

**Distributional Characteristics of Income Insecurity
in the United States, Germany and Britain**

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DISTRIBUTIONAL CHARACTERISTICS OF INCOME INSECURITY IN THE U.S., GERMANY AND BRITAIN

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This paper studies income volatility using recent data from the Cross National Equivalence File (CNEF). Techniques from the inequality literature are applied to longitudinal household incomes and we refer to the results as measurements of income insecurity. Using this method we examine (i) cross national differences in average insecurity levels, (ii) the effects of taxes and transfers on the insecurity levels of different income groups and (iii) the relationships between income insecurity and long-run household income. We find that insecurity in pre-government incomes is highest in Britain and lowest in Germany. However estimates of insecurity in post-government incomes are highest in the U.S. It is shown that insecurity in market incomes is heavily concentrated around low income households; however governments appear effective in insulating low income households from this phenomenon.

Keywords: economic insecurity, income volatility, risk, inequality

JEL Classification: D31

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I. Introduction

Economic insecurity has been a topic of increasing interest in academic literature over recent years. Though still new enough to lack a formal definition, the term is used broadly to refer to a state of stress or anxiety about one's financial future. This concept has consolidated by Bossert and D'Ambrosio (2009), Hacker (2006) and a number of works by Osberg (1998, 1999, 2009, 2010), Osberg and Sharpe (2002, 2008) and Sharpe and Osberg (2009) who have characterized insecurity in terms of perceptions concerning threats to future income or wealth. Such threats typically include unemployment, illness, unexpected expenses, retirement, widowhood, crime and a range of other factors.

While there is no great consensus on how insecurity should be measured, the majority of these works indicate that economic insecurity has increased in recent years. For instance Osberg and Sharpe (2002) have found that economic *security* decreased in most OECD countries over the 1990s, while Hacker (2006) and Hacker et al. (2010) focus on the U.S. and reach similar conclusions. Such increases have been regarded as the flipside of policy making that has favoured work incentives and labour market flexibility at the expense of welfare and job security.

High or increasing economic insecurity may be a legitimate cause for concern. If there are significant negative psychological effects associated with risks and uncertainty, these should be included in an understanding of how personal or household finances translate into economic welfare. To examine this issue it is useful to separate the welfare effect of insecurity into the sum of two components. These are (i) direct disutility from risk, and (ii) additional psychological afflictions stemming from that risk. The negative effect of financial risk is well established and depends upon the notion that households are constrained in their ability to smooth their consumption through time. When a liquidity constraint binds, shocks to income or wealth can lead to over consumption in some periods and under consumption in others, leading to diminished utility if households are risk averse.

The psychological distresses associated with income risk are more difficult to study given that they are highly dependent on personal characteristics. Nevertheless there is substantial evidence of their importance. Tversky and Kahneman (1991) for instance highlight a cognitive bias for individuals to view losses and gains asymmetrically, with a greater emphasis placed on losses than gains. Similarly Akerlof and Kranton's (2000) work on economics and identity shows that there is likely to be significant social and psychological costs for an individual who is unable to meet certain social norms concerning employment and consumption. Further a survey based study by Luechinger et al. (2009) shows that individuals with more secure employment exhibit higher subjective wellbeing scores, while the links between various stresses and perceptions of economic risk are studied by Scheve and Slaughter (2004); Dominitz and Manski (1997); Rockefeller Foundation (2007); and the Kaiser Family Foundation (2009). Other empirical evidence comes from Offer et al. (2010) who highlight links between insecurity (in terms of probability of unemployment) and obesity.

As economic insecurity contains this nebulous psychological component as well as the financial costs of risk, objective and comprehensive measurement is difficult. In this paper we simplify the problem by focussing on only one aspect of economic insecurity - income volatility, and ignore other sources of risk and the associated psychological costs. Although this glosses over certain aspects of the problem, the focus on income insecurity can be justified for a number of reasons. Firstly income insecurity is closely related to job insecurity which is a key factor in workers' well-being. Secondly most households rely on their income to pay for daily expenses and to save for future needs including medical expenses, debt payment and retirement. Thirdly many factors that cause anxiety like illness, disability and bankruptcy often have negative impacts on income, making it a barometer for those adversities. Lastly, households' ability to borrow to meet unexpected financial need is

positively related to their income level. Further as there is a wealth of high quality income data available this approach allows for some tangible results. However we refer to our results as measurements of ‘income insecurity’ rather than ‘economic insecurity’ to indicate the specific nature of our findings.

As a study of income dynamics our method is thus related to other areas of research including the mobility work pioneered by Shorrocks (1978, 1981), Burkhauser and Puopore (1997), Canto (2000) and Jarvis and Jenkins (1998) and the work on transitory variance typified by Moffitt and Gottschalk (2002) and Gottschalk and Moffitt (2009). There are however enough differences between income insecurity and these concepts to warrant an altogether independent approach. For instance income mobility studies typically summarize income movements over an entire sample rather than identifying the impact upon the individual or household¹. Similarly the works on transitory income variance have been concerned with examining longitudinal trends in income fluctuations rather than looking at cross sectional characteristics (although the recent paper by Drewianka (2010) is an exception).

The angle taken in this paper is similar to that of Dynan et al. (2007) and Shin and Solon (2008) who study income or earnings dynamics using simple descriptive statistics. This appears to be an acceptable method for measuring insecurity; however there are a few imperfections with the approach. For example an insecurity measure should ideally be ‘forward looking’ as it deals with future perceptions, however we only measure realized volatility, and hence this *ex post* approach is ‘backward looking’ and ignores income risks that did not eventuate. Further it is unclear precisely how the income volatility we observe translates into insecurity. Voluntary income fluctuations such as those due to taking time off work may not cause insecurity, while involuntary ones such as from retrenchment are likely to have strong negative effects. As we have no way of determining which is which, we feel the most parsimonious approach is to include (almost) all sources of volatility in the analysis and treat all fluctuations equivalently.

Although these objections are reasonable it is not clear how problematic they are in practice. Realized income volatility is likely to make a good proxy for future insecurity if agents form their expectations on past experience, so a backward looking measure can have forward looking relevance. Secondly while it is difficult to determine the extent to which a single income fluctuation drives insecurity of a household, it appears reasonable to apply a ‘law of large numbers’ argument to income fluctuations across households. Therefore insecurity comparisons over large samples of similar households should be informative, although comparisons between individual households are probably not.

The primary objectives of the paper are as follows. Firstly we argue that (at least for exploratory studies such as this one) a measure of intertemporal income inequality makes a reasonable *ex post* measure of income insecurity. Secondly, we examine average insecurity levels in the U.S., Germany and Britain and compare the effects of the respective

¹ Jarvis and Jenkins (1998) do however make an explicit link between mobility and insecurity, suggesting that mobility is a ‘Good Thing’ in that it reduces permanent income inequality, but also a ‘Bad Thing’ as it increases insecurity.

governments. Thirdly we wish to model the relationship between our measure of insecurity and long-run income as this may affect our concern for the issue. If insecurity rises with income it may be considered to be an acceptable price of affluence, and hence may be seen as having a reducing effect on long run inequality. However if insecurity falls with income it may be that lower income earners face more disadvantages than previously thought. This point is especially salient if one considers that low income households are likely to have low savings and high liquidity constraints which otherwise may be used to cushion against income shocks.

The paper is structured as follows: Section II discusses the approach to measuring insecurity and section III previews the data. Section IV presents some cross-national results for averages of the insecurity index before and after governmental taxes and transfers. Section V examines the relationship between income and insecurity and plots their distributions. Lastly section VI summarizes the results and gives some concluding comments.

II Measuring Income Insecurity

To measure insecurity we take a vector of realized incomes for each household and attempt to summarize the risk inherent in the observed stream. Before deciding on the exact specification of the measure however, it is useful to establish a set of properties that the index should exhibit. Certain axioms of inequality measurement appear to be useful in establishing properties for an *ex post* insecurity index and these are reviewed in the context of income insecurity. There are n households and we consider household i with income stream $x_i = (x_{i1}, x_{i2}, \dots, x_{iT})$ over T time periods and insecurity index $I: x \rightarrow \mathbb{R}_+$. Some desirable properties for $I(x)$ are:

- (1) **Scale invariance.** The measure should be insensitive to changes in the scale of the dependent variable. This property makes the insecurity measure a purely proportional index, measuring the volatility of an income stream relative to the average of that stream and ensuring that, a scalar change in income (such as a 10% rise across all time periods) will not affect the measure. This property is consistent with the argument made by Hacker (2006) that insecurity can be independent of average income. This also distinguishes insecurity from the concept of ‘vulnerability’ (see Dercon, 2005; Bandyopadhyay and Cowell, 2007; Naude et al., 2008) which relates to the probability of an individual falling below a certain poverty line.
- (2) **Normalization and Non-negativity.** It is useful to require that $I(x) = 0$ when all incomes are equal and that the insecurity index is strictly positive when there is a degree of volatility within the income stream.
- (3) **Intertemporal transfers.** As insecurity is generally considered an increasing function of income volatility, a small transfer from a period of higher income to a period of lower income should decrease the measure, while the converse transfer

should increase the measure. It is required that the intertemporal transfer must be sufficiently small such that the income rankings are not reversed. More formally if we consider two income streams $x_i = (x_{i1}, x_{i2}, x_{i3})$ and $x_j = (x_{j1}, x_{j2} + \varepsilon, x_{j3} - \varepsilon)$ then $I(x_i) > I(x_j)$ if $x_2 < x_3$ and $\varepsilon < x_3 - x_2$ where ε is the intertemporal transfer. This property therefore ensures that $I(x)$ is an increasing function of the volatility of x .

- (4) Diminishing intertemporal transfers.** Given the psychological asymmetry between losses and gains the measure should place an increasing sensitivity on periods of relative poverty. For this reason a transfer of income from a period of middling income to a period of very low income will have a larger reduction in insecurity than a transfer from a period of high income to a period of middling income, and that the effect will diminish when the considered incomes increase.

The first of these properties is analogous to the relativity axiom of inequality measurement discussed by Foster (1983), Sen (1973) and Cowell and Kuga (1981) amongst others, while the normalization property is a standard feature of inequality metrics. Similarly the concept of intertemporal transfers is equivalent to the Pigou-Dalton transfer principle, stating that inequality is reduced if a small quantity of income is transferred from a higher to a lower income earner. Lastly the increased sensitivity of the measure to lower incomes comes from Kolm's (1976) diminishing transfer principle, which requires the same higher sensitivity at the lower end of an income distribution of a cross sectional inequality metric.

An index of relative inequality will therefore capture income insecurity to the degree that it is defined by properties 1-4. A method that has some appeal is the Social Welfare class (SWF) of measure employed by Atkinson (1970), Blackorby and Donaldson (1978) and Ebert (1987) amongst others. To place this approach in the context of insecurity measure suppose household i receives the income stream x_i . If there are insufficient mechanisms in place to smooth the incomes stream through time, it is likely that the members of the household may prefer to accept some slightly lower average income if the new income level could be fixed without fluctuations. As this implies that a volatile income stream is less desirable than a steady one for the same average value, we proceed by adjusting estimates of the permanent income of each individual to account for this. The function $u_{it}(x_{it}) = \frac{x_{it}^{1-\alpha}}{1-\alpha}$ is used where u_{it} is the social utility of household i in period t and α specifies an attitude to risk. Choosing a value of zero for α implies no aversion towards income volatility while positive values for α introduce an element of concavity to the function and a corresponding degree of aversion to income volatility².

Once a choice for α has been made, a constant, 'risk free' income level is determined for each household that yields the same social welfare as income stream x_i . This income represents an alternative to the original income stream and is fixed throughout time such that

² This approach has been applied to income streams by Osberg et al (1998), Makdissi and Woden (2003), Cruces (2005a; 2005b; 2006) and Allanson (2008). Osberg (1999) however expresses some reservations about confusing the cost of 'risk' with the cost of uncertainty with this method.

an individual earning this income level is free of the economic insecurity from income volatility. This income level may be calculated as

$$x_i^{CE}(\alpha) = \left[\left(\frac{1}{T} \sum_{t=1}^T u_{it} \right) (1 - \alpha) \right]^{\frac{1}{1-\alpha}} \quad (1)$$

where x_i^{CE} is referred to as the Certainty Equivalent (CE) income that provides the same welfare as the original income stream.

We also define a long-run income level x_i^* which is the arithmetic average of household incomes over the time period. The CE income will match the long-run household income when incomes are constant through time (i.e. $x_i^{CE} = x_i^*$ if $x_{i1} = x_{i2} = x_{i3} \dots x_{it}$). If there is a degree of volatility through time however (e.g. $x_{i1} \neq x_{i2}$) then the CE income will be less than the average level (i.e. $x_i^{CE} < x_i^*$), reflecting the reduction in utility due to the risky nature of the income stream.

From the CE income a ‘risk premium’ exists for each household as $r_i = x_i^* - x_i^{CE}$. This provides a measure of the burden of the risk borne by the individual in dollar terms. The greater the risk premium, the greater the volatility of the income stream and the greater the income insecurity faced. If r_i is expressed as a proportion of the household long-run income we arrive at a definition for the index $I_i = r_i/x_i^*$ which is used as our insecurity metric throughout the rest of the paper³.

A potential issue is that this approach is sensitive to macroeconomic movements such as economic growth or inflation which will add to nominal household income volatility. However if all incomes move proportionately it is not clear that these movements should contribute strongly to insecurity. To filter out these effects we rescale incomes in each wave such that the mean income of all subsequent waves is set equal to the mean of the first wave. This eliminates any macroeconomic trends in income and renders the insecurity estimates insensitive to these factors. The implication of this rescaling is that measurement of insecurity only considers income volatility relative to the mean of the income distribution. Thus a business cycle that affects all households proportionally will have no influence on the measure; however any movement that affects relative positions within the distribution will still drive the index. Measuring insecurity relative to the mean of the distribution circumvents a difficult problem, specifically what level of nominal economic growth needs to be obtained in order to hold insecurity constant. Although this ignores a potential driver of insecurity it can be seen that its effect is likely to be fairly small, as volatility in aggregate income is considerably smaller than the volatility of a particular household. Indeed if occurring proportionately across the population, a recession that costs several percent of GDP is a relatively minor disturbance at the household level. As a result of this rescaling the ‘long-run’ income level x^* does not have the convenient interpretation of a permanent income as it removes all economy wide growth in the household’s income stream. Thus this ‘long-run’

³ Here $I(x)$ is an alternative formulation of Atkinson’s inequality index.

income level is slightly less than, but approximately proportional to the permanent income level.

III. Data

Data comes from the Cross National Equivalence File (CNEF) compiled by researchers at Cornell University. This file consists of harmonized panel surveys coming from the Panel Study of Income Dynamics (PSID) from the U.S., the British Household Panel Survey (BHPS), and the German Socio-Economic Panel (GSOEP). Similar datasets from other countries such as Australia, Switzerland, Canada and South Korea are also available. The CNEF is valuable for cross national comparisons as it draws comparable variables from these surveys across countries and provides constructed variables that are not directly available from the original sources. More information on this dataset can be found in Burkhauser et al (2001).

For this paper we take data on household incomes for the U.S., Britain and Germany. Our time span is 1991-2007 for German data while British data covers 1991-2006. This is the longest available time period for British data and it was considered desirable to limit the use of German data to the same period. Data taken from the U.S. started in 1991 and continues until 1997 without interruption. However the PSID changed from being an annual survey in 1997 to being semi-annual and hence every second wave is missing from this year onwards. The final wave of the PSID data used was in 2007 and hence there are five waves missing relative to German data and four relative to Britain.

In all cases we use the pre-government household income variable coded I11101XX within the CNEF file, and for Britain and Germany we use the post-government household income variable coded I11102XX. Data on U.S. post-government income was not recorded in the PSID after 1992 and hence we use the simulated series I11113XX created using the TAXSIM algorithm written by David Feenberg (Feenberg and Coutt, 1993) in its place. This program is designed to approximate the effect of taxes on U.S. incomes and is recommended for this purpose in the PSID handbook. For all three countries the pre-government income series captures the combined income of household members before tax, and the post-government income series measures the sum of incomes accruing to household members after taxes and transfers for all household members. There are a few minor technical differences in recording which can be found by consulting the relevant codebooks.

Cross sectional surveys from each country are merged into longitudinal panels by matching household heads through time. As there is some evidence that national income dynamics are slowly evolving we follow Burkhauser and Puorpore (1997) by requiring that an income is recorded for each household in every wave of our sample. All other observations are dropped, though this still leaves 600-1200 households in the samples for each country. The data is then weighted by employing the individual-level longitudinal weights assigned to each household head (coded W11103XX in the CNEF) to account for biases caused by attrition between the

surveys. We also weight each household by the number of occupants and each income is equivalised by dividing by the square root of the household size to give an approximation of the total income accruing to each individual. The waves are then rescaled to the mean of the first wave⁴. Negative incomes are also dropped although these only constitute a tiny fraction of the sample, while zero incomes are included. Lastly we drop households with heads aged less than 30 years or greater than 55 years averaged over the sample to avoid volatility associated with entering and leaving the labour force.

IV. Results

Atkinson's index is applied to both pre-government and post-government income streams and the results are given in Table 1. The unweighted number of households in each sample is given in row 1 and average long-run equivalized household incomes (benchmarked at 1991 levels in the respective currencies) are provided in row 2. Insecurity estimates averaged across each sample appear in rows 3-7. To check for robustness several sets of results are obtained using slightly different methodologies. These include using a range of values for α (rows 3, 4 and 5), excluding years 1998, 2000, 2002, 2004, 2006 and 2007 for all three countries as these years are not present in the US or British data⁵ (row 6) and trimming the top and bottom 1% of households as ordered by income (row 7). Insecurity estimates for trimmed data and for consistent time periods are determined using $\alpha = 0.5$. To preface our results in the next section which examine the relationship between insecurity and income we also include estimates of the Gini coefficient of inequality for long-run and CE incomes, and correlation coefficients between the insecurity index and the long-run income level (rows 8-10).

⁴ This is performed prior to dropping households with missing observations.

⁵ All years are available in the GSOEP-CNEF data file, thus eliminating these years leaves a consistent set of waves for all three countries. This required as the Atkinson inequality index has a degree of small sample bias (Breunig and Hutchinson, 2008) and therefore it is important to express measurements across consistent sample sizes when longitudinal observations are limited.

Table 1. Income Insecurity estimates for the United States, Germany and Britain

		United States		Germany		Britain	
		Pre-Govt	Post-Govt	Pre-Govt	Post-Govt	Pre-Govt	Post-Govt
1.	n	1,172	1,172	850	850	620	620
2.	\bar{x}^*	30,275	22,775	22,514	15,812	12,421	9,671
3.	$\bar{I}(0.1)$	0.0106	0.0061	0.0086	0.0030	0.0163	0.0049
4.	$\bar{I}(0.3)$	0.0323	0.0183	0.0269	0.0090	0.0499	0.0148
5.	$\bar{I}(0.5)$	0.0548	0.0307	0.0472	0.0151	0.0852	0.0241
6.	$\bar{I}(0.5)$ Omitted	0.0514	0.0279	0.0410	0.0138	0.0846	0.0224
7.	$\bar{I}(0.5)$ Trimmed	0.0523	0.0289	0.0472	0.0148	0.0791	0.0221
8.	$G(x^*)$	0.3586	0.3069	0.2756	0.2171	0.3081	0.2372
9.	$G(x^{CE}; 0.5)$	0.3545	0.3001	0.2829	0.2166	0.3221	0.2391
10.	$\rho(I(0.5); x^*)$	-0.093	0.2223	-0.3185	0.0098	-0.4722	-0.1496

Note: The leftmost of the paired columns gives results obtained using pre-government incomes while the right hand column gives equivalent results for post-government incomes.

Source: Authors' own calculations from CNEF dataset⁶.

Cross national comparisons of insecurity can be made by examining the estimates across various rows of the table. Taking the estimates in row 5 as a baseline shows that Britain has the highest level of pre-government income insecurity, with the U.S. second and Germany last. The relative magnitudes of these estimates seem reasonably insensitive to omitting years or trimming the dataset, and the ordering is unaffected by employing different risk aversion weights. For post-government incomes the U.S. has the highest insecurity estimate followed by Britain and Germany. Again this ordering appears robust to changes in methodology. The high estimates for U.S. post-government insecurity are surprising as the literature on income dynamics has generally shown incomes in Germany as being more mobile than in the United States (Burkhauser and Puopore, 1997; Maasoumi and Trede, 2001). Recent data however suggests that this difference has been closing (or even slightly reversed) in later years (Gangl, 2005; Chen, 2009) and thus the result appears compatible with these findings. Another possible factor contributing to this difference is that unlike mobility measures (such as Shorrocks' 'R' as applied to the Gini coefficient) our measure of insecurity is "bottom-heavy", placing greater weighting on low income years relative to high income years. If the German social welfare system is more effective than the corresponding system in the U.S. at protecting households from sharp reductions in income (as is commonly perceived) this may explain our results as such movements are designed to be strong drivers of the index.

The aggregate effect of governmental taxation and transfers on smoothing household incomes can be compared by examining the differences in insecurity between pre-government and post-government incomes. Taking the ratios of post-government to pre-government estimates

⁶ The Gini estimates from Table 1 provide a useful check as the results are generally in line with expectations. The U.S. is estimated as having the highest long-run inequality, followed by Britain then Germany. This is consistent with many findings, the most recent of which is probably Leigh (2009). The inequality estimates are lower in all cases after the influence of government, and the difference between pre-government and post-government incomes is lowest in the U.S.

for each country (from rows 3-7) shows U.S. estimates of post-government insecurity are from 54-57% as high as for pre-government incomes, indicating that the U.S. government insulates households from 43-46% of insecurity in market incomes. Similarly post-government German insecurity levels are 32-34% as high as pre-government insecurity, and for Britain the corresponding figures are from 26-30%. Again the results appear consistent to changes in methodology and weighting parameters. The finding that the U.S. government does the least in insulating households from insecurity while the British and German government does more is consistent with general expectations about the differences in social welfare systems and the roles of governments between the countries.

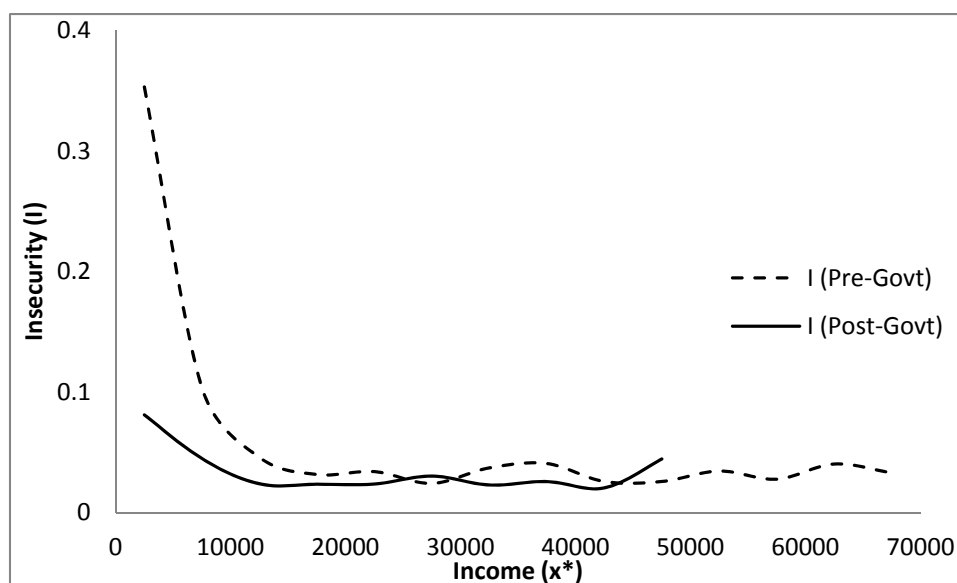
Relationships between Income and Insecurity

The correlations between insecurity and long-run pre-government income in Table 1 (row 10) suggest that in, most instances, income insecurity is relatively high amongst low income earning families. This conclusion is consolidated by the evidence presented in this section. To show the relationship between these variables we plot the average insecurity level against income which is determined over successive income intervals. That is, the sample is ordered in terms of x^* and partitioned to form mutually exclusive income groups and the insecurity measurements are then averaged within each group. For the U.S. the groups are constructed on the basis of 5000USD intervals, such that the first group contains all households with incomes ranging from 0-5000USD while the second group contains households with incomes from 5000-10,00USD. For Germany the intervals are 4000EUR wide and intervals of 2000GBP are used for Britain. A sufficient number of intervals are constructed to cover approximately the lowest earning 95% of the population in each case. The upper 5% of incomes is excluded as there is a great variation in both income and insecurity within this segment of the population, and many income intervals contain zero or one observation.

The results are graphed in Figures 1-37. In each case the dashed lines correspond to averaged insecurity estimates from pre-government incomes and the solid lines correspond to estimates from post-government incomes. As both curves have been included the same axis, the units of measurement depend upon the curve being examined. That is, the horizontal axis refers to pre-government incomes when interpreting pre-government insecurity and the converse also applies. Due to the combining of the axes it should be noted that a household represented at a given pre-government income level will not correspond to a household represented at the same post-government income.

⁷ All insecurity estimates implicit in Figures 1-6 are determined using $\alpha = 0.5$. Results are generally robust to changes in this value.

Figure 1. Average U.S. insecurity estimates against long run income

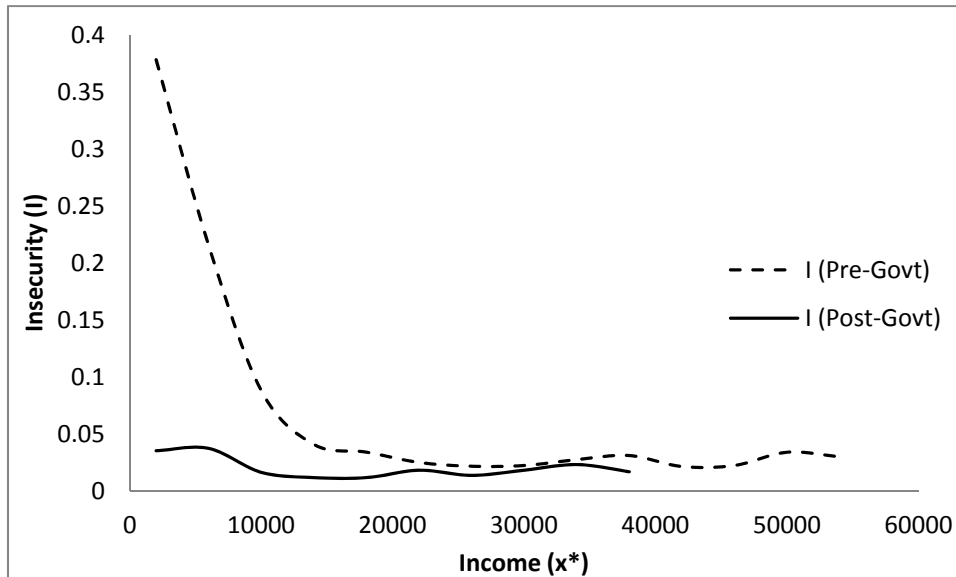


Note: The horizontal axis gives the long-run income level in USD for both income variables and the vertical axis gives the smoothed average insecurity level as a proportion of the horizontal axis. The units on the horizontal axis are long-run equivalized pre-government incomes benchmarked at 1991 levels for the dashed line, and the corresponding post-government incomes are indicated with the solid line.

Figure 1 gives the relationship between long-run income and insecurity for the U.S. The most notable feature of the graph is the high insecurity levels for low income households and the negative relationship that exists between the variables at low incomes. This phenomenon is present for both pre-government and post-government incomes but is especially strong in the former case. Insecurity is lowest for families with pre-government equivalized incomes from around 20,000-45,000USD (13,000-25,000USD for post government incomes).

For post-government incomes the relationship appears to follow a skewed and flattened ‘U’ shape, with rising insecurity for incomers over 40,000USD. Note that the overall positive correlation between income and insecurity estimates for U.S. post-government incomes of 0.2223 given in Table 1 is not especially evident in Figure 1. This correlation is primarily driven by a very small number of extremely high income earners. If the correlation is re-estimated after truncating the sample at the top 5% of income earning households as was done in Figure 1, this value drops to -0.1397 which is consistent with the figure. Insecurity can also be seen to be substantially reduced by the effect of government across the distribution of income. This is especially evident at the lower end where a substantial gap between pre-government and post-government insecurity estimates exists.

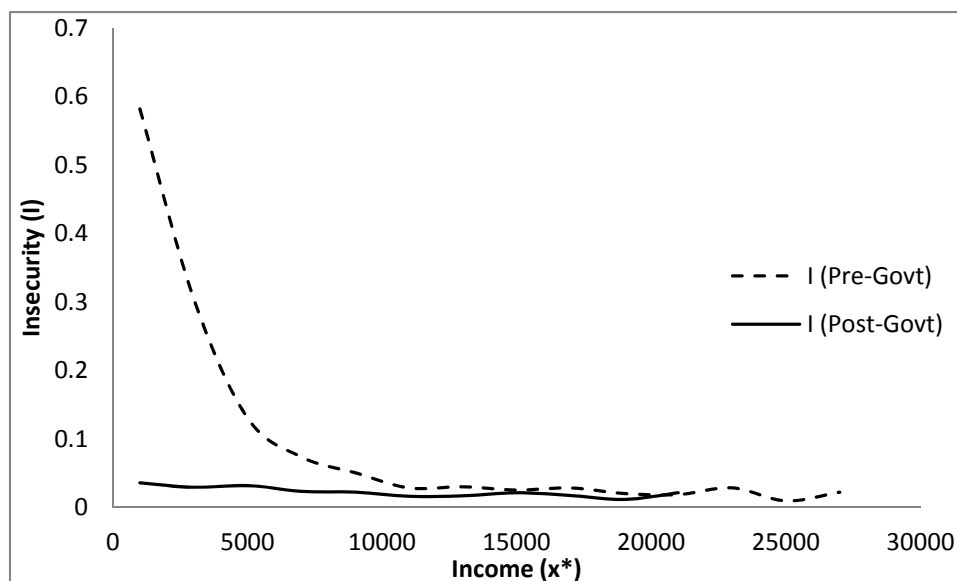
Figure 2. Average German insecurity estimates against long run income



Note: The horizontal axis gives the long-run income level in EUR for both income variables and the vertical axis gives the smoothed average insecurity level as a proportion of the horizontal axis. The units on the horizontal axis are long-run equivalized pre-government incomes benchmarked at 1991 levels when interpreting the dashed line, and the corresponding post-government incomes for the solid line.

Comparable results for Germany are given in Figure 2. Again there are high average insecurity levels for low income households and relatively low insecurity levels for households with middle and higher incomes. As with the U.S. there is a strong reduction in the magnitudes of the estimates after governmental smoothing. Pre-government insecurity declines sharply with income for incomes less than around 30,000EUR, after which no strong relationship is evident. Post-government insecurity appears to decline with income for households with less than 10,000EUR, but follows a slight upward trend thereafter.

Figure 3. Average British insecurity estimates against long run income



Note: The horizontal axis gives the long-run income level in GBP for both income variables and the vertical axis gives the smoothed average insecurity level as a proportion of the horizontal axis. The units on the horizontal axis are long-run equivalized pre-government incomes benchmarked at 1991 levels when interpreting the dashed line, and the corresponding post-government incomes for the solid line.

The representation for Britain in Figure 3 is broadly similar to that for the U.S. and Germany, with a strong but diminishing negative relationship between x^* and $I(x)$ and a notable reduction in insecurity for post-government incomes. One qualitative difference is that there is no particular sign of increased insecurity in either pre-government or post-government incomes after a certain income level.

A comparison of Figures 1-3 suggests that governments in the three countries differ in the extent to which they smooth incomes at lower and higher levels. This can be evaluated by comparing the correlations between incomes and insecurity estimates before and after governmental smoothing (row 10). In Britain pre-government insecurity is negatively correlated with income ($\hat{\rho} = -0.4722$) when evaluated over the entire distribution, but this is greatly reduced for post-government incomes ($\hat{\rho} = -0.1496$). The difference between the two correlation coefficients provides a rough guide to the extent to which governments are 'progressive' in the sense of insulating lower income households from risk more than higher income households. This difference is 0.322 in Britain, 0.328 in Germany and 0.315 in the U.S., indicating that German and British governments smooth more at the lower end relative to the higher end of the income distribution than in the U.S. However market insecurity in the U.S. has substantially less negative correlation with income than in the other two countries, and as such less is left for governmental policy to affect this relationship. The less negative (or more positive) relationships between income and insecurity for households in the U.S. can be seen as a slightly egalitarian characteristic, as it implies that a greater level of

insecurity falls upon high income households. This is also evident in the Gini coefficients of inequality from Table 1 (rows 8-9), which compare inequality of long-run incomes (x^*) with Certainty Equivalent incomes (x^{CE}). While U.S. Gini coefficients are relatively high, they are slightly reduced when considering risk-adjusted income streams over their long-run counterparts, indicating that to some small extent, the distribution of risk serves as a counter-balance to inequality in the distribution of income. This is not true of German or British Gini coefficients, which are relatively low, but in most cases increase when insecurity is accounted for.

Concentration Curves for Income Insecurity

Further light can be shed on the distributional relationships between income and insecurity and the effects of government with the use of concentration curves. The curves are generated by ordering household incomes from lowest to highest and plotting the cumulative proportion of aggregate insecurity against cumulative population share. If household i has weighting w_i the cumulative population share p_j and cumulative insecurity share q_j are given as:

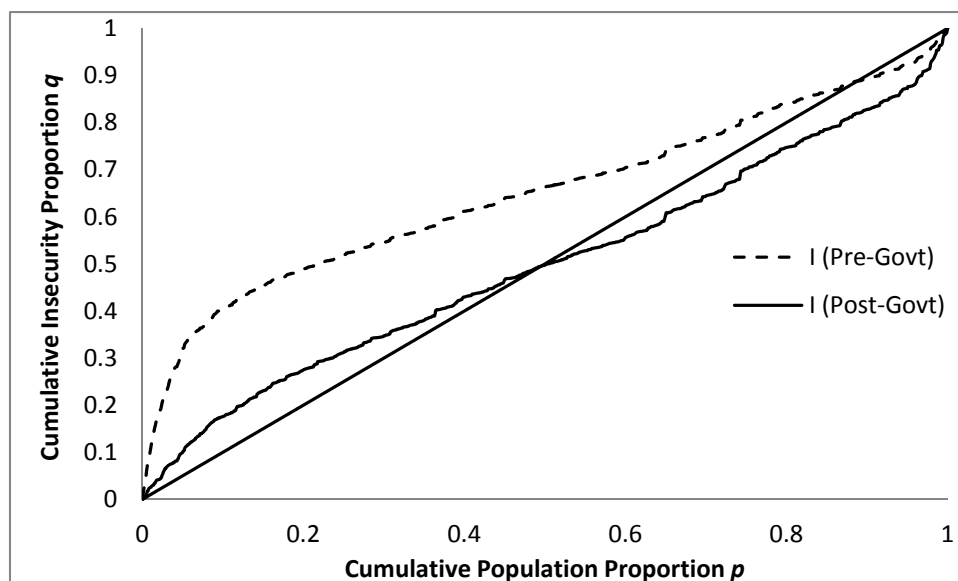
$$p_j = \frac{\sum_{i=1}^j w_i}{\sum_{i=1}^n w_i} \quad q_j = \frac{\sum_{i=1}^j I_i w_i}{\sum_{i=1}^n I_i w_i}$$

where both p_j and q_j are defined on the interval $[0,1]$.

The results are shown in Figures 4-6 where in each plot, both curves are determined by ordering according to pre-government income⁸. The concentration curves for all three countries show that market income insecurity is heavily distributed on lower income earning households. The lowest earning 10% of the population accrue approximately 40% of all national income insecurity in the U.S. and Germany and over 50% in Britain. The corresponding figures for post-government incomes are greatly reduced, with the lowest earning 10% accruing around 20% of insecurity. Similar results can be obtained for higher income shares, which demonstrate the strong concentration of insecurity around low income households. Further, in all cases the governmental curve lies below the market curve which indicates that all three governments reduce the proportional insecurity share borne by the lowest earning p th percentile for all p . This is consistent with the observation that governments are progressive in sheltering lower earning households to a greater degree than higher income households.

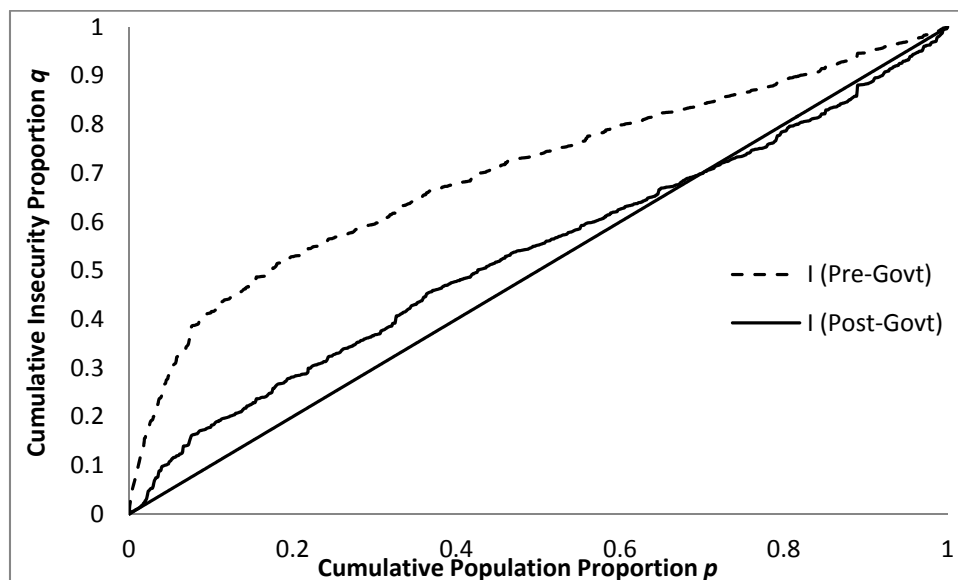
⁸ This is why the post-government insecurity line is not as 'smooth' as the curve for pre-government incomes.

Figure 4. Concentration Curves for Pre-Government and Post-Government Insecurity in the U.S.



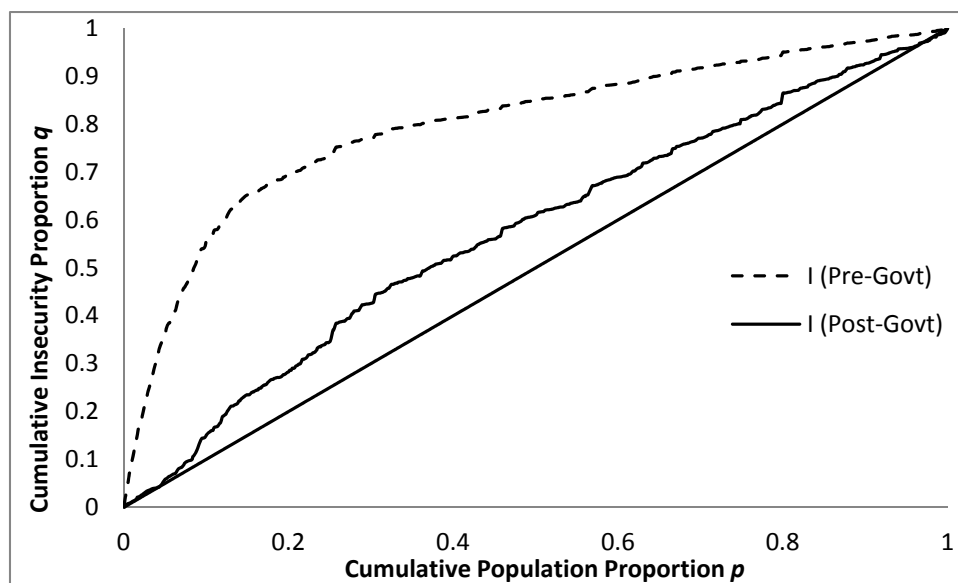
Source: Authors' calculations from CNEF data. The horizontal axis gives the cumulative population proportion and the vertical axis gives the cumulative insecurity proportion where observations are ordered with respect to pre-government incomes. Results are generated with $\alpha = 0.5$.

Figure 5. Concentration Curves for Pre-Government and Post-Government Insecurity in Germany



Source: Authors' calculations from CNEF data. The horizontal axis gives the cumulative population proportion and the vertical axis gives the cumulative insecurity proportion where observations are ordered with respect to pre-government incomes. Results are generated with $\alpha = 0.5$.

Figure 6. Concentration Curves for Pre-Government and Post-Government Insecurity in Britain



Source: Authors' calculations from CNEF data. The horizontal axis gives the cumulative population proportion and the vertical axis gives the cumulative insecurity proportion where observations are ordered with respect to pre-government incomes. Results are generated with $\alpha = 0.5$.

It is of further interest to compare the distribution of insecurity in the three countries using the relative slopes of the curves. When the gradient is greater than the 45° line the household at that percentile has a greater than proportional share of insecurity, while a gradient less than 45° indicates a lower than equal share. For the U.S. we see that the ends of the income distribution (approximately the lowest 10% and highest 5%) have higher than average insecurity – a relationship that exists for both income variables. Conversely there is no indication that the highest income households in Britain have disproportionately high insecurity for either income variable, and there is only a slight indication of this trend existing in German data for post-government incomes. Taken together, these results show that while the U.S. has higher inequality and high post-government insecurity than either Germany or Britain, the U.S. insecurity is less skewed towards low income earners. Conversely British insecurity seems highly concentrated for low incomes, while Germany has the lowest inequality and insecurity with a middling tendency for this to fall on low income households.

The Marginal Distributions of Insecurity and Long-Run Income

Having established the relationships between insecurity and long-run income we now turn to modelling their distributions. The distribution of insecurity estimates I is of particular interest and to our knowledge has not been studied before in the academic literature. In all cases this variable appears right skewed and has a singular mode around zero with non-negative support, and hence may be effectively modelled with an exponential distribution of the form:

$$f(A) = \lambda e^{-\lambda I} \quad \text{for} \quad I, \lambda > 0 \quad (2)$$

where λ is the parameter of the distribution with maximum likelihood estimator $1/\bar{I}$.

Parametric distributions are also estimated for the distribution of long-run incomes and Certainty Equivalent incomes. The objective is to determine the difference between the distribution of long-run incomes, which approximately reflect the commonly used distribution of permanent incomes, and the corresponding risk adjusted incomes. This is only done for pre-government data but similar (although less exaggerated) results may also be obtained for post-government incomes. The distributions are modelled with the Singh-Maddala (1976) specification. This three parameter model has the flexibility to fit a variety of different shaped distributions and has been employed for this purpose by McDonald (1985) and Jenkins (1999) amongst others. The specification is:

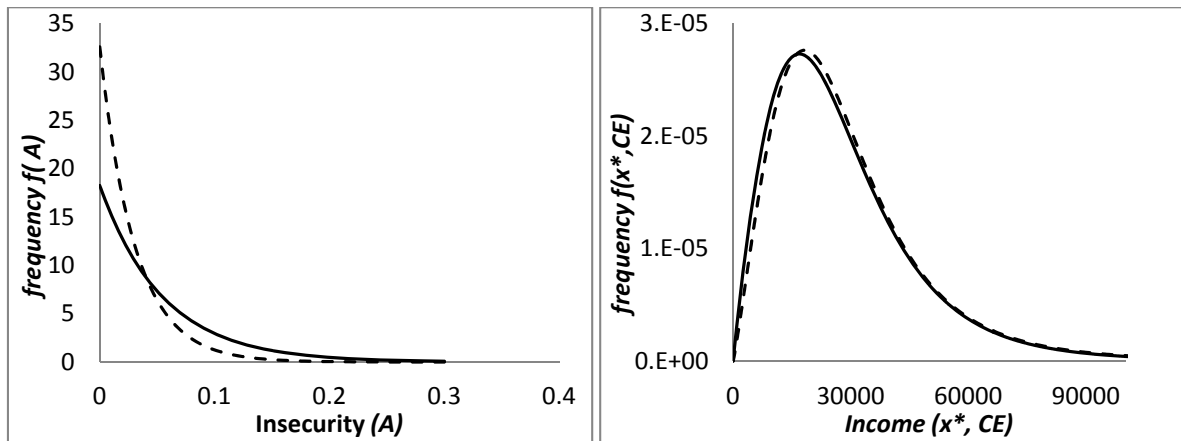
$$f(x^*) = \frac{aqx^{*a-1}}{[b^a(1+(x^*/b)^a)^{1+q}]} \quad \text{for} \quad x^*, a, b, q > 0 \quad (3)$$

where parameter estimates \hat{a} , \hat{b} and \hat{q} are estimated using maximum likelihood.

The left panels of Figures 7-9 show the estimated insecurity distributions for pre-government and post-government incomes for the three countries. These plots reveal that most households are only exposed to low levels of insecurity and that higher levels of insecurity are increasingly uncommon. The effect of government taxes and transfers can be seen to strongly increase the frequency of low insecurity households for all three countries, albeit by varying amounts.

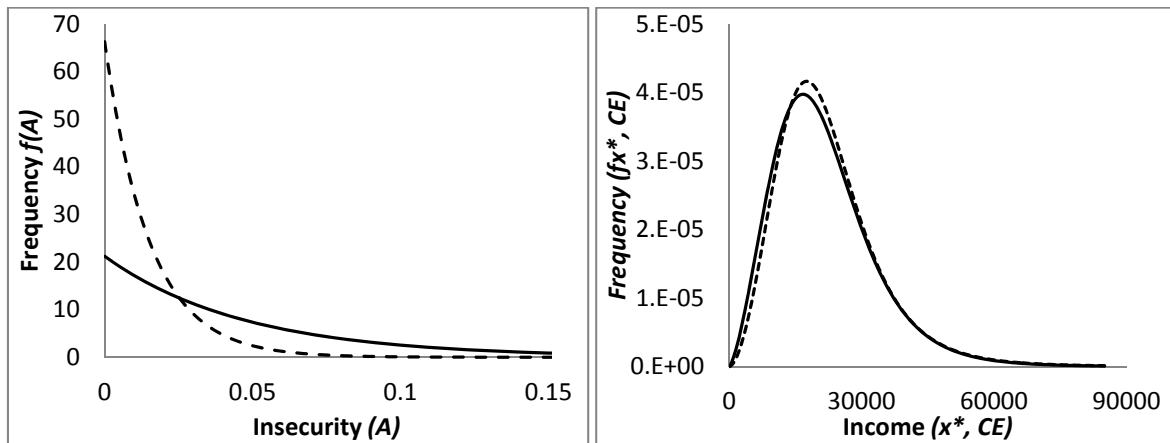
The right panels show the distributions of pre-government income before and after insecurity has been accounted for. In this case the dashed line is still used for pre-government incomes however the solid line now represents Certainty Equivalent pre-government incomes. While the distributions are not greatly different overall it is evident that the relative frequency of low income earners is increased (the distribution of CE incomes is shifted leftward) however the distributions appear largely unchanged in the upper tails. This result is reasonably consistent over the three countries; however the effect appears most prominent in Britain where pre-government insecurity estimates are the highest.

Figure 7. U.S. pre-government and post-government insecurity distributions (A ; left panel) and pre-government income distributions (x^* , x^{CE} ; right panel)



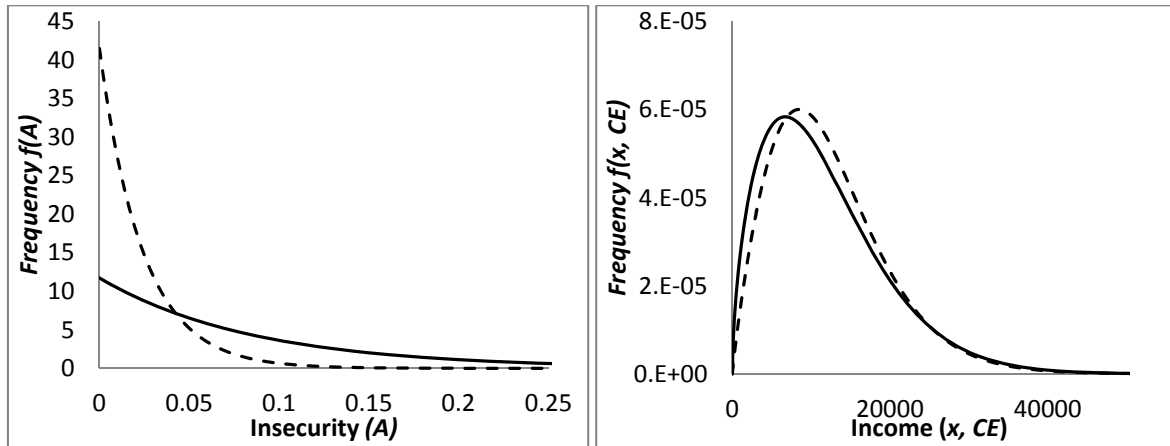
Note: For the left panel the dashed line gives the distribution of insecurity for pre-government incomes while the solid line gives the distribution for post-government incomes. Parameter estimates for the distributions are $\hat{\lambda} = 18.24$ and $\hat{\lambda} = 32.57$ respectively. The right panel gives the pre-government income distributions for x^* (long run incomes, USD, dashed line) and x^{CE} (certainty equivalent incomes, USD, solid line). Parameter estimates for the distribution of x^* are $\hat{a} = 2.108$, $\hat{b} = 38087$ and $\hat{q} = 2.014$ while for x^{CE} they are $\hat{a} = 1.912$, $\hat{b} = 46431$ and $\hat{q} = 2.775$.

Figure 8. Germany pre-government and post-government insecurity distributions (A ; left panel) and pre-government income distributions (x^* , x^{CE} ; right panel)



Note: For the left panel the dashed line gives the distribution of insecurity for pre-government incomes while the solid line gives the distribution for post-government incomes. Parameter estimates for the distributions are $\hat{\lambda} = 21.19$ and $\hat{\lambda} = 66.23$ respectively. The right panel gives the pre-government income distributions for x^* (long run incomes, EUR, dashed line) and x^{CE} (certainty equivalent incomes, EUR, solid line). Parameter estimates for the distribution of x^* are $\hat{a} = 2.758$, $\hat{b} = 28450$ and $\hat{q} = 2.048$ while for x^{CE} they are $\hat{a} = 2.429$, $\hat{b} = 34356$ and $\hat{q} = 2.9714$.

Figure 9. Britain pre-government and post-government insecurity distributions (A ; left panel) and pre-government income distributions (x^* , x^{CE} ; right panel)



Note: For the left panel the dashed line gives the distribution of insecurity for pre-government incomes while the solid line gives the distribution for post-government incomes. Parameter estimates for the distributions are $\hat{\lambda} = 9.62$ and $\hat{\lambda} = 41.49$ respectively. The right panel gives the pre-government income distributions for x^* (long run incomes, GBP, dashed line) and x^{CE} (certainty equivalent incomes, GBP, solid line). Parameter estimates for the distribution of x^* are $\hat{a} = 1.340$, $\hat{b} = 290239$ and $\hat{q} = 76.204$ while for x^{CE} they are $\hat{a} = 1.201$, $\hat{b} = 1384247$ and $\hat{q} = 344.6$.

A number of welfare implications can be drawn from the above findings. Firstly in most cases low-income households are disproportionately burdened by income insecurity compared to their more affluent counterparts. This implies that income level based measures such as poverty, deprivation and vulnerability indicators may not fully capture the economic hardship experienced by low-income groups. Secondly, government taxes and transfers have been effective in mitigating income insecurity and thus in improving welfare. However differences in the results between the U.S. on the one side and Germany and Britain on the other side indicate that there remain variations in the effectiveness of government policies in income smoothing, which probably depend on the designs of the respective tax and welfare systems. Thirdly, despite the observation that insecurity mostly impacts on low-income groups, surprisingly its inclusion does not have a great impact on the Gini coefficient measure of income inequality.

V. Conclusion

The paper has argued that an intertemporal application of Atkinson's inequality metric makes a good *ex post* measure of income insecurity, which is an important component of economic insecurity. The technique is applied to household ranging from 1991 to 2007 for the U.S., Germany and Britain and some similarities and differences between the countries are discussed.

We determined that of the three countries, insecurity in pre-government incomes is highest in Britain and lowest in Germany, while insecurity in post-government incomes is highest in the U.S. and lowest in Germany. Accordingly the U.S. government appears to reduce insecurity less than the other two governments. Furthermore we find that insecurity in market incomes are negatively correlated with income in all three countries, but also that insecurity in post-government incomes is less correlated with income. This suggests governments are quite progressive in that they shelter lower income earning households more than higher income households from income insecurity. Although there are some cross national differences in the extent that this occurs across the three countries the effects of government appear broadly similar.

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