

## INCOME VOLATILITY AND INSECURITY IN THE U.S., GERMANY AND BRITAIN

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Income volatility is studied as a component of economic insecurity 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 of different income groups and (iii) the relationships between income insecurity and long-run household income. We find that for pre-government incomes Britain exhibits the highest levels of income insecurity, with the U.S. the lowest. However estimates of insecurity in post-government incomes are highest in the U.S. It is shown that insecurity in market incomes is primarily concentrated around low income families and that this pattern is strongest in Germany and weakest in the U.S. Insecurity in post-government incomes is for the most part found to be unrelated to household income.

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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 broadly used to refer to a state of psychological anxiety about one's financial future. This concept has been solidified by authors such as Bossert and D'Ambrossio (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 future threats to income or wealth. Such threats typically include unemployment, illness, unexpected expenses, retirement, widowhood and crime as well as a range of other factors.

While there is no great consensus within these studies on how insecurity should be measured, the majority of the works contend that economic insecurity has increased in recent years. For instance Osberg and Sharpe (2002) have found that economic *security* decreased in most OECD countries (including the U.S.) over the 1990s, while Hacker (2006) and Hacker et al. (2010) cite a number of examples from the U.S. reaching similar conclusions. These findings have been based on observations of increasing income volatility, bankruptcy rates and the proportion of households experiencing major economic losses. Such increases have generally 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.

If economic insecurity is high or increasing this may be legitimate cause for concern. Motivation comes from the belief that there are significant negative psychological effects associated with risks and uncertainty which should be included in an understanding of how personal or household finances translate into economic welfare. It is noted that the welfare effect of insecurity is generally regarded as a function of two components, direct disutility from risk, and 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 this applies, shocks to income or wealth 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 likely to be highly dependent on personal characteristics. Nevertheless there is substantial evidence of their existence. Tversky and Kahneman (1991) for instance highlight a cognitive bias for individuals to view losses and gains asymmetrically, with a greater emphasis placed on the disutility of loss than the utility of a gain. Akerlof and Kranton's (2000) work on economics and identity is also important for understanding insecurity as it 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. 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); 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 a largely 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 of those adversities. Lastly, households' ability to borrow to meet unexpected financial need is closely related to their income level. Furthermore as there is a wealth of high quality income data available this approach allows for some tangible results. However we refer to these as measurements of 'income insecurity' rather than 'economic insecurity' to avoid conflating the concepts. While clearly imperfect, this simplification is acceptable if one is prepared to make the assumption that income insecurity is a reasonable proportional proxy for economic insecurity as a whole.

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 household<sup>1</sup>. 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, 2009 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 approach appears to be acceptable for measuring insecurity; however there are a few imperfections. For instance an insecurity measure should ideally be 'forward looking' as it deals with future perceptions, however we can only measure realized volatility, and hence this ex post approach will ignore income risks that did not eventuate. Furthermore it is unclear precisely how the income volatility we observe translates into insecurity. It is likely for example that some income fluctuations such as from voluntary decisions to take time off work will not be strong drivers of insecurity, while others of equal magnitude (perhaps from unemployment) may have strong negative effects. As we have no way of determining which

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<sup>1</sup> Jarvis and Jenkins (1998) 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.

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, especially if agents form their expectations on past experience. 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. Therefore comparisons over large samples of similar households should be valid, although comparisons at the individual level probably are 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 cross national differences in average insecurity levels and differences in the influence of government. This allows for comparisons between several different types of market economies and of the effectiveness of various forms of governmental policy. 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 summary 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  $I$  would be:

- (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 proportional 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 property 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. Furthermore for a comparison of insecurity and income to be valid it is necessary that the definitions of income and insecurity are orthogonal.
- (2) Normalization.** It is useful to require that  $I = 0$  when all incomes are equal and hence 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 incomes are not reversed. More formally if we consider two income streams  $x_i = (x_1, x_2, x_3)$  and  $x_j = (x_1, x_2 + \varepsilon, x_3 - \varepsilon)$  then  $I(x_i) > I(x_j)$  if  $x_2 < x_3$  and  $\varepsilon < x_3 - x_2$  where  $\varepsilon$  is the intertemporal transfer. This ensures that  $I$  is an increasing function of the volatility of  $x$ .
- (4) Diminishing intertemporal transfers.** Given the 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 second is a standard feature of inequality metrics. Similarly the property 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. An inequality metric that has a certain appeal for this purpose is

Atkinson's (1970) measure<sup>2</sup> which has a convenient welfare interpretation. To place Atkinson's index in the context of an insecurity measure suppose household  $i$  receives the income stream  $x_i$  over  $T$  time periods. 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 volatile long run incomes are less desirable than steady incomes, we proceed by adjusting estimates of the permanent income of each individual to account for this disutility. To capture this we use the utility function

$$U(x) = \frac{x^{1-\alpha}}{1-\alpha} \quad 0 \leq \alpha \quad (1)$$

where  $\alpha$  is a measure of risk. Choosing a value of zero for  $\alpha$  implies no aversion towards income volatility such that the household would be indifferent between any two income streams of the same average monetary amount, while positive values for  $\alpha$  introduce an element of concavity to the utility function and a corresponding degree of aversion to income volatility. Once a choice for  $\alpha$  has been made, a constant, 'risk free' income level is determined for each household that yields the same utility as income stream  $x_i$ . This income represents an alternative to the original income stream and is fixed throughout time such that an individual earning this income level is free of the economic insecurity from income volatility. This income level may be calculated as

$$x_i^{CE}(\alpha) = \left[ \left( \frac{1}{T} \sum_{t=1}^T U(x_{it}) \right) (1-\alpha) \right]^{\frac{1}{1-\alpha}} \quad (2)$$

where  $x_i^{CE}$  is referred to as the Certainty Equivalent (CE) income that provides the same utility 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 utility due to the risky nature of the income stream.

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<sup>2</sup> Osberg (1999) discusses this technique as a measure of insecurity though he expresses some reservations about confusing the cost of 'risk' with the cost of uncertainty with this method. However a number of authors have used this or a related method including Makdissi and Woden (2003), Cruces (2005a; 2005b; 2006), Osberg et al (1998) and Allanson (2008).

From the CE income we also define a ‘risk premium’ 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 and may be interpreted as the maximum amount the person is willing to pay per year to stabilize their income over the time period. 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 Atkinson’s inequality index  $A_i = r_i/x_i^*$  which is used as our insecurity metric throughout the rest of the paper<sup>3</sup>.

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 they occur proportionately it is not clear that these should contribute to insecurity in any meaningful sense. To filter out these effects we rescale the 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 one potential source of insecurity (the average effect of the business cycle) it can be seen that this will be fairly trivial, 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 as a permanent income level as the mean equalizing over time has removed all economy wide growth in the household’s income stream. Thus the ‘long-run’ income level is slightly less than, but approximately proportional to the permanent income level.

### III. Data

Data for our analysis comes from the Cross National Equivalence File (CNEF) compiled by researchers at Cornell University. This file consists of harmonized panel surveys coming

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<sup>3</sup> There is a further aspect to the methodology that requires justification. One may feel that time trends in income make an important contribution to insecurity, as an income that trends upward may feel more secure than an income trending downward. For this reason it is emphasized that the insecurity measure is defined only within the specific timeframe, and hence a period of relative poverty followed by relative affluence is no better or worse than a period of affluence followed by a period of poverty.

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 (2001).

For this paper we take data on household incomes for the U.S., Britain and Germany. Our time span is 1991-2005 for German data while British data covers 1991-2004. This is the longest available time period for British data and it was considered undesirable to use German data that extended significantly beyond this range. 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 2005 and hence there are four waves missing relative to German data and three 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 Coult, 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' capture 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 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 1500-2000 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 wave such that any time-trends are removed<sup>4</sup>. Negative incomes are also dropped although these only constitute a tiny fraction of the sample, while zero incomes are included.

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<sup>4</sup> This is performed prior to dropping households with missing observations.



## 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 units are provided in row 2. Insecurity estimates averaged across each sample appear in rows 3-7. To check for robustness the results are obtained for several different cases involving slightly different methodologies. These include using a range of values for  $\alpha$  (rows 3, 4 and 5), excluding years 1998, 2000, 2002, 2004 and 2005 for all three countries as these years are not present in the US or British data<sup>5</sup> (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 level (rows 8-10).

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

Case	United States		Germany		Britain	
	Pre-Govt	Post-Govt	Pre-Govt	Post-Govt	Pre-Govt	Post-Govt
1. $n$	1,995	2,000	1,741	1,743	1,575	1,587
2. $\bar{x}^*$	28,505	22,562	19,309	15,430	10,685	9,586
3. $\bar{A}(\alpha = 0.1)$	0.0129	0.0060	0.0167	0.0029	0.0202	0.0047
4. $\bar{A}(\alpha = 0.3)$	0.0392	0.0181	0.0518	0.0087	0.0616	0.0142
5. $\bar{A}(\alpha = 0.5)$	0.0666	0.0301	0.0896	0.0146	0.1040	0.0241
6. $\bar{A}$ Omitted years	0.0617	0.0272	0.0738	0.0134	0.0960	0.0219
7. $\bar{A}$ Trimmed	0.0636	0.0290	0.0876	0.0141	0.1007	0.0237
8. $G(x^*)$	0.3863	0.3112	0.3310	0.2183	0.3739	0.2256
9. $G(x^{CE})$	0.3855	0.3056	0.3518	0.2189	0.3895	0.2263
10. $corr(A, x^*)$	-0.1787	0.1284	-0.4855	-0.0793	-0.4511	-0.0323

Source: Authors' own calculations from CNEF dataset<sup>6</sup>.

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 we see that Britain has the highest level of pre-government income insecurity (a risk premium around 10.4% of income<sup>7</sup>), followed by Germany (8.96%) then the U.S. (6.66%). The relative magnitudes of

<sup>5</sup> All years are available in the GSOEP-CNEF data file, thus eliminating these years leaves a consistent set of waves for all three countries.

<sup>6</sup> 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.

<sup>7</sup> The magnitude of the risk premium depends upon the arbitrarily chosen value for  $\alpha$ . Hence the insecurity estimates are best interpreted relative to other estimates rather than as absolute magnitudes.

these estimates seem reasonably insensitive to omitting years or trimming the dataset and the ordering is unaffected by employing different parametric weights. For post-government incomes the U.S. has the highest insecurity estimate (3.01%) followed by Britain (2.41%) and Germany (1.46%). 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 evidence however has found 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 uses Atkinson-type utility which 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 United States 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 government intervention on smoothing household incomes can be compared by examining the differences in insecurity between pre-government and post-government insecurity. To do so the ratios of post-government to pre-government estimates are taken for each country from rows 3-7. U.S. estimates of post-government insecurity are from 44-47% as high as for pre-government incomes, indicating that the U.S. government insulates households from 53-56% of insecurity in market incomes. Similarly post-government German insecurity levels are 16-18% as high as pre-government insecurity, and for Britain the corresponding figures are from 22-24%. In all cases the ratios appear remarkably consistent to changes in methodology and weighting parameters. The result that the U.S. government does the least in insulating households from insecurity while the German government does the most appears consistent with general expectations about the differences in social welfare systems and the roles of governments between the countries.

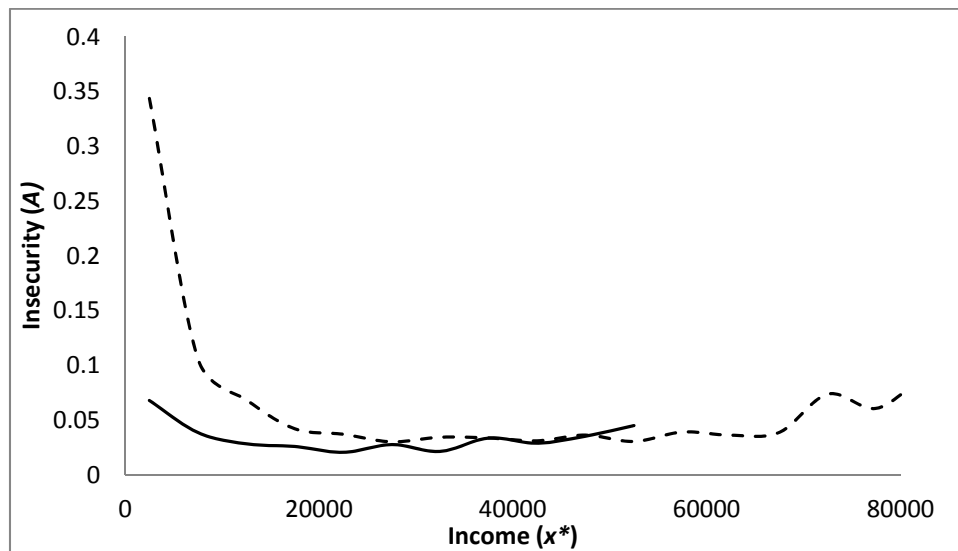
### *Relationships between Income and Insecurity*

The negative correlation coefficients between insecurity and long-run pre-government income (row 10) suggest that on average 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 begin by ordering the sample in terms of  $x^*$  and partition the variable to form successive mutually exclusive income groups. For the U.S. the income 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 average weighted insecurity level is then calculated for incomes within each income group and the results are graphed in Figures 1-3<sup>8</sup>. 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 the plots have been spliced together the horizontal axis refers to pre-government incomes when interpreting the dashed lines and post-government incomes for the solid lines. 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. For example a household with a pre-government income of 40,000USD in Figure 1 does not match with a post government income at the same level. Rather this household will be represented by a point on the post-government axis of around 30,000USD where the difference reflects the reduction in income due to tax. It is for this reason that the curves depicting post-government incomes are much shorter than the curve depicting pre-government incomes.

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

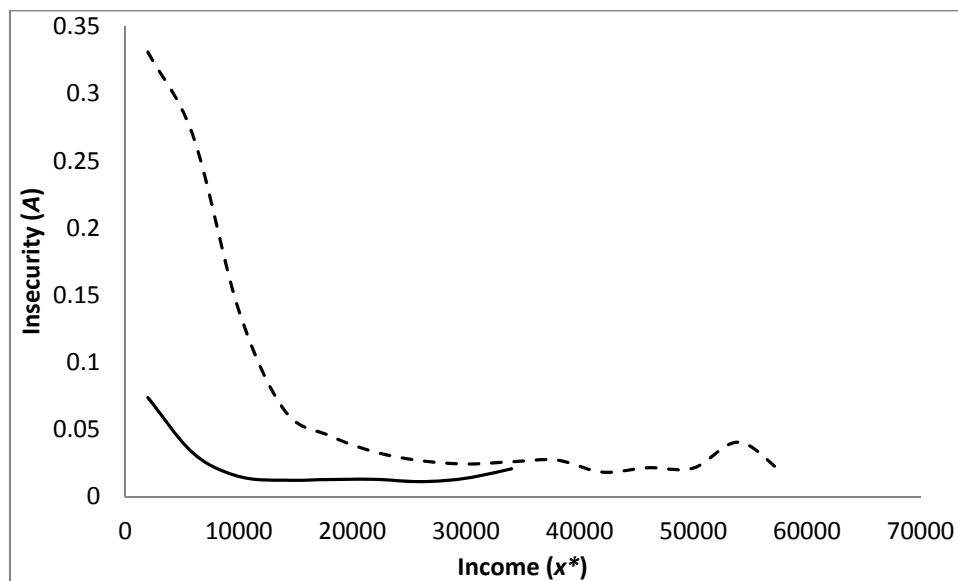


Note: The horizontal axis gives the long-run income level in USD and the vertical axis gives the smoothed average insecurity level as a proportion of the horizontal axis. The units on the horizontal axis are long-run equivalized pre-government incomes benchmarked at 1991 levels when interpreting the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

<sup>8</sup> 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 gives the relationships 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 earning families and the negative relationship between the variables as income increases. This phenomenon is present for both pre-government and post-government incomes but is especially strong in the former case. Insecurity appears minimized for families with pre-government equivalized incomes from around 30,000-50,000USD (20,000-30,000USD for post government incomes) and there appears to be a tendency for insecurity to rise with income thereafter. Thus in both cases the relationship follows a skewed and flattened ‘U’ shape. We note that the overall positive correlation between income and insecurity estimates for U.S. post-government incomes of 0.1284 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 -0.043 which is in accordance 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, illustrating the extent to which the U.S. government insulates low income households.

**Figure 2. Average German insecurity estimates against long run income**

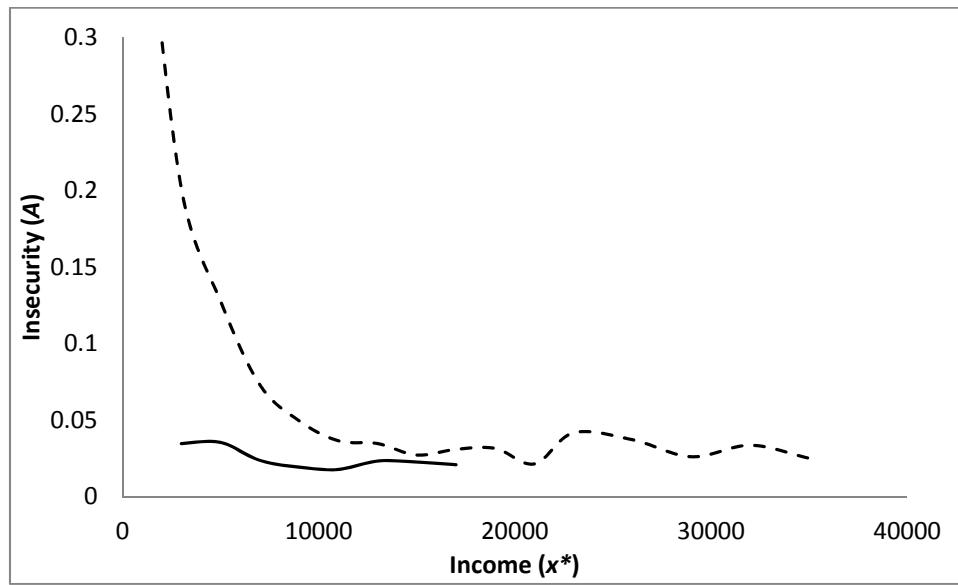


Note: The horizontal axis gives the long-run income level in EUR and the vertical axis gives the smoothed average insecurity level as a proportion of the horizontal axis. The units on the horizontal axis are long-run equivalized pre-government incomes benchmarked at 1991 levels when interpreting the 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 families 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

particular relationship is evident. Post-government insecurity appears to decline with income for households with less than 10,000EUR, and seems low and uncorrelated for incomes from around 10,000-28,000EUR, with a slight upward trend discernable thereafter.

**Figure 3. Average British insecurity estimates against long run income**



Note: The horizontal axis gives the long-run income level in GBP 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  $A$  and a notable reduction in insecurity for post-government incomes. One qualitative difference is that there is no sign of increased insecurity in either pre-government or post-government incomes after a certain income level<sup>9</sup>.

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 ( $\hat{\rho} = -0.4511$ ) when evaluated over the entire distribution, but post-government insecurity is almost uncorrelated with income ( $\hat{\rho} = -0.0323$ ). The difference between the two correlation coefficients provides a rough guide to the extent to which

<sup>9</sup> There is some evidence that insecurity is increased for the highest few percent of households in all three countries; however this relies upon such a limited number of observations that it has not been represented in Figures 1-3.

governments are ‘progressive’ in the sense of insulating lower income households from risk more than higher income households. This difference is 0.42 in Britain, 0.41 in Germany and 0.31 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 remove this relationship. The non-negative (or slightly positive) relationship between post-government income and insecurity for households in the U.S. appears to be a vaguely egalitarian characteristic which is not present (or very weakly present for the other countries). This is 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 both of which increase when insecurity is accounted for.

### *The 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  $A$  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:

$$f(A) = \lambda e^{-\lambda A} \quad \text{for } A, \lambda > 0 \quad (4)$$

where  $\lambda$  has the maximum likelihood estimator  $1/\bar{A}$ .

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 broadly 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 (1995) and Stern (1989) amongst others. The specification is:

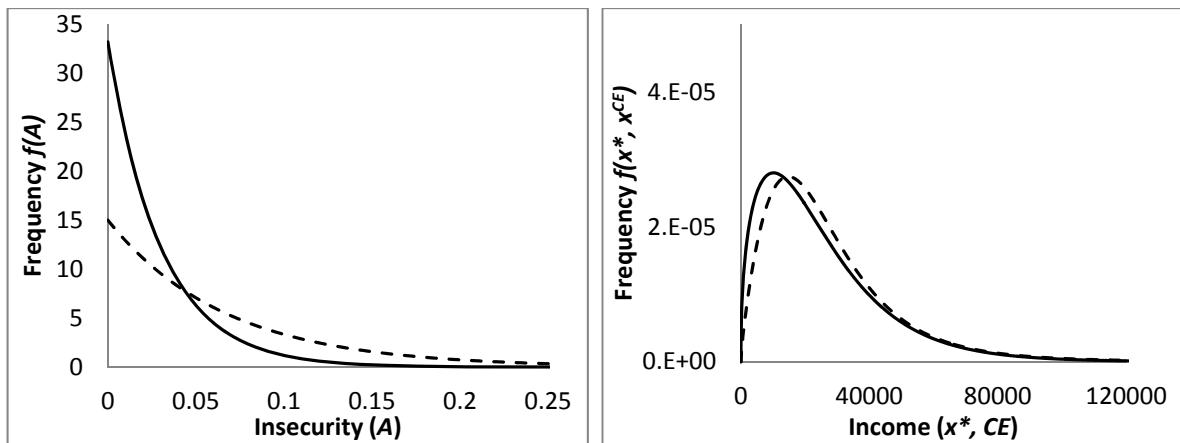
$$f(x^*) = \frac{aqx^{*a-1}}{[b^a(1+(x^*/b)^a)^{1+q}]} \quad \text{for } x^*, a, b, q > 0 \quad (3)$$

where parameter estimates  $\hat{a}$ ,  $\hat{b}$  and  $\hat{q}$  are determined using an iterative maximum likelihood procedure.

The left panels of Figures 4-6 show the estimated insecurity distributions for pre-government and post-government incomes for the three countries. Again dashed lines are used for pre-government incomes and solid lines are used for post-government incomes. 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.

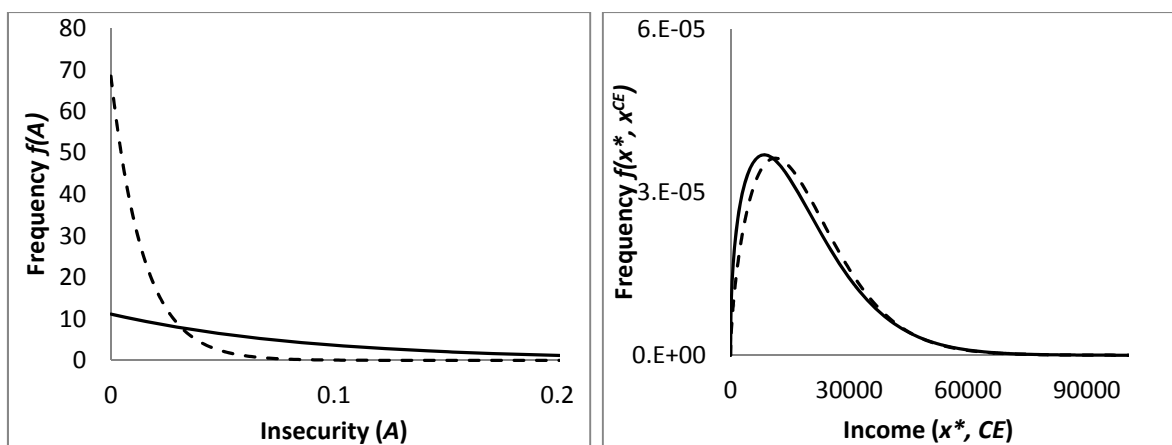
The right panels show the distributions of pre-government income before and after insecurity has been accounted for. In this case the dashed line is still used for pre-government incomes however the solid line now represents Certainty Equivalent pre-government incomes. While the distributions are not greatly different overall it is evident that the relative frequency of low income earners is increased, 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.

**Figure 4. U.S. pre-government and post-government insecurity distributions ( $A$ ; left panel) and pre-government income distributions ( $x^*$ ,  $x^{CE}$ ; right panel)**



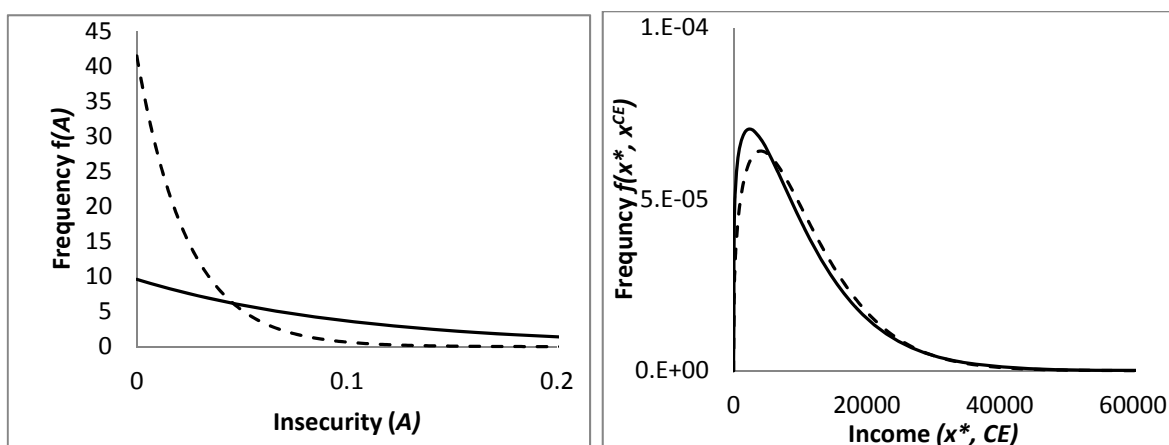
Note: For the left panel the dashed line gives the distribution of insecurity for pre-government incomes while the solid line gives the distribution for post-government incomes. Parameter estimates for the distributions are  $\hat{\lambda} = 15.02$  and  $\hat{\lambda} = 33.22$  respectively. The right 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  $\hat{a} = 1.785$ ,  $\hat{b} = 44712$  and  $\hat{q} = 2.625$  while for  $x^{CE}$  they are  $\hat{a} = 1.602$ ,  $\hat{b} = 61327$  and  $\hat{q} = 3.984$ .

**Figure 5. 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  $\hat{\lambda} = 11.16$  and  $\hat{\lambda} = 64.89$  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  $\hat{a} = 1.624$ ,  $\hat{b} = 124047$  and  $\hat{q} = 18.215$  while for  $x^{CE}$  they are  $\hat{a} = 1.4268$ ,  $\hat{b} = 1026323$  and  $\hat{q} = 275.59$ .

**Figure 6. 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 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 can be very effective in mitigating income insecurity and thus in improving welfare. However, the differences in the results between the U.S. on the one side and Germany and Britain on the other side indicate that there remain large variations in the effectiveness of government policies in income smoothing, pending on the design of the tax and welfare systems. Thirdly, despite the fact that insecurity mostly pounds on low-income groups, surprisingly its inclusion does not have much materialistic impacts on the Gini coefficient measure of income inequality. Taken at face value this suggests that at the aggregate level, insecurity is more important in determining the level of welfare than in its distribution.

## V. Conclusion

The paper has argued that an intertemporal application of Atkinson's inequality metric makes a reasonable ex post measure of income insecurity, which in turn is an important component of economic insecurity. The technique is applied to household ranging from 1991 to 2005 for the United States, Germany and Britain and some similarities and differences between the countries are discussed.

To briefly summarize our results, we find that of the three countries insecurity in pre-government incomes is highest in Britain and lowest in the United States. Conversely insecurity in post-government incomes is highest in the United States 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 strongly negatively correlated with income in all three countries, however insecurity in post-government incomes is largely uncorrelated with income. This suggests that governments are quite progressive in the manner in which they shelter lower income earning households more than higher income households from income insecurity. There are some cross national differences in the extent that this occurs across the three countries but the effects of government appear broadly similar.

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