5001
DNK	Denmark	2382	5924	7481
ESP	Spain	3428	25887	25313
FIN	Finland	2703	5810	8829
FRA	France	2597	4298	4613
GBR	United Kingdom	5195	12179	12659
GRC	Greece	2605	4969	5125
HKG	Hong Kong-China	2438	4837	4670
HUN	Hungary	2799	4605	4810
IDN	Indonesia	4089	5136	5622
IRL	Ireland	2128	3937	5016
ISL	Iceland	1882	3646	3508
ITA	Italy	2765	30905	31073
JPN	Japan	2924	6088	6351
KOR	Korea	2769	4989	5033
LIE	Liechtenstein	175	329	293
LUX	Luxembourg	1959	4622	5258
LVA	Latvia	2149	4502	4306
MEX	Mexico	2567	38250	33806
NLD	Netherlands	1382	4760	4460
NOR	Norway	2307	4660	4686
NZL	New Zealand	2048	4643	4291
POL	Poland	1976	4917	4607
PRT	Portugal	2545	6298	5722
ROU	Romania	2682	4776	5074
RUS	Russia	3719	5308	5231
SWE	Sweden	2464	4567	4736
THA	Thailand	2959	6225	6606
USA	United States of America	2135	5233	4978

This table lists the number of student respondents, by year, for the 40 countries which comprise our sample – defined as the countries which were asked all possession questions in years 2000, 2009 and 2012. ISO Code details the 3 letter country codes used to identify economies in both PISA and our analysis.

Appendix Table A2: PISA Possession Data Summary Statistics

	Question Type	Percentage of Responses Missing (%)	Mean Possessions per Student	Across-Country Variation in Means	Mean of Within-Country Variation
Artwork	Binary	3.199	0.585	0.139	0.472
Classic Lit	Binary	3.423	0.537	0.166	0.469
Desk	Binary	2.271	0.895	0.100	0.268
Dictionary	Binary	2.083	0.944	0.055	0.206
Dishwasher	Binary	2.946	0.530	0.279	0.405
Educ. Software	Binary	3.912	0.518	0.169	0.469
Internet	Binary	2.438	0.709	0.290	0.321
Own Room	Binary	2.035	0.798	0.132	0.365
Poetry	Binary	3.123	0.559	0.155	0.470
Study Place	Binary	2.422	0.880	0.075	0.307
Textbooks	Binary	2.513	0.860	0.084	0.327
Bathrooms	Multiple	2.101	1.373	0.375	0.683
Cars	Multiple	2.564	1.306	0.549	0.792
Computers	Multiple	2.442	1.471	0.672	0.772
(Cell) Phones	Multiple	1.724	2.441	0.665	0.633
TVs	Multiple	1.704	2.137	0.370	0.725

Column 1 details whether the corresponding possession was asked as a binary or multiple response question in the PISA survey. Column 2 presents the percentage of responses with a missing value for a given possession. Column 3 presents the average self-reported number of possessions within a household, across all countries and time periods. Column 4 presents the standard deviation of country-year specific possession quantity means, i.e. the across-country standard deviation in means, whilst column 5 details the mean of country-year specific possession quantity standard deviations, i.e. the mean of within-country standard deviations.

Appendix Table A3: MWI Values and Rankings, by Year and Levels/Changes

	2000 Levels		2009 Levels		2012 Levels		00-09 Annual %Δ		09-12 Annual %Δ		00-12 Annual %Δ	
	MWI	Rank	MWI	Rank	MWI	Rank	MWI	Rank	MWI	Rank	MWI	Rank
ALB	1891	38	2600	37	2766	38	4.65	5	2.08	8	3.87	6
ARG	2381	30	2791	35	2903	36	2.29	21	1.33	13	2	19
AUS	4194	2	4827	4	4864	4	1.57	34	0.25	28	1.24	34
AUT	3688	11	4335	14	4383	11	1.81	29	0.36	23	1.45	29
BEL	3283	22	4161	19	4214	20	2.67	15	0.42	21	2.1	16
BGR	2498	28	3583	27	3709	27	5.28	2	1.16	14	4.03	4
BRA	2081	37	2570	38	2905	35	2.37	20	4.17	4	2.82	11
CAN	4168	3	4864	3	4911	2	1.73	30	0.32	25	1.38	31
CHE	3479	17	4164	18	4257	18	2.02	25	0.74	18	1.7	24
CHL	2230	33	3014	31	3565	29	4.39	6	5.76	2	4.8	2
CZE	2622	26	3800	25	3955	25	4.21	9	1.34	12	3.49	9
DEU	3648	13	4172	17	4300	15	1.5	35	1.01	15	1.38	30
DNK	3613	14	4095	20	4142	22	1.4	37	0.38	22	1.15	36
ESP	3369	19	4049	23	4238	19	2.06	24	1.53	10	1.93	20
FIN	3669	12	4450	11	4364	13	2.17	22	-0.65	37	1.46	28
FRA	3301	21	4186	16	4271	17	2.67	14	0.67	19	2.17	15
GBR	3595	15	4269	15	4380	12	1.93	28	0.85	16	1.66	25
GRC	3008	24	4074	21	4028	23	3.43	12	-0.38	36	2.46	13
HKG	2324	31	2234	39	2659	39	-0.56	40	5.98	1	1.36	32
HUN	2470	29	3577	28	3605	28	4.2	10	0.25	27	3.2	10
IDN	1402	40	1606	40	1741	40	1.95	27	2.73	6	2.19	14
IRL	3358	20	4638	6	4601	7	3.66	11	-0.27	35	2.66	12
ISL	3965	7	4574	8	4342	14	1.6	32	-1.72	40	0.76	40
ITA	3827	9	4448	12	4475	10	1.69	31	0.2	29	1.31	33
JPN	3567	16	3892	24	3915	26	0.97	39	0.19	30	0.78	39
KOR	2768	25	3420	29	3468	30	2.38	19	0.46	20	1.9	21
LIE	3735	10	4526	10	4760	5	2.16	23	1.69	9	2.04	17
LUX	3890	8	4650	5	4659	6	2	26	0.07	31	1.52	27
LVA	2203	34	3406	30	3441	31	4.96	4	0.34	24	3.79	8
MEX	2231	32	2769	36	2791	37	2.43	17	0.26	26	1.88	22
NLD	3269	23	4057	22	4155	21	2.43	18	0.8	17	2.02	18
NOR	4000	5	4613	7	4596	8	1.6	33	-0.13	34	1.16	35
NZL	4034	4	5014	2	4907	3	2.44	16	-0.72	38	1.64	26
POL	2536	27	3711	26	3993	24	4.32	7	2.46	7	3.86	7
PRT	3443	18	4391	13	4281	16	2.74	13	-0.84	39	1.83	23
ROU	2096	36	2976	32	3104	34	5.14	3	1.42	11	4.01	5
RUS	1825	39	2971	33	3233	33	5.57	1	2.85	5	4.88	1
SWE	3976	6	4537	9	4543	9	1.48	36	0.04	32	1.12	37
THA	2188	35	2927	34	3318	32	4.24	8	4.26	3	4.25	3
USA	4588	1	5092	1	5075	1	1.16	38	-0.11	33	0.84	38

Columns (1), (3) and (5) present the MWI value for the relevant country-year, whilst the associated rankings are displayed in the column to the right (note, lower ranking values indicate higher levels of MWI). Columns (7), (9) and (11) display annualised MWI percentage growth rates for each country-period, with the associated rankings displayed in the column to the right (note, lower rankings indicate higher MWI growth rates).

Appendix Table A4a: AIM(1) Values and Rankings, by Year and Levels/Changes

	2000 Levels		2009 Levels		2012 Levels		00-09 Annual %Δ		09-12 Annual %Δ		00-12 Annual %Δ	
	AIM(1)	Rank	AIM(1)	Rank	AIM(1)	Rank	AIM(1)	Rank	AIM(1)	Rank	AIM(1)	Rank
ALB	0.071	28	0.085	36	0.082	36	0.002	38	-0.001	17	0.001	39
ARG	0.097	36	0.083	35	0.068	33	-0.002	13	-0.005	3	-0.003	6
AUS	0.047	13	0.031	12	0.03	13	-0.002	16	0	26	-0.001	19
AUT	0.044	9	0.033	16	0.031	14	-0.001	29	-0.001	19	-0.001	29
BEL	0.046	10	0.032	14	0.03	10	-0.002	22	-0.001	20	-0.001	22
BGR	0.066	26	0.06	32	0.055	32	-0.001	32	-0.002	10	-0.001	28
BRA	0.114	39	0.11	37	0.09	37	0	35	-0.007	2	-0.002	11
CAN	0.05	18	0.036	20	0.034	18	-0.001	23	-0.001	18	-0.001	23
CHE	0.049	15	0.03	9	0.029	7	-0.002	12	0	25	-0.002	14
CHL	0.095	34	0.071	33	0.077	35	-0.004	6	0.002	40	-0.002	13
CZE	0.067	27	0.037	21	0.037	25	-0.003	7	0	34	-0.002	8
DEU	0.05	17	0.038	22	0.032	15	-0.001	26	-0.002	9	-0.001	18
DNK	0.04	6	0.029	6	0.028	4	-0.001	28	0	29	-0.001	31
ESP	0.059	25	0.046	28	0.035	22	-0.001	24	-0.004	7	-0.002	10
FIN	0.041	7	0.027	4	0.03	11	-0.002	20	0.001	37	-0.001	32
FRA	0.049	16	0.035	17	0.033	17	-0.002	21	-0.001	21	-0.001	25
GBR	0.053	20	0.036	19	0.034	21	-0.002	15	-0.001	22	-0.002	16
GRC	0.055	23	0.042	26	0.037	26	-0.001	25	-0.002	11	-0.001	17
HKG	0.047	12	0.045	27	0.036	24	0	36	-0.003	8	-0.001	30
HUN	0.084	32	0.042	25	0.041	27	-0.005	2	0	30	-0.004	2
IDN	0.08	30	0.121	38	0.108	39	0.006	40	-0.004	6	0.003	40
IRL	0.054	22	0.032	13	0.028	5	-0.003	9	-0.001	14	-0.002	9
ISL	0.035	1	0.025	2	0.029	8	-0.001	30	0.002	39	0	37
ITA	0.046	11	0.031	10	0.03	12	-0.002	18	0	31	-0.001	24
JPN	0.047	14	0.036	18	0.033	16	-0.001	27	-0.001	15	-0.001	26
KOR	0.043	8	0.027	5	0.026	3	-0.002	17	0	27	-0.001	20
LIE	0.035	3	0.026	3	0.025	2	-0.001	31	-0.001	23	-0.001	33
LUX	0.052	19	0.031	11	0.035	23	-0.002	10	0.001	38	-0.001	21
LVA	0.084	33	0.048	29	0.045	29	-0.004	4	-0.001	16	-0.003	3
MEX	0.138	40	0.142	40	0.129	40	0	37	-0.004	4	-0.001	34
NLD	0.036	4	0.022	1	0.021	1	-0.002	19	0	33	-0.001	27
NOR	0.035	2	0.03	7	0.029	9	-0.001	34	0	32	0	36
NZL	0.053	21	0.033	15	0.034	20	-0.002	11	0	36	-0.002	15
POL	0.096	35	0.052	30	0.047	31	-0.005	1	-0.002	12	-0.004	1
PRT	0.075	29	0.042	24	0.042	28	-0.004	5	0	35	-0.003	7
ROU	0.108	38	0.077	34	0.076	34	-0.004	3	0	28	-0.003	4
RUS	0.081	31	0.057	31	0.045	30	-0.003	8	-0.004	5	-0.003	5
SWE	0.037	5	0.03	8	0.028	6	-0.001	33	-0.001	24	-0.001	35
THA	0.108	37	0.132	39	0.107	38	0.003	39	-0.008	1	0	38
USA	0.056	24	0.038	23	0.034	19	-0.002	14	-0.001	13	-0.002	12

Atkinson Inequality Measures (AIM) reflect the inequality of the HMW distribution, and are computed for coefficient $\varepsilon = 1$. Columns (1), (3) and (5) present the AIM(1) for the relevant country-year. The associated rankings are displayed in the column to the right where lower ranking value indicates lower levels of AIM(1) inequality. Columns (7), (9) and (11) display the annualised change in AIM(1) for each country-year, with the columns to the right listing the associated rankings.

Appendix Table A4b: AIM(2) Values and Rankings, by Year and Levels/Changes

	2000 Levels		2009 Levels		2012 Levels		00-09 Annual %Δ		09-12 Annual %Δ		00-12 Annual %Δ	
	AIM(2)	Rank	AIM(2)	Rank	AIM(2)	Rank	AIM(2)	Rank	AIM(2)	Rank	AIM(2)	Rank
ALB	0.129	27	0.161	36	0.158	36	0.005	38	-0.001	28	0.003	39
ARG	0.18	35	0.16	35	0.134	33	-0.003	23	-0.009	4	-0.005	8
AUS	0.101	15	0.067	14	0.064	14	-0.004	16	-0.001	27	-0.003	17
AUT	0.088	8	0.068	16	0.062	11	-0.002	29	-0.002	15	-0.002	29
BEL	0.089	10	0.066	13	0.06	9	-0.003	26	-0.002	17	-0.002	23
BGR	0.129	26	0.125	32	0.115	32	-0.001	35	-0.003	10	-0.001	34
BRA	0.205	38	0.21	38	0.175	37	0.001	36	-0.012	2	-0.002	24
CAN	0.105	17	0.077	21	0.072	23	-0.003	20	-0.002	22	-0.003	21
CHE	0.098	13	0.062	7	0.059	6	-0.004	13	-0.001	26	-0.003	13
CHL	0.174	34	0.134	33	0.154	35	-0.006	7	0.006	40	-0.002	30
CZE	0.131	28	0.075	20	0.075	24	-0.006	6	0	32	-0.005	7
DEU	0.105	16	0.079	22	0.066	15	-0.003	22	-0.004	9	-0.003	15
DNK	0.081	6	0.059	6	0.054	4	-0.002	27	-0.002	21	-0.002	27
ESP	0.116	24	0.096	28	0.07	21	-0.002	30	-0.009	5	-0.004	11
FIN	0.081	7	0.052	4	0.059	8	-0.003	19	0.002	37	-0.002	32
FRA	0.107	19	0.073	17	0.067	18	-0.004	14	-0.002	19	-0.003	12
GBR	0.105	18	0.073	18	0.069	19	-0.004	17	-0.002	23	-0.003	16
GRC	0.109	21	0.084	25	0.075	26	-0.003	25	-0.003	13	-0.003	20
HKG	0.089	9	0.083	24	0.067	16	-0.001	34	-0.005	7	-0.002	28
HUN	0.162	32	0.085	27	0.081	27	-0.009	2	-0.001	25	-0.007	2
IDN	0.151	29	0.208	37	0.194	38	0.008	39	-0.005	8	0.004	40
IRL	0.11	23	0.065	12	0.058	5	-0.005	8	-0.002	18	-0.004	9
ISL	0.071	1	0.05	2	0.06	10	-0.002	28	0.004	38	-0.001	35
ITA	0.092	12	0.064	11	0.064	12	-0.003	21	0	31	-0.002	26
JPN	0.098	14	0.073	19	0.067	17	-0.003	24	-0.002	16	-0.003	22
KOR	0.09	11	0.056	5	0.053	3	-0.004	15	-0.001	29	-0.003	18
LIE	0.071	2	0.052	3	0.048	2	-0.002	31	-0.001	24	-0.002	31
LUX	0.108	20	0.064	9	0.075	25	-0.005	9	0.004	39	-0.003	19
LVA	0.165	33	0.096	29	0.089	29	-0.008	4	-0.002	14	-0.006	3
MEX	0.244	40	0.276	40	0.253	40	0.004	37	-0.008	6	0.001	37
NLD	0.071	3	0.042	1	0.043	1	-0.003	18	0	33	-0.002	25
NOR	0.073	4	0.062	8	0.064	13	-0.001	33	0.001	34	-0.001	36
NZL	0.109	22	0.068	15	0.07	20	-0.005	11	0.001	36	-0.003	14
POL	0.187	36	0.104	30	0.094	31	-0.009	1	-0.003	11	-0.008	1
PRT	0.151	30	0.084	26	0.086	28	-0.007	5	0.001	35	-0.005	6
ROU	0.21	39	0.156	34	0.153	34	-0.008	3	-0.001	30	-0.006	5
RUS	0.158	31	0.116	31	0.089	30	-0.005	10	-0.009	3	-0.006	4
SWE	0.077	5	0.064	10	0.059	7	-0.001	32	-0.002	20	-0.002	33
THA	0.192	37	0.255	39	0.214	39	0.009	40	-0.014	1	0.002	38
USA	0.12	25	0.081	23	0.072	22	-0.004	12	-0.003	12	-0.004	10

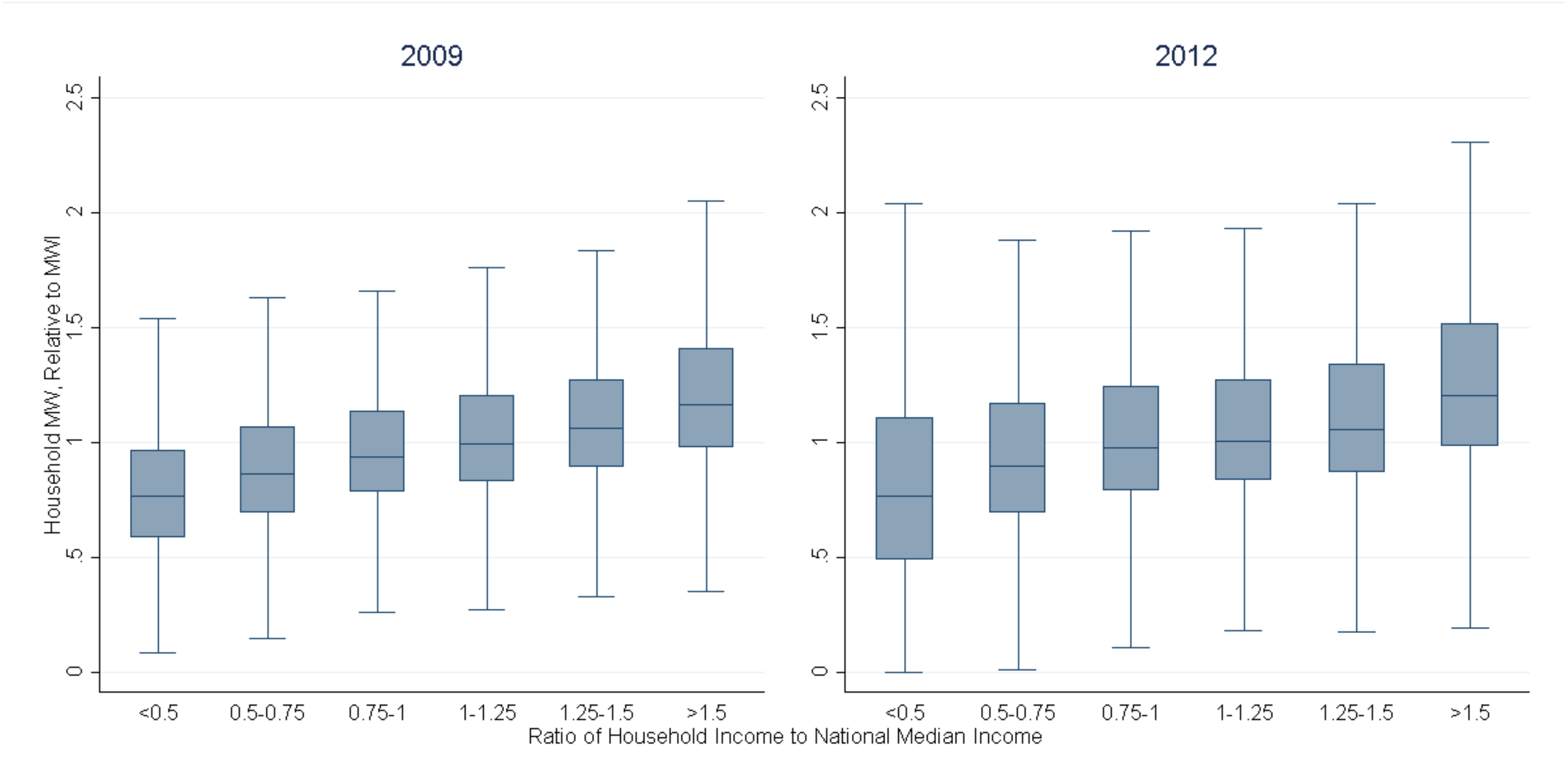
Atkinson Inequality Measures (AIM) reflect the inequality of the HMW distribution, and are computed for coefficient $\varepsilon = 2$. Columns (1), (3) and (5) present the AIM(2) for the relevant country-year. The associated rankings are displayed in the column to the right where lower ranking value indicates lower levels of AIM(2) inequality. Columns (7), (9) and (11) display the annualised change in AIM(2) for each country-year, with the columns to the right listing the associated rankings.

Appendix Table A4c: AIM(3) Values and Rankings, by Year and Levels/Changes

	2000 Levels		2009 Levels		2012 Levels		00-09 Annual %Δ		09-12 Annual %Δ		00-12 Annual %Δ	
	AIM(3)	Rank	AIM(3)	Rank	AIM(3)	Rank	AIM(3)	Rank	AIM(3)	Rank	AIM(3)	Rank
ALB	0.176	23	0.231	34	0.229	35	0.008	38	0	30	0.005	39
ARG	0.248	35	0.231	35	0.204	33	-0.002	29	-0.009	6	-0.004	18
AUS	0.165	17	0.131	26	0.112	19	-0.004	22	-0.006	10	-0.004	17
AUT	0.134	9	0.112	13	0.094	9	-0.002	28	-0.006	12	-0.003	24
BEL	0.132	8	0.13	24	0.094	8	0	34	-0.012	5	-0.003	27
BGR	0.19	24	0.204	33	0.196	32	0.002	35	-0.003	21	0.001	36
BRA	0.276	37	0.3	38	0.26	37	0.003	36	-0.013	3	-0.001	31
CAN	0.173	21	0.127	21	0.134	27	-0.005	19	0.002	33	-0.003	26
CHE	0.148	13	0.097	6	0.09	6	-0.006	16	-0.002	24	-0.005	14
CHL	0.24	33	0.19	32	0.228	34	-0.007	11	0.013	40	-0.001	33
CZE	0.193	26	0.126	19	0.121	23	-0.007	10	-0.002	28	-0.006	11
DEU	0.207	27	0.126	20	0.107	16	-0.009	7	-0.006	9	-0.008	5
DNK	0.124	7	0.099	7	0.08	3	-0.003	27	-0.006	11	-0.004	22
ESP	0.171	20	0.158	30	0.11	18	-0.001	31	-0.016	1	-0.005	12
FIN	0.122	5	0.077	3	0.089	5	-0.005	20	0.004	37	-0.003	29
FRA	0.216	28	0.115	16	0.103	13	-0.011	3	-0.004	18	-0.009	2
GBR	0.159	15	0.111	12	0.103	15	-0.005	17	-0.003	23	-0.005	16
GRC	0.163	16	0.129	22	0.117	22	-0.004	23	-0.004	19	-0.004	21
HKG	0.135	10	0.119	18	0.095	10	-0.002	30	-0.008	8	-0.004	20
HUN	0.233	32	0.132	27	0.124	25	-0.011	2	-0.003	22	-0.009	3
IDN	0.226	29	0.278	37	0.274	38	0.007	37	-0.001	29	0.005	38
IRL	0.167	18	0.1	8	0.09	7	-0.007	9	-0.003	20	-0.006	9
ISL	0.11	3	0.08	4	0.097	11	-0.003	25	0.006	38	-0.001	34
ITA	0.138	11	0.112	15	0.122	24	-0.003	26	0.003	36	-0.001	32
JPN	0.154	14	0.116	17	0.103	14	-0.004	21	-0.004	17	-0.004	19
KOR	0.139	12	0.087	5	0.082	4	-0.006	15	-0.002	26	-0.005	15
LIE	0.109	2	0.077	2	0.071	2	-0.004	24	-0.002	25	-0.003	28
LUX	0.174	22	0.101	9	0.132	26	-0.008	8	0.01	39	-0.003	23
LVA	0.241	34	0.151	28	0.136	29	-0.01	5	-0.005	14	-0.009	4
MEX	0.323	40	0.394	40	0.368	40	0.008	39	-0.009	7	0.004	37
NLD	0.109	1	0.062	1	0.069	1	-0.005	18	0.002	34	-0.003	25
NOR	0.117	4	0.105	10	0.115	21	-0.001	32	0.003	35	0	35
NZL	0.169	19	0.107	11	0.109	17	-0.007	12	0.001	31	-0.005	13
POL	0.277	38	0.158	29	0.144	31	-0.013	1	-0.005	16	-0.011	1
PRT	0.227	30	0.129	23	0.135	28	-0.011	4	0.002	32	-0.008	7
ROU	0.305	39	0.238	36	0.233	36	-0.01	6	-0.002	27	-0.007	8
RUS	0.231	31	0.178	31	0.137	30	-0.006	14	-0.013	4	-0.008	6
SWE	0.123	6	0.112	14	0.097	12	-0.001	33	-0.005	15	-0.002	30
THA	0.257	36	0.36	39	0.316	39	0.015	40	-0.015	2	0.006	40
USA	0.19	25	0.13	25	0.114	20	-0.007	13	-0.005	13	-0.006	10

Atkinson Inequality Measures (AIM) reflect the inequality of the HMW distribution, and are computed for coefficient $\varepsilon = 3$. Columns (1), (3) and (5) present the AIM(3) for the relevant country-year. The associated rankings are displayed in the column to the right where lower ranking value indicates lower levels of AIM(3) inequality. Columns (7), (9) and (11) display the annualised change in AIM(3) for each country-year, with the columns to the right listing the associated rankings.

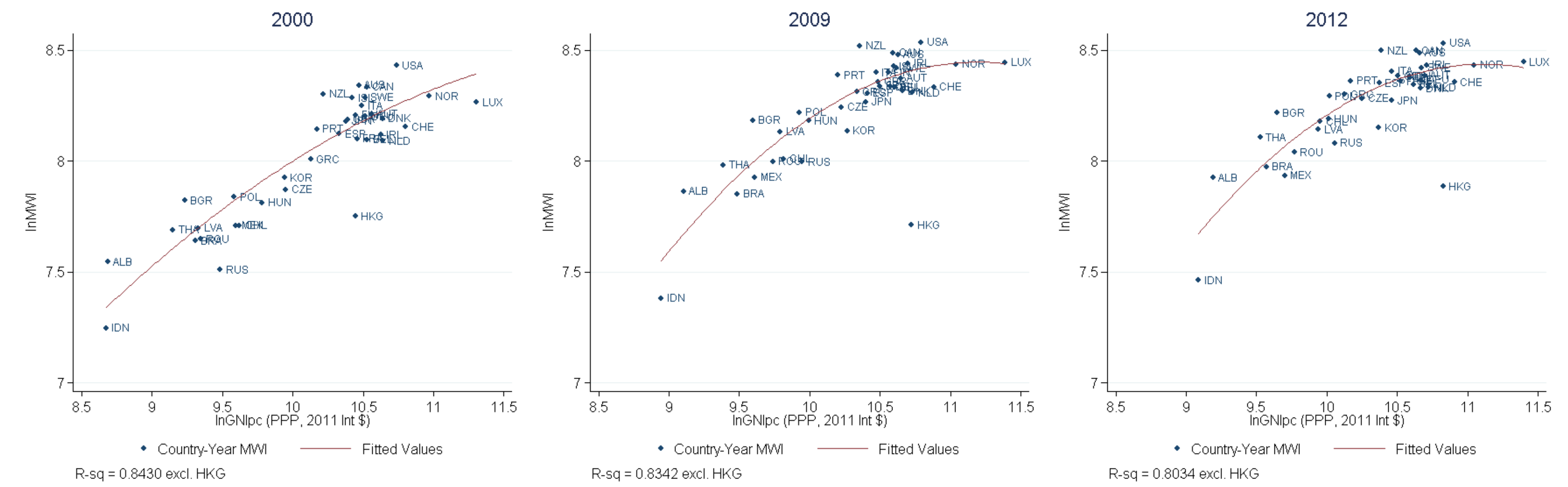
Appendix Figure A1: Household-level Material Wellbeing (MW) and Income, by Year



Box and whiskers are drawn as follows: the top and bottom of each solid box depicts the upper and lower quartiles of the relevant distribution, respectively; the band inside each box illustrates the median; whilst the whiskers represent the range between the upper (lower) quartile and the upper (lower) adjacent values, where adjacent values are defined as the highest (lowest) value not greater (less) than the upper (lower) quartile by 150% of the inter quartile range. Outside values, which are values that extend beyond the adjacent values, are not displayed.

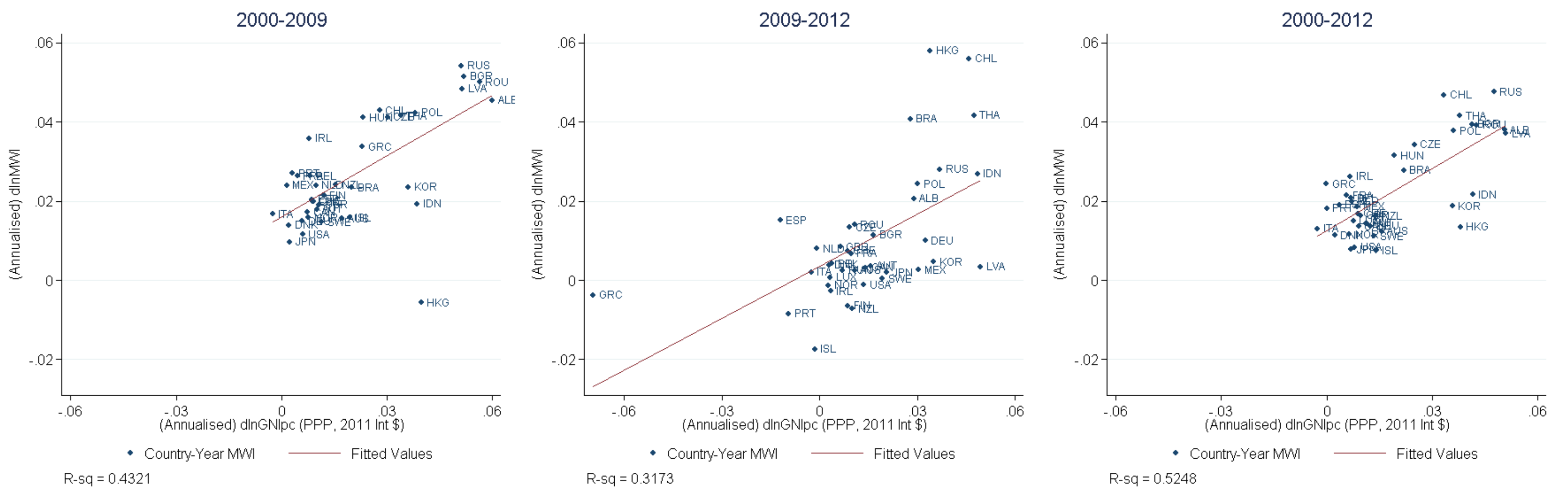
Countries which administered the parental survey in 2009: CHL, DEU, DNK, HKG, HRV, HUN, ITA, KOR, LTU, MAC, NZL, PAN, POL, PRT, QAT. Countries which administered the parental survey in 2012: BEL, CHL, DEU, HKG, HRV, HUN, ITA, KOR, MAC, MEX, PRT.

Appendix Figure A2: Comparison of MWI and GNI per capita, by Year



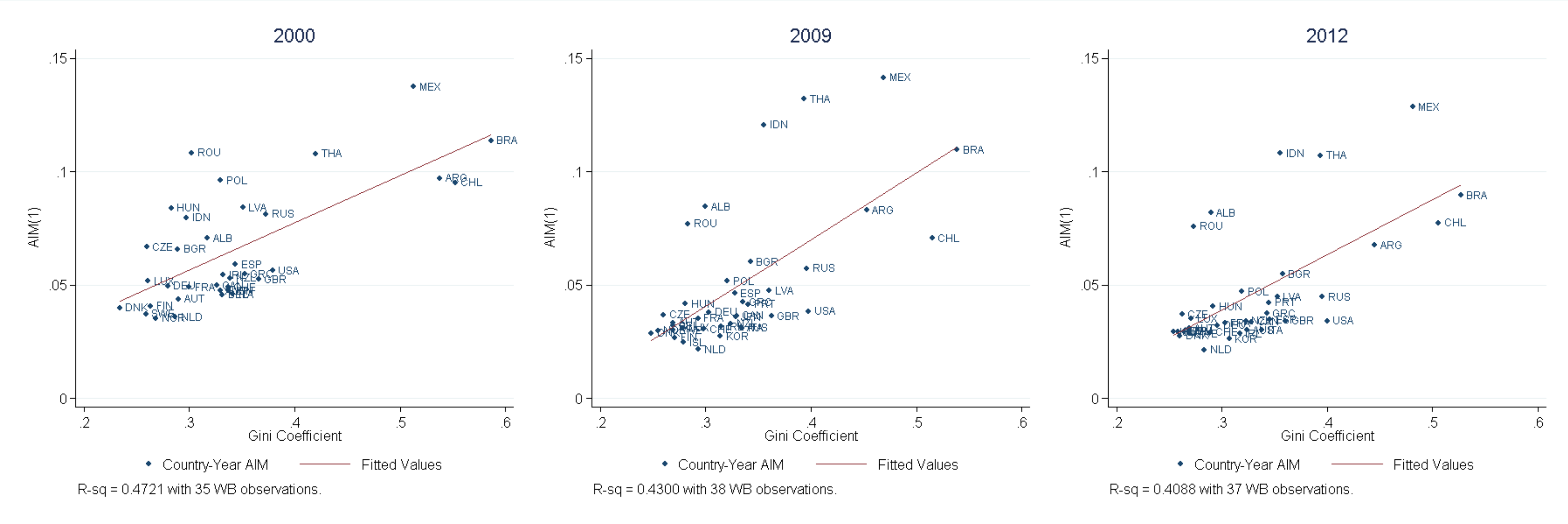
R-sq denotes the R-squared coefficient from a quadratic regression of lnMWI on lnGNIpc, from which the fitted values are obtained, where GNIpc is PPP-adjusted and expressed in 2011 International dollars. Note, whilst Hong Kong appears in the figure it is excluded from each regression as it is a strong outlier in the relationship between lnMWI and lnGNIpc.

Appendix Figure A3: Comparison of MWI and GNI per capita Growth Rates, by Period



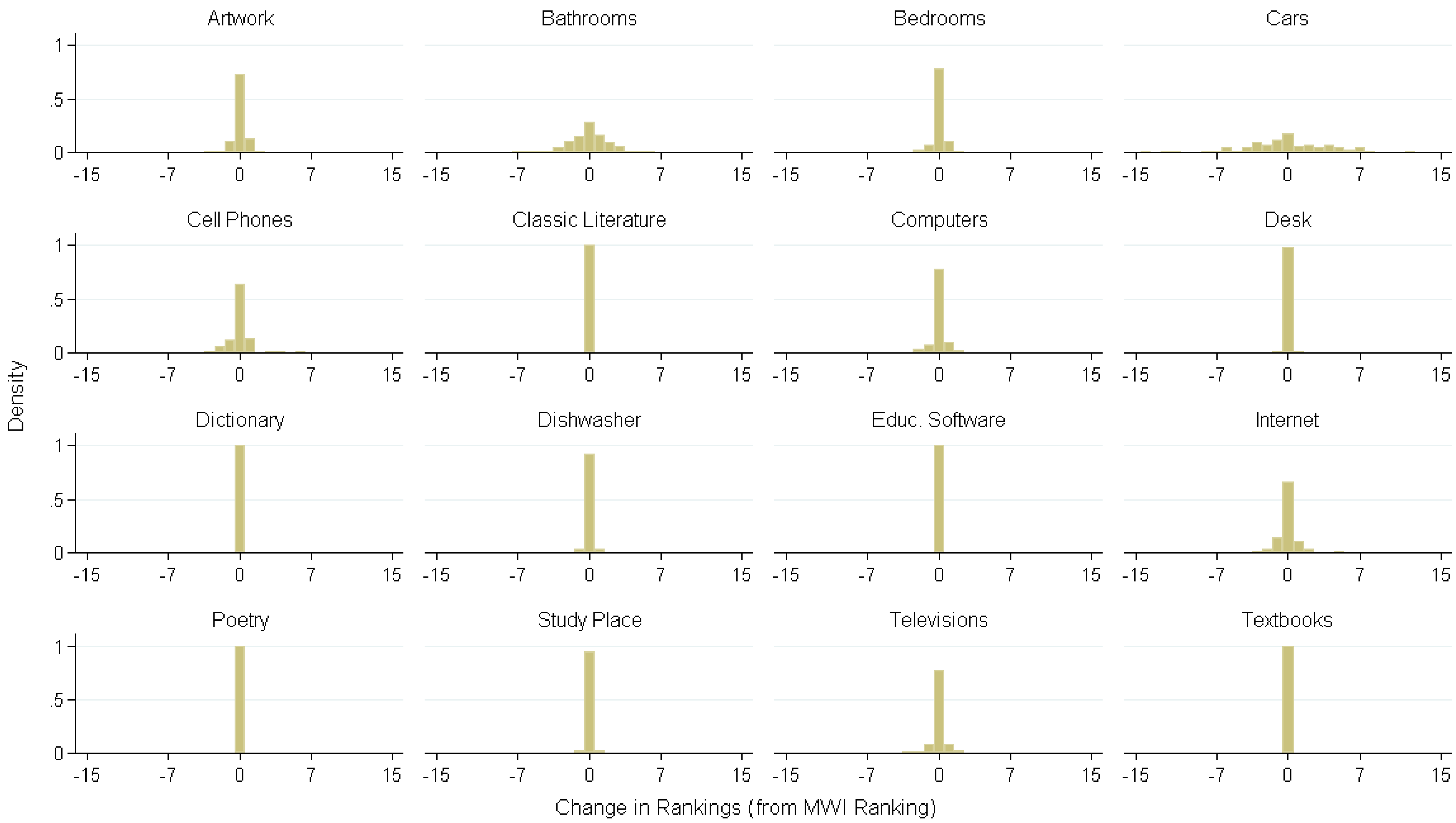
R-sq denotes the R-squared coefficient from a simple regression of dlnMWI on dlnGNIpc, that is, a regression of the change in lnMWI on the change in lnGNIpc over the regression period, from which the fitted values are obtained, where GNIpc is PPP-adjusted and expressed in 2011 International dollars. Note, whilst Hong Kong appears in the figure it is excluded from each regression as it is a strong outlier in the relationship between lnMWI and lnGNIpc.

Appendix Figure A4: Comparison of AIM(1) and the Gini Coefficient, by Year



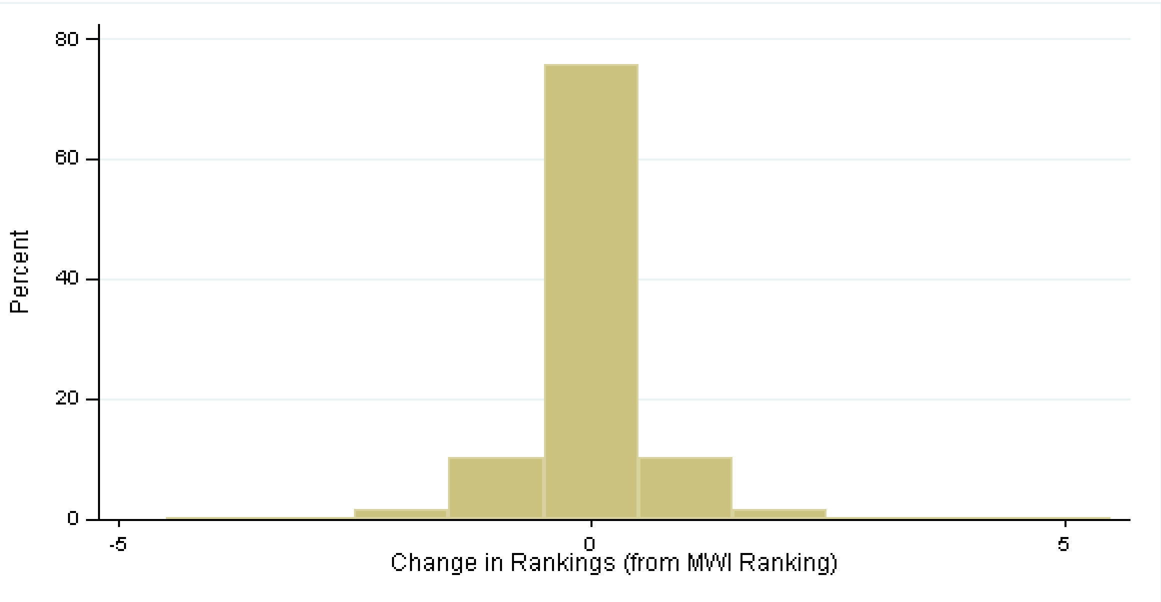
R-sq denotes the R-squared coefficient from a simple regression of AIM(1) on the Gini coefficient of household incomes that was obtained from a combination of World Bank and OECD data, from which the fitted values are obtained.

Appendix Figure A5: Distribution of MWI and Excluded Possessions Pseudo-MWI Ranking Deviations, Pooled over Years, by Possession



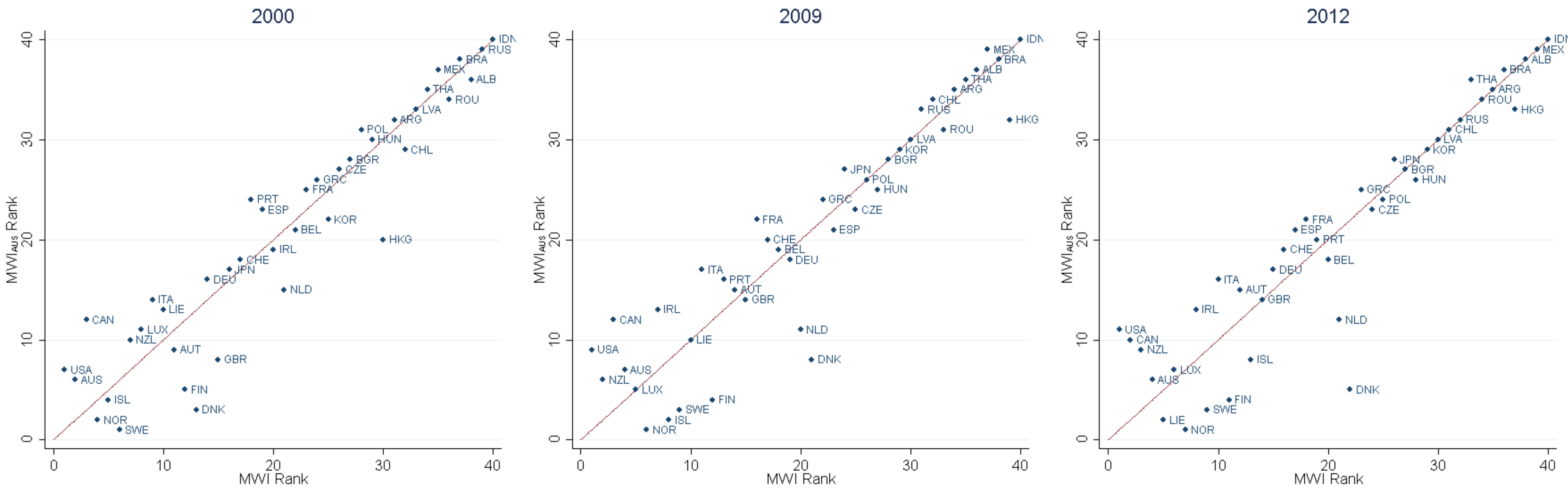
The change in ranking for a specific country-year observation is defined as their year-specific Pseudo-MWI ranking (for a given omitted possession), less their corresponding MWI rank.

Appendix Figure A6: Distribution of MWI and Price Shock Pseudo-MWI Ranking Deviations, Pooled over Years and Repetitions



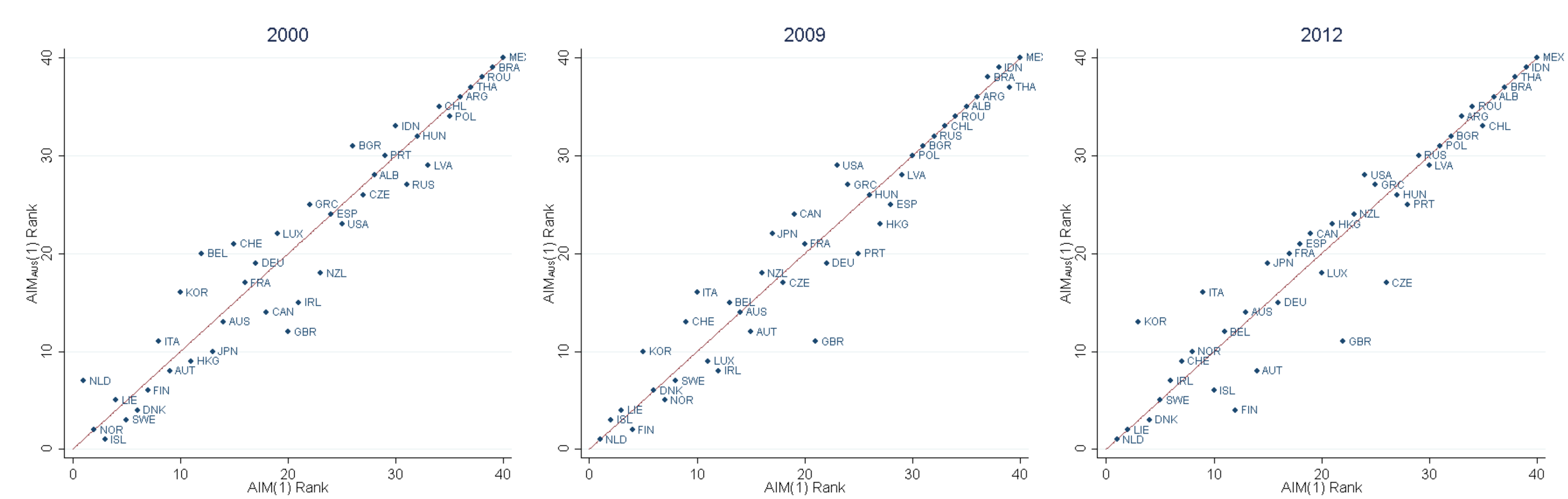
The change in ranking for a specific simulation-country-year observation is defined as their simulation-year-specific Pseudo-MWI ranking (for a given price shock vector), less their corresponding MWI rank.

Appendix Figure A7: A Comparison of MWI and Australian Expenditure Weighted Pseudo-MWI Rankings, by Year



The figure plots the ranking of country-year observations by MWI on the x-axis, and by the Pseudo-MWI that uses Australian expenditure weights on the y-axis - the 45° line depicted shows where rankings are equivalent across constructions.

Appendix Figure A8: A Comparison of AIM(1) and Australian Expenditure Weighted Pseudo-AIM(1) Rankings , by Year



The figure plots the ranking of country-year observations by AIM(1) on the x-axis, and by the Pseudo-AIM(1) that uses Australian expenditure weights on the y-axis - the 45° line depicted shows where rankings are equivalent across constructions.