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Self-employment and allostatic load

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ABSTRACT

Self-employment can be stressful and its long-term effects on individual health could be significant; yet, the physiological outcomes of self-employment related stress remain under-explored. Drawing on allostatic load as a long-term biological consequence of physiological wear-and-tear and an indicator of stress response, we use three different studies to provide a more nuanced understanding of the relationship between self-employment and physiological outcomes. In Study 1, based on a sample of 194 self-employed and 1511 employed individuals, we find that self-employment is marginally related to allostatic load and allostatic load marginally mediates the relationship between self-employment and physical, but not mental, health. Study 2, based on a sample of 776 self-employed and 8003 employed individuals, extends these findings, and provides evidence that those who are self-employed for longer periods have a higher allostatic load. Finally, in Study 3 we draw on a sample of 174 twins and, consistent with Study 2, show that those reporting self-employment in two waves (about eight years apart) had a higher allostatic load, however, when leveraging problem-focused coping such individuals experienced lower allostatic load. Taken together, these three studies extend our understanding of the relationship between self-employment and wellbeing.

Executive summary

Self-employment can be a highly demanding occupation (DeTienne et al., 2008), and the increased demands that entrepreneurs face over-and-above other employment situations can affect individual health and wellbeing. Although prior research has examined linkages between self-employment and stress, the results of these investigations have been mixed—studies suggest that self-employment can increase (Cardon and Patel, 2015) or decrease (Baron et al., 2016) individual's stress levels. These mixed findings point to the fact that stress is a highly complex combination of physiological factors that represent the body's response to challenging situations (Juster et al., 2010). Therefore, traditional measures that combine all of these factors into a general, self-reported "stress" variable could result in an oversimplified and inaccurate representation of the full array of stress indicators. This inaccurate representation of stress could impact findings relating to the relationship between self-employment and individual health and wellbeing.

In this study, we incorporate perspectives from the theory of allostasis and allostatic load (AL) to develop a more comprehensive and nuanced understanding of the association between self-employment and individual health and wellbeing. In doing so, we hope to clarify the relationship between self-employment and stress and stimulate future research that expands our theoretical and empirical

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understanding of this important concept. The AL model has been identified as the overarching framework related to the body's adaptive physiological response to stressors (McEwen and Seeman, 2008). From this perspective, there are a complex set of neuroendocrine, cardiovascular, immunological, and metabolic changes that occur as a result of stressors (i.e. allostatic load), and when left unresolved, these changes can lead to "wear-and-tear" on the body, which can be the precursor to a host of serious physical and mental health conditions (Gonzalez-Mulé and Cockburn, 2017). We propose that individuals who are self-employed will experience higher levels of AL, that longer durations of self-employment will lead to higher AL, and that specific forms of coping can help to reduce the relationship between self-employment and AL.

Our empirical study draws on three large-scale samples, two from the United States and one from the United Kingdom, to examine the link between self-employment and AL. Results from Study 1 suggest that self-employed individuals do have a higher AL (marginal significance) and that AL mediates the relationship between self-employment and reduced physical health (marginal significance) but does not mediate the relationship between self-employment and poorer mental health. In Study 2, we build on these foundational results and present evidence suggesting that individuals who engage in self-employment for longer periods of time have higher levels of AL than those who have been self-employed for shorter durations. Finally, in Study 3 we draw on a sample of twins and find that self-employed individuals who employ problem-focused coping strategies are likely to experience lower levels of AL.

Our study contributes to the growing interest in the relationship between self-employment and individual health and wellbeing. By adopting the perspective of AL, we present a more comprehensive assessment of how self-employment is related to specific physiological processes that can influence health and wellbeing. Additionally, we respond to calls for more attention to the role that physiology plays within the field of management (Heaphy and Dutton, 2008), and build upon recent research into the entrepreneurship/biology interface (Nicolaou and Shane, 2014). Finally, by examining the association between self-employment and AL we address the need to incorporate more objective forms of measurement into management research.

1. Introduction

Work can be demanding; however, the levels of stress and strain that individuals experience within occupational settings can vary substantially, resulting in a wide range of potential consequences to overall health and wellbeing (Deci et al., 2001; Huppert, 2009). While there is a growing interest in understanding the relationship between work and individual's stress (Baumann et al., 2005; Colligan and Higgins, 2006), results on this relationship are largely mixed. While appraisal or emotion-based models for stress responses have been critical in advancing stress-related scholarship, this self-appraisal approach has limitations in that it can be subject to reporting bias (Coyne and Racioppo, 2000; Hagger and Orbell, 2003) and it does not account for the complex system of biological and physiological mediators related to how the body copes with psychosocial, environmental, and physical challenges (McEwen, 1998a).

In parallel with the general scholarship on stress, research on the relationship between self-employment and stress has primarily drawn upon self-appraisal-based models which have produced interesting albeit mixed results. While some evidence suggests that entrepreneurs experience lower levels of stress than the employed (Baron et al., 2016; Hessels et al., 2017), while other evidence supports the notion that self-employment can actually increase individual's experienced levels of stress (Cardon and Patel, 2015; Jamal, 1997). Furthermore, while increased stress has been linked to a higher propensity for serious mental and physical health conditions (Beehr and Newman, 1978; Delongis et al., 1988), studies exploring the relationship between self-employment and individual health have produced conflicting results (Buttner, 1992; Rahim, 1996).

This study builds on previous conceptualizations of stress, and seeks to advance our understanding of the relationship between self-employment and physiological indicators of stress. To accomplish this, we draw on biology- and physiology-based scholarship, which identifies the comprehensive, objective physiological responses to stressors (Lupien et al., 2009; McEwen, 2009). Specifically, we draw on bio-physiological theories on stress, allostasis, and allostatic load (Karlamangla et al., 2002; McEwen, 2004) to develop a more comprehensive empirical test of the physiological impact of self-employment. Building upon this bio-physiological theory of stress, we seek to answer the following research question: *what is the relationship between self-employment and physiological wear-and-tear* (i.e. *allostatic load*)?

Consistent with existing physiological theory on stress (McEwen, 2009), we define stressors as the environmental stimuli that are perceived and interpreted by individuals as threatening or potentially disruptive, which can result in strain – the physical and psychological symptoms that individuals experience as a result of such stressors (Koeske and Koeske, 1993). *Allostasis* refers to the process by which an organism maintains physiological stability by altering parameters of its internal processes and systems to match external environmental demands (Sterling and Eyer, 1988). Essentially, our bodies have systems (e.g. cardiovascular, metabolic, endocrine, etc.) that respond to the bodily state (e.g. sleeping, waking, exercising, etc.) as well as conditions in the external environment (e.g. sudden loud noise, isolation, excessive heat or cold, etc.) and that promote adaptation to adverse conditions. These systems are most useful when they can be rapidly switched on in response to external stimuli and similarly quickly turned down again when they are not needed. However, the prolonged activation of these systems can result in negative consequences commonly referred to as *allostatic load.* Allostatic load (AL) is the wear-and-tear on the body and brain resulting from chronic over activity of physiological systems that regulate adaptation to environmental stimuli (i.e. stress) (McEwen, 1998b). Consistent with this theory, AL represents the degree of stress experienced by individuals as they attempt to manage external stressors. The wear-and-tear of AL has been shown to have a negative relationship with individual physical and mental health (Juster et al., 2010). In brief, AL can impact wellbeing.

From the perspective of self-employment, it is possible that individuals who engage in entrepreneurial activities could be susceptible to higher levels of AL as a result of the multiple and demanding job roles of an entrepreneurial career. Greater levels of AL could be induced by the higher degree of uncertainty, instability, and threat of substantial losses that entrepreneurs experience as a result of self-employment (Lewin-Epstein and Yuchtman-Yaar, 1991). This elevated level of AL could, in turn, lead to a host of adverse health consequences that diminish wellbeing (Juster et al., 2010). However, it is also possible that AL could be lower for the self-employed due to the high degree of autonomy and job control associated with self-employment (Hessels et al., 2017). The ability to determine which actions and activities to engage in on a day-to-day basis could allow individuals to better manage situations that could be perceived as stressful, resulting in an overall reduction in AL. Indeed, research suggests that autonomy and job control are two important factors in increasing job satisfaction and wellbeing while attenuating workplace stress (Prottas and Thompson, 2006; Thompson and Prottas, 2006).

Given the ambiguity in the plausible association between self-employment, AL, and wellbeing, we employ three empirical studies to examine these relationships. First, in Study 1, we explore whether self-employed individuals experience higher levels of AL and whether AL mediates the relationship between self-employment and mental or physical health. Second, in Study 2 we examine whether persistence in self-employment (over time) is associated with higher levels of AL. Finally, in Study 3 we draw on a sample of biological twins to explore how individuals leverage problem- and emotion-based coping strategies to manage the self-employment-AL relationship.

In completing these studies, we make three important contributions. First, we seek to contribute to the ongoing conversation regarding the relationship between self-employment and "stress". While perceptions of stress have been conceptually viewed as including losses, threats, and challenges (Lazarus, 2006), most commonly employed survey measures for stress, such as the Perceived Stress Scale (Cohen et al., 1994), focus primarily on items regarding only threats or losses, to the exclusion of stress that could be related to *challenges* (i.e., opportunities that are demanding and yet perceived in a positive manner). By employing an AL perspective, we assess physiological responses to stress, and although these differ depending upon whether the stressful experience is perceived as a threat or a challenge, they both have marked effects on measurable physiological outcomes (Tomaka et al., 1997).

Second, we extend the literature related to how coping can influence important components within the entrepreneurial process. Prior studies have shown that both problem- and emotion-focused coping strategies can help to reduce the negative emotions experienced by individuals who are self-employed (Patzelt and Shepherd, 2011). However, although some qualitative evidence suggests that these coping strategies can influence physiological symptoms related to failure (Singh et al., 2007), less attention has been paid to how coping might influence the relationship between self-employment and the stress that individuals experience, as well as the physiological strains they exhibit as a result of stressful occupations. Our results provide support for the notion that coping strategies, particularly problem-focused coping, can be beneficial in reducing the overall AL experienced by self-employed individuals.

Finally, we respond to recent calls for more attention to human physiology across a wide range of management phenomena (Heaphy and Dutton, 2008). While researchers have long recognized the usefulness of incorporating a physiological perspective to research on work outcomes (Caplan et al., 1975; Fried et al., 1984), relatively less attention has been given to how such perspectives can extend our knowledge and understanding of the long-term relationships between stressors, strain, and self-employment (c.f., White et al., 2006; Nicolaou et al., 2009). Furthermore, while valuable insight has come from recent work examining specific health measures within the context of self-employment using a limited range of physiological markers (Stephan and Roesler, 2010), we draw on a more comprehensive set of biomarkers validated in the broader medical literature. In the sections that follow we develop and evaluate hypotheses to address our research questions. In developing hypotheses, we introduce each empirical study and discuss the results. This allows for a progressive and staged assessment of our core research questions in a way that builds on prior research. Finally, we discuss the overall implications of our results and potential avenues for future research.

2. Theory and hypotheses

2.1. Self-employment and allostatic load

As previously noted, allostasis refers to the body's physiological changes (e.g. neuroendocrine, cardiovascular, immune, etc.) in response to stressors in an attempt to maintain stability. The AL model builds on the theory of allostasis (McEwen and Stellar, 1993), and argues that the adaptive physiological response to stressors (AL) represents the "wear-and-tear" experienced by physiological systems when stressors are left unresolved (Juster et al., 2010). The result of this process (when unchecked) "leads to proximal indicators of strain, such as elevated stress hormones, elevated body mass, and burnout, which eventually cause more distal indicators of strain, such as depression, cardiovascular disease, and, ultimately, death" (Gonzalez-Mulé and Cockburn, 2017:80).

While there has been a growing interest in examining the consequences of self-employment using measures of physical and mental health, the results of these studies have been somewhat mixed. For instance, while evidence suggests that entrepreneurs could experience lower blood pressure and decreased frequencies of hypertension (Stephan and Roesler, 2010), other studies have found that specific conditions associated with self-employment (i.e. high levels of time spent working) can potentially result in increased blood pressure and reduced health (Rau et al., 2008). Furthermore, recent findings suggest that the relationship between self-employment and certain health outcomes such as morbidity are in fact contingent on multiple factors (i.e. job demands and job control) (Gonzalez-Mulé and Cockburn, 2017). These seemingly mixed findings could be a result of the fact that what accounts for "stress" is indeed a much more complex combination of factors, and as such, capturing comprehensive measures of physiological responses associated with external stressors could add to our understanding of physiological manifestation of stress (Coyne and Racioppo, 2000; Hagger and Orbell, 2003).

Although common nomenclature employs the term "stress" to incorporate numerous phenomena, stress is well defined in the academic literature. Conceptually, there are three general forms of psychological stress: (1) *harm/loss* which refers to damage that has already occurred, (2) *threat* which refers to harm or loss that could potentially occur in the future, and (3) *challenge* which refers to positive anticipation of difficulties that can be overcome with concerted effort (Lazarus, 2006). As noted in a recent review (Stephan, 2018), it is likely that individuals who are self-employed experience stress that they perceive as a threat (i.e. role stress) as well as stress they perceive as a challenge (i.e. workload). This is important because both threats and challenges have been shown to have distinct cognitive and physiological antecedents (Tomaka et al., 1997) as well as produce different physiological responses (Seery, 2011). Indeed, the presence and influence of different stress types (positive and negative) could account for some of the inconsistencies in results of studies exploring the relationship between self-employment and physiological health measures. By examining the association between self-employment and allostatic load, we are able to provide a complementary picture of how self-employment relates to the physiological manifestation of stress that individuals can experience. Furthermore, in adopting an allostatic load perspective, we are able to investigate specific theoretical aspects of stress, namely challenge-related stressors, which have not necessarily received adequate attention in previous studies.

2.1.1. Self-employment, allostatic load, and physical health

A number of contextual features of self-employment—such as high levels of uncertainty, instability, and threat of potential losses—can lead to adverse physical health consequences (Lewin-Epstein and Yuchtman-Yaar, 1991). Despite these challenging contextual features, self-employed individuals may perceive that they have a high degree of job control, which could create a view of their stressful situation as a challenge rather than threat (Holman and Wall, 2002; Stephan, 2018). However, given the extent of potential stressors, it is possible that self-employment (and the resulting stress) can result in potentially negative physiological consequences (McEwen, 2008; Seery, 2011). For this reason, it is important to capture wider physiological measures of stress (i.e., AL), as self-appraised measures of *challenge*-related stressors may be interpreted as "less stressful" than what is actually occurring physiologically.

We argue that AL can play a key role in mediating the relationship between self-employment and wellbeing. For example, one of the primary physiological responses to stress in the cardiovascular system is a release of catecholamines (McEwen and Seeman, 1999; Seeman et al., 1997). Within the cardiovascular system, catecholamines allow the body to adapt to physical exertion, or lack thereof, by helping to adjust heart rate and blood pressure in response to the level of physical strain an individual is experiencing (e.g. sleeping, walking, sprinting). While this adaptation is beneficial in the short-term, repeated surges of blood pressure as a result of job stressors can accelerate the development of atherosclerosis and can increase the likelihood of Type II diabetes (McEwen et al., 1997). If indeed individuals who are self-employed do experience higher levels of stress, either threat *or* challenge related, it is possible that they could be at a higher risk of negative physical health consequences as a result of the increased AL associated with elevated, persistent levels of stress. Based upon this reasoning we predict the following:

Hypothesis 1a. Self-employment will have an indirect negative association with physical health, as mediated by allostatic load.

2.1.2. Self-employment, allostatic load, and mental health

Entrepreneurship and self-employment are inherently emotional activities, and individuals who engage in such endeavors often experience intense levels of both positive (Cardon et al., 2009; Cardon et al., 2005) and negative (Shepherd, 2009; Shepherd et al., 2009) emotions throughout the entrepreneurial process. Therefore, we anticipate that the relationship between self-employment and mental health can also be mediated by AL (McEwen, 1998b). From AL perspective, the hypothalamic-pituitary-adrenal axis (HPA axis) in the brain is responsible for the secretion of adrenal steroids and catecholamines, which help to foster and retain emotionally charged memories. Therefore, it is likely that the HPA axis is often active in individuals who are self-employed. While this activity can be beneficial from the perspective of solidifying emotional memories on a short-term basis, prolonged over activity of the HPA axis can result in reduced neuronal excitability and neuronal atrophy (McEwen and Magarinos, 2001; Meurant, 2012), which have been linked to certain mental disorders (Greenberg et al., 2000; Sheline et al., 1996). As a result, it is likely that the relationship between self-employment and mental health will also be mediated by AL. Based upon this reasoning we predict the following:

Hypothesis 1a. Self-employment will have an indirect negative association with mental health, as mediated by allostatic load.

3. Study 1

To explore the influence of self-employment on physical and mental health, as mediated by AL, we draw on the Nurse Health Assessment (2010 – 2012) in Understanding Society, an annual survey of adults in the United Kingdom (University of Essex, 2013, 2017). The Understanding Society survey is the largest continuous population survey in the world of individuals 16 years and older. The study includes comprehensive demographic, psychological, physiological, and sociological information of the participants. A detailed discussion of the data is beyond the scope of this study; therefore, we refer interested readers to the study's website for additional details (https://www.understandingsociety.ac.uk).

For the purposes of our study, we draw on waves 2 and 3 of the Nurse Health Assessment, in which data was collected through physical examination, blood and urine tests, and questionnaires. Wave 2 (2010 – 2011) data were collected from 15,591 adults and Wave 3 (2011 – 2012) data were collected from 5053 individuals. The self-report data were collected through computer-assisted personal interviewing (CAPI). We restrict the sample to individuals who are not close to retirement (age 60, based on the average

Table 1
Study 1 – Sample Descriptive Statistics.

	Variable	Mean	sd	Min	Max	1	2	3	4	5	6	7
1	SF-12 physical component summary	53.355	7.965	13.19	70.74	*0.8057*						
2	SF-12 mental component summary	49.625	9.169	9.95	68.9	−0.1447*	*0.8446*					
3	Allostatic load	1.047	0.519	−1.1287	3.9398	−0.1386*	0.0018	1				
4	Self-employed (0 – employee; 1 – self-employed)	0.114	0.318	0	1	0.0322	0.0182	0.0268	1			
5	Sex (1-male; 2-female)	1.514	0.500	1	2	−0.0334	−0.1142*	−0.1203*	−0.0916*	1		
6	Age (log)	3.706	0.279	2.8904	4.09434	−0.1021*	0.0653*	0.2390*	0.1398*	−0.0109	1	
7	White (1-white; 0-non-white)	0.939	0.239	0	1	0.0255	0.0295	−0.0019	0.0064	0.0073	−0.0399	1
8	Gross-monthly labor income (log)	7.347	0.877	0.0020	9.6158	0.1003*	0.0758*	0.0354	−0.1142*	−0.3101*	0.1500*	−0.0284

Notes
$N = 1705$ participants (194 self-employed and 1511 wage earners).
Casewise deletion based on full model including the weighting variable *indbdub_xw* [cross-sectional blood person weight].
The italicized values in the diagonal are Cronbach's alpha.
* $p < 0.05$ (two-tailed).

retirement age of 60 for females and 65 for males in the UK)[2] and to those who are eligible for participation in the labor force (age 18 or above). Based on case-wise deletion our sample includes 1705 adults (194 self-employed and 1511 wage earners).

3.1. Measures

3.1.1. Allostatic load

We use eight biomarkers to assess AL based on established measures using the Nurse Health Assessment dataset (Juster et al., 2010; Karlamangla et al., 2002): (i) albumin (g/l); (ii) C-reactive protein (mg/l); (iii) mean systolic blood pressure; (iv) mean diastolic blood pressure; (v) mean pulse rate; (vi) cholesterol total (mmol/l); (vii) glycated hemoglobin (ifcc standardized; mmol/mol hb); (viii) high-density lipoprotein cholesterol (mmol/l). Consistent with prior literature, we standardized each biomarker. We reverse-coded these values because lower values of albumin and high-density lipoprotein cholesterol indicate higher AL. Our final measure of AL is the mean of the standardized values of the eight biomarkers. For a more detailed discussion of the measurement of allostatic load in this study and the broader AL literature see Appendix A.

3.1.2. Self-employed

The respondents were asked whether they were employed or self-employed. We coded this where 1 indicates self-employed and 0 indicates employed.

3.1.3. SF-12 physical and mental component summary

The SF-12 Physical Component Summary provides a single physical functioning score, resulting in a continuous scale with a range of 0 (low functioning) to 100 (high functioning). The SF-12 Mental Component Summary provides a single mental functioning score, resulting in a continuous scale with a range of 0 (low functioning) to 100 (high functioning). Data were obtained through self-reports and the scale is well-established in the literature (Ware et al., 2001).

3.1.4. Controls

We include baseline control variables consistent with those typically used in AL-related studies (Kobrosly et al., 2014; Nugent et al., 2015) – sex (1-male, 2-female), race (1-white; 0-non-white), and log of gross-monthly labor income. Because self-employment tenure and income are not available in the data set, we include the log of age as a proxy for work experience. In Table 1 we present the descriptive statistics.

3.2. Study 1 results

Table 2 presents the results of the generalized structural equation model in Stata 15 (routine *gsem* that allows for the specification of dichotomous variables in the model). Based on weighting guidelines in the Nurse Health Assessment documentation, we include the weighting variable *indbdub_xw* [cross-sectional blood person weight] using the *pweight* option in Stata 15. The choice of the weighting scheme is based on those providing blood samples.

The results are presented using stepwise models (the difference between the two models is significant). The results show that

[2] Source: From TradingEconomics.com; https://tradingeconomics.com/united-kingdom/retirement-age-women; https://tradingeconomics.com/united-kingdom/retirement-age-men

Table 2
Study 1 – Generalized SEM Estimates[a].

		Coef.	s.e.	z	P > |z|	[95% C.I.]		Coef.	s.e.	z	P > |z|	[95% C.I.]	
SF-12 physical component summary ≤ =	Allostatic load	−1.843	0.528	−3.490	0.000	−2.879	−0.808	−1.838	0.527	−3.490	0.000	−2.871	−0.805
	Sex	−0.631	0.534	−1.180	0.238	−1.678	0.416	−0.502	0.546	−0.920	0.358	−1.573	0.569
	Age (log)	−1.709	1.033	−1.650	0.098	−3.732	0.315	−1.918	1.070	−1.790	0.073	−4.015	0.179
	White	0.469	1.059	0.440	0.658	−1.606	2.545	0.465	1.065	0.440	0.662	−1.622	2.552
	Gross monthly income (log)	1.033	0.360	2.870	0.004	0.327	1.738	1.172	0.384	3.050	0.002	0.419	1.926
	Self-employed							1.517	0.703	2.160	0.031	0.140	2.894
	_cons	54.463	4.008	13.590	0.000	46.607	62.319	53.805	4.097	13.130	0.000	45.776	61.835
SF-12 mental component summary ≤ =	Allostatic load	−0.847	0.624	−1.360	0.175	−2.070	0.377	−0.828	0.626	−1.320	0.186	−2.055	0.398
	Sex	−1.244	0.593	−2.100	0.036	−2.407	−0.082	−1.203	0.606	−1.980	0.047	−2.391	−0.015
	Age (log)	1.122	1.149	0.980	0.329	−1.130	3.375	0.960	1.168	0.820	0.411	−1.329	3.249
	White	1.152	1.523	0.760	0.449	−1.833	4.138	1.154	1.525	0.760	0.449	−1.835	4.142
	Gross monthly income (log)	0.490	0.440	1.110	0.265	−0.372	1.351	0.463	0.453	1.020	0.307	−0.425	1.352
	Self-employed							0.026	0.898	0.030	0.977	−1.734	1.785
	_cons	43.511	4.924	8.840	0.000	33.861	53.162	44.233	4.986	8.870	0.000	34.461	54.005
Allostatic load ≤ =	Self-employed							0.092	0.047	1.950	0.052	−0.001	0.185
	_cons							1.050	0.018	57.370	0.000	1.014	1.086
	var(e.SF-12 physical component summary)	65.070	4.708			56.467	74.983	64.963	4.690			56.392	74.836
	var(e.SF-12 mental component summary)	84.867	4.436			76.604	94.022	84.740	4.462			76.431	93.953
	var(e.allostatic load)|							0.285	0.021			0.247	0.328
	cov(e.SF-12 physical component summary, e.SF-12 mental component summary)	−13.659	2.798	−4.880	0.000	−19.144	−8.175	−13.532	2.804	−4.830	0.000	−19.027	−8.036
	Log pseudolikelihood	−6938.173						−7686.178					
	Difference in Log pseudolikelihood	$p < 0.001$											

Indirect effect

	Indirect effect	Sobel	Aroian	Goodman
Self-employed → allostatic load → SF-12 physical component summary (PCS)	−0.170	−1.700	−1.649	−1.755
Self-employed → allostatic load → SF-12 mental component summary (PCS)	−0.076	−1.095	−1.008	−1.209

Notes. $N = 1705$ participants (194 self-employed and 1511 wage earners); Weighting variable *indbdub_xw* [cross-sectional blood person weight].

[a] Because there are three dichotomous variables–self-employment, sex, and white—in the model we used the generalized SEM model in Stata 15 (routine: *gsem*). The program at the time of analysis does not provide fit statistics, and the options listed here are available (https://www.statalist.org/forums/forum/general-stata-discussion/general/1371618-gsem-goodness-of-fit and https://www.statalist.org/forums/forum/general-stata-discussion/general/1012-gsem-goodness-of-fit).

while self-employment is positively and marginally significantly associated with AL ($p = 0.052$), it has a negative marginally significant association through AL to the physical component summary (indirect effect: $-0.170, p < 0.10$), providing marginal support for H1a. However, self-employment has no effect on the mental component summary through AL (indirect effect: -0.076, $p > 0.10$), providing no support for H1b.

The effect size is interpreted as follows—for self-employed individuals, a ten-point increase in SF-12 Physical Component (range from 13.19 to 70.74), results in a reduction of the SF-12 Physical Component score of -0.170 units, or 16.23% ($-0.170/1.047$ [mean of AL]), suggesting small effect sizes with marginal support. The results of Study 1 indicate that although self-employment has a marginally significant association with AL and it marginally lowers physical health through AL, the indirect effect of self-employment on mental health mediated by AL was not significant.

3.3. Self-employment and physiological wear-and-tear over time

In Study 1 we are limited to only cross-sectional observations of whether an individual is self-employed. To address the "wear-and-tear" from self-employment over time, we build on Study 1 to propose that those who were self-employed for longer periods would be more likely to have a higher AL. As argued previously, the process of allostasis involves additive physiological responses as individuals are exposed to environmental stressors (Juster et al., 2010). This additive process likely shapes the self-employed as they operate their ventures over time. It is possible that sources of stress related to threat or harm (such as role stress) could increase as individuals persist within self-employment (Wei et al., 2015), which could result in higher AL. However, evidence suggests that these effects could be mitigated for self-employed individuals who perceive that they have higher levels of job control (Hessels et al., 2017), and/or that the stress could involve *challenges* that come with potential opportunities. While the increased level of autonomy that individuals who are self-employed experience could help to alleviate stress related to threat or harm, it is unlikely that autonomy and job control can eliminate all forms of stress.

Most notably, sources of stress that are interpreted as challenge stressors (e.g., workload) are not likely to be influenced by autonomy, and indeed evidence suggests that entrepreneurs and the self-employed work substantially longer hours than individuals in other occupations (Kolvereid, 1996). Furthermore, it is possible that sources of stress perceived as challenges could be interpreted as satisfying and serve to increase overall job satisfaction for those who are self-employed (Bradley and Roberts, 2004). This could result in individuals actually seeking out such stressors, and while this might have some benefits with regards to certain aspects of wellbeing (Millán et al., 2013), it could also result in an increase in AL since even challenge-related stressors can elicit distinct physiological responses, which could result in long-term health consequences (Blascovich, 2000; Blascovich and Katkin, 1993). Therefore, it is possible that the overall AL self-employed individuals experience over time will increase, if not as a result of the negative forms of stress experienced as a result of high job demands, then rather from a persistent form of challenge related stress unique to the self-employment context. Based upon this logic we propose the following:

Hypothesis 2. Physiological "wear-and-tear" (i.e. allostatic load) will increase the longer individuals are self-employed.

4. Study 2

4.1. Data

To test whether high AL is more prevalent among the self-employed over time, we draw on the NHANES III (1988–1994) data set, which is a nationally representative sample of civilian and non-institutionalized individuals within the United States. The NHANES III study includes interview, clinical exam, and laboratory-based biomarker measurement components (National Center for Health Statistics, 1998-1994) and is one of the most widely used studies on health-related outcomes in the United States. For our analysis, we use the NHANES III interview and laboratory data.[3] Based on case-wise deletion, our final sample includes 8779 individuals.

4.2. Measures

4.2.1. Self-employment

Self-employment is coded as 1 if an individual reports self-employment as an incorporated or non-incorporated business. The variable is coded as 0 if the individual reports being an employee in a private company, federal, state, or local government. All other cases are coded as missing. Among the participants, 776 were self-employed and 8003 were employed (i.e., wage-earners).

4.2.2. Years in current occupation

Years in current occupation is a continuous measure adjusted for the age of an individual by dividing months in current employment by an individual's age in years. There are two primary reasons for normalizing months in current employment by biological age. First, age and tendency to remain in the current occupation are strongly correlated. As such, labor market frictions and filial constraints limit switching across occupations. Second, age and years in current occupation could be highly correlated for younger individuals. By dividing months in occupation by age we normalize months in current occupation for each age level.

[3] Additional information on NHANES III and the laboratory protocols for measuring the biomarkers is available at: https://www.cdc.gov/nchs/nhanes/nhanes3.htm

Table 3
Study 2 – Descriptive Statistics.

	Variable	Mean	SD	Min	Max	1	2	3	4	5	6	7
1	Allostatic load	1.8835	1.4619	0	8	1						
2	Sex (1-male; 2-female)	1.4718	0.4992	1	2	−0.0559*	1					
3	Poverty to income ratio	2.7494	1.7922	0	11.8890	−0.0038	−0.0256*	1				
4	White (1-non-Hispanic white; 0-all other races)	0.3999	0.4899	0	1	−0.0409*	0.0137	0.3621*	1			
5	Have insurance (1-yes; 2-no)	1.1933	0.3949	1	2	−0.0413*	−0.0582*	−0.3634*	−0.1953*	1		
6	Self-employed (1-self-employed; 0-employed)	0.0884	0.2839	0	1	0.0624*	−0.0773*	0.0850*	0.1619*	0.0325*	1	
7	Months in current job (age-adjusted)	2.0098	2.0198	0	12.7059	0.1679*	−0.1240*	0.2190*	0.1053*	−0.1905*	0.1814*	1

Notes.
$N = 8779$ participants based on casewise deletion; 776 self-employed and 8003 wage-earners.
* $p < 0.05$ (two-tailed).

4.2.3. Allostatic load

We use a continuous measure of allostatic load based on past work on AL using NHANES III data (Geronimus et al., 2006; Seeman et al., 2008), and used cutoffs of the nine reported biomarkers as listed in Table B1 (Appendix B). The biomarkers provide an overall assessment of multi-system risk related to inflammatory, metabolic, and cardiovascular systems. Specifically, biomarkers related to

Table 4
Study 2 – OLS Estimates.

	(1)	(2)	(3)	(4)	(5)
Variables	Allostatic load	Allostatic load	Allostatic load	Allostatic load	Allostatic load (age ≥18 and ≤65)
Sex			−0.295***	−0.240***	−0.252***
			(0.0446)	(0.0449)	(0.0460)
Poverty to income ratio			−0.0140	−0.0330**	−0.0341**
			(0.0132)	(0.0133)	(0.0139)
White			−0.136***	−0.157***	−0.170***
			(0.0464)	(0.0469)	(0.0481)
Have insurance (1 = yes; 2 = no)			−0.0667	−0.0123	0.00704
			(0.0671)	(0.0669)	(0.0682)
Self-employed		0.332***		0.362***	0.320***
		(0.104)		(0.106)	(0.112)
Months in current job (age-adjusted)		0.109***		0.111***	0.109***
		(0.0115)		(0.0119)	(0.0123)
Self-employed × months in current job (age-adjusted)		−0.0624**		−0.0717***	−0.0761***
		(0.0258)		(0.0259)	(0.0295)
Constant	1.707***	1.473***	2.366***	2.066***	2.066***
	(0.0224)	(0.0329)	(0.132)	(0.136)	(0.140)
Observations	8779	8779	8779	8779	8239
R-squared	0.000	0.024	0.013	0.036*	0.035
Change in R-square		0.024		0.023	
Log-likelihood	−15,365	−15,261	−15,308	−15,206	−14,227
Model difference test	(2) vs. (1)		(4) vs. (3)		
Chi-square test	209.04 (3)***		204.12 (3)***		
F-stat	0	35.84	14.16	22.68	20.99
df_m	0	3	4	7	7
df_r	8778	8775	8774	8771	8231
p-value		< 0.001	< 0.001	< 0.001	0
Sample weight variable	*wtpfex6*	*wtpfex6*	*wtpfex6*	*wtpfex6*	*wtpfex6*

Notes
Robust standard errors in parentheses.
776 self-employed and 8003 wage-earners.
The difference between models cannot be reported using F-test because Stata 15 regress routine does not allow for F-test when using sample weights. Therefore, Chi-square test based on Log-likelihood are reported.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

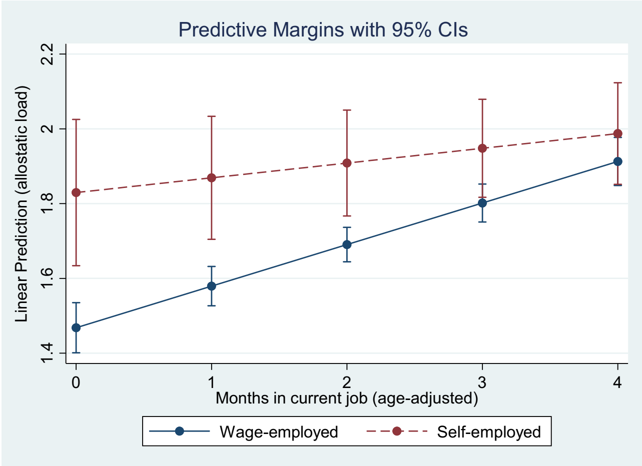

Fig. 1. Moderation effect.

the inflammatory system are C-reactive protein (mg/dL) and albumin (g/dL). The metabolic biomarkers include glycated hemoglobin (%), total cholesterol (mg/dL), HDL cholesterol (mg/dL), and waist-to-hip ratio. Finally, the cardiovascular biomarkers include systolic blood pressure (mmHg), diastolic blood pressure (mmHg), and resting heart rate (bt/min). These biomarkers are available for all age groups. If the value of a biomarker was above the cutoff it was coded as 1, else it was coded as 0 (zero). The measure of AL is the total of the scores above the cut-off values. This approach is consistent with previous works using this data (Geronimus et al., 2006; Seeman et al., 2008).

4.2.4. Controls

To reduce the influence of rival explanations we use some baseline controls. Past work has shown that females are less likely to engage in self-employment (Parker, 2004) and the biological basis of AL could be different between males and females (Seeman et al., 2002), therefore we control for sex (1-male; 2-female). To control for the overall economic wellbeing of a household, we include the poverty-income ratio. The poverty income ratio is based on the numerator (mid-point of the observed family income category) divided by poverty threshold values from the Census Bureau (P-60). Because race influences self-employment (Parker, 2004) and health outcomes (Parente et al., 2013), we include a control for whether the respondent is white (1-Non-Hispanic white; 0-all other races). As insurance coverage influences self-employment (Gumus and Regan, 2015) and access to healthcare could influence AL, we include whether the individual is covered by health insurance (1-yes, 2-no).

4.3. Study 2 results

Table 3 lists the sample descriptive statistics. To test Hypothesis 2, we use a stepwise OLS model. Per the guidelines in NHANES III, we use the variable *wtpfex6* ("total mec [medical exam clinic] examined sample final weight") using the *pweight* option in Stata 15. In Table 4, we first introduce the null model (Model 1), followed by the length of self-employment in Model 2. The change in R-square is 0.024, and the LR test shows a significant difference between models 1 and 2. We use a similar approach in Models 3 and 4 but with controls. Again, the change in R-square is 0.023, and the model difference is significant ($p < 0.01$). In Model 4, self-employment is positively associated with AL ($\beta = 0.362$, $p < 0.01$). Those self-employed for a longer period of time in the same job also had a higher AL (Model 3: $\beta = 0.111$, $p < 0.01$). Hypothesis 2 proposed that self-employed individuals who were self-employed for a longer period of time would have a higher AL ($\beta = -0.0717$, $p < 0.01$). Fig. 1 shows that self-employed individuals generally have higher levels of AL than those who are employed, providing support for Hypothesis 2.

Related to the effect size, we computed the derivative with respect to years in current job (age-adjusted) for self-employed and wage employed individuals using the *margins* routine in Stata 15. We find that relative to wage employed individuals, for each unit increase in a month of self-employment a year (adjusted for age in years), AL is about 0.07 points greater. The mean of AL in the sample is 1.88, representing a 3.7% increase. Given the significant wear-and-tear represented in AL we infer a small but meaningful effect size. As an additional robustness check, we restricted the sample to individuals between 18 and 65 to assess those in primary work-ages (Model 5, shown in Table 4), and found similar results.

Table 5
Matched-pair sampling.

Matching approach	Sample	Treated	Controls	Difference	S.E.	T-stat
With replacement	Unmatched	2.1765	1.8551	0.3215	0.0549	5.86
	ATT	1.9626	0.2139	0.0793	2.7000	
No replacement	Unmatched	2.1765	1.8551	0.3215	0.0549	5.86
	ATT	2.1765	2.0129	0.1637	0.0738	2.22
Nearest neighbor (five neighbors)	Unmatched	2.1765	1.8551	0.3215	0.0549	5.86
	ATT	2.1765	1.9907	0.1858	0.0638	2.91
Kernel matching	Unmatched	2.1765	1.8551	0.3215	0.0549	5.86
	ATT	2.1765	1.9670	0.2095	0.0588	3.56
Local linear regression matching	Unmatched	2.1765	1.8551	0.3215	0.0549	5.86
	ATT	2.1765	1.9855	0.1910	0.0793	2.41

Notes.
Matching covariates are the control variables and months in current job (age-adjusted).
776 self-employed and 8803 wage-earners.

4.3.1. Matched pair sampling

In addition to the previous OLS analysis we use five different matched pair sampling approaches due to the smaller prevalence of the self-employed in the sample: one-to-one matching with replacement; one-to-one matching without replacement; nearest neighbor matching; kernel matching; and local linear regression matching (see Table 5). Matching covariates are the control variables and months in current job (age-adjusted). The results show that the self-employed had a higher AL than wage earners on average, with the lowest difference in mean being 0.0793 (one-to-one matching without replacement).

4.3.2. Additional insights

In reviewing our results, we also noticed the pattern of increasing AL levels for the employed (Fig. 1), demonstrating advancing stress for both the employed and self-employed over time. First, this suggests that as individuals persist in a career, they likely acquire more job demands, giving potential validity to studies associating burnout, fatigue, and exhaustion with AL (Bellingrath et al., 2009; von Thiele et al., 2006). Second, our data reveal that the self-employed have a much higher *starting point* of AL than the employed. This could have at least two major implications: (1) the self-employed already endure higher AL, and thus have a "shorter distance to go" in reaching the top of the scale; (2) the slope (i.e., change in AL over time) is steeper for the employed, likely due to the greater room for upward change in AL-levels given their starting point. Finally, this finding may help explain why self-report studies on stress levels face limitations due to anchor and adjustment biases (Tversky and Kahneman, 1974). That is, the self-employed may perceive lower levels of stress due to lower changes in slopes from a high stress anchor, whereas the employed may perceive higher levels of stress based on a lower stress-level anchor and therefore higher sloped changes. We anticipate future contributions could come by comparing perceived stress and AL-measured stress methods to gain a clearer understanding of workplace stress. In summary, Study 2 builds on the results of Study 1 and indicates that longer periods of self-employment are associated with higher levels of AL.

5. Coping and allostatic load

To this point, we have primarily focused on the association between self-employment and allostatic load without accounting for how individuals might mitigate or respond to those stressors. We know that behavioral responses (i.e., coping mechanisms) help explain differences in how individuals experience and respond to stressors (Lazarus, 1993; Lazarus and Folkman, 1984). Coping refers to thoughts and actions people use to manage distress or problems causing pain (Folkman, 2013). Importantly, not all coping mechanisms promote health. For example, some people cope with stress by engaging in unhealthy behaviors such as alcohol and/or drug consumption and a sedentary lifestyle (Baumeister, 1991; Heatherton and Baumeister, 1991; Robbins et al., 2012). On the other hand, positive coping responses can help reduce stress and promote resilient functioning despite stressful contexts (Folkman, 2008; McEwen, 2003). Therefore, psychosocial responses to negative events are likely to influence one's interpretation of, and physiological response to, stressors (Ganster and Rosen, 2013). Evidence has shown that within the context of self-employment, both problem-focused and emotion-focused coping strategies can be beneficial in reducing the negative emotions that individuals can experience as a result of failure (Singh et al., 2007) as well as over the course of their careers (Patzelt and Shepherd, 2011). We extend this scholarship by examining how specific coping strategies might influence the relationship between self-employment and AL. In this section, we briefly review the literature on effective coping and develop hypotheses for how these approaches influence physiological wear-and-tear.

5.1. Problem-focused coping

Coping strategies typically fall into two main categories, namely problem- and emotion-focused coping (Carver et al., 1989). *Problem-focused coping* involves efforts aimed at "altering the troubled person-environment relation causing the distress" (Folkman et al., 1986) and includes strategies such as "information gathering, seeking advice, drawing on previous experience, negotiating, and problem-solving" (Folkman, 2013: 1984). This form of coping has been shown to be helpful in mitigating the adverse impact of stressful situations, particularly when individuals perceive their situation as controllable (Folkman and Moskowitz, 2000) and the future as positive (Rasmussen et al., 2006). Additionally, problem-focused coping enhances employee wellbeing (Lapierre and Allen, 2006) as well as reduces the likelihood of employee burnout (Hare et al., 1988). Importantly, when a situation is not perceived as controllable (e.g., bereavement [(Carroll, 2013)]), then problem-focused coping is less likely to be helpful in reducing the stressor. The literature on the self-employed and problem-focused coping has similarly found that problem-focused coping attenuates the relationship between self-employment and negative emotions (Patzelt and Shepherd, 2011), facilitates wellbeing and performance (Drnovsek et al., 2010) and is influenced by other factors including prior experience with entrepreneurship (Uy et al., 2013).

5.2. Emotion-focused coping

Emotion-focused coping involves efforts to "regulate stressful emotions" (Folkman et al., 1986), and focuses on mitigating the emotional effects of the consequences of stressful situations rather than eliminating the stressors themselves. That is, emotion-focused coping emphasizes *managing* rather than *changing* a stressful circumstance (Carroll, 2013). Strategies for emotion-focused coping might include self-talk, distancing oneself (Uy et al., 2013) and/or seeking emotional relief from a stressful situation (Carver et al., 1989; Lazarus and Folkman, 1984), and seeking emotional support (Folkman and Moskowitz, 2004). Evidence suggests that emotion-focused coping can increase positive emotions while decreasing negative emotions (McCraty et al., 1998). Furthermore, cognitive reappraisal, or construing a potentially emotion-eliciting situation in a way that changes its emotional impact (Lazarus and Alfert, 1964) has been shown to mitigate the negative effects of stressful events (Gross and John, 2003). Evidence suggests that employees tend to favor an emotion-focused strategy in coping with hostile work environments (Mawritz et al., 2014). Emotion-focused coping is particularly effective when individuals cannot control a circumstance (e.g., bereavement) (Folkman and Moskowitz, 2004), and is likely more effective when used as a short-term strategy (Austenfeld and Stanton, 2004). Indeed, long-term, exclusive reliance on emotion-focused coping can be dysfunctional and inhibit wellbeing (Uy et al., 2013). For the self-employed, the effectiveness of a coping strategy depends on the goodness of fit with the context (Folkman and Moskowitz, 2004) and various individual factors (i.e., prior experience with coping (Boyd and Gumpert, 1983; Kets de Vries, 1980), experience as an entrepreneur (Uy et al., 2013), as well as available coping resources (Hobfoll, 1989). In combining the arguments listed above, we offer the following hypotheses:

Hypothesis 3. Problem-focused coping will moderate the relationship between self-employment and physiological "wear-and-tear" (i.e. allostatic load), such that self-employed individuals who employ higher levels of problem-focused coping will have lower levels of physiological "wear-and-tear" (i.e. allostatic load).

Hypothesis 4. Emotion-focused coping will moderate the relationship between self-employment and physiological "wear-and-tear" (i.e. allostatic load), such that self-employed individuals who employ higher levels of emotion-focused coping will have lower levels of physiological "wear-and-tear" (i.e. allostatic load).

6. Study 3

6.1. Sample

Building on the findings in Studies 2 and 3 we first confirm whether longer period of self-employment is associated with AL. Next, we assess the moderation effects of coping styles on the relationship between self-employment length and AL. While the inferences in Study 2 do draw on objectively measured biomarkers, Study 3 involves a twin-based sample to allow for shared genetic characteristic controls (i.e., monozygotic/dizygotic twins) that could influence biomarker presentation. Despite the clear benefits in taking this approach, entrepreneurship studies rarely (c.f., Nicolaou et al., 2009; White et al., 2006) draw upon objective, biological and genetic data to inform management theories. For a more detailed explanation of the advantages of twin samples in self-employment related studies please refer to Shane and Nicolaou (2015).

We draw our sample from the Midlife in the United States (MIDUS) study, which is a comprehensive, longitudinal study of individual wellbeing for adults between the ages of 35 and 86. More importantly, it is one of the only comprehensive studies in the United States with twin and necessary biomarker data for measuring AL. A more detailed description of this extensive study is available at http://midus.colectica.org/. To complement the MIDUS data, we draw on biomarker data from the National Survey of Midlife Development in the United States 2004–2006 (MIDUS II) (Ryff et al., 2017). The data on twins is derived from MIDUS I (1996) (Brim et al., 2017). We merged twin zygosity information in MIDUS I with MIDUS II general survey and MIDUS II biomarker survey information to construct our sample. We excluded cases where zygosity was not determined.

6.2. Measures

6.2.1. Allostatic load

For this study, we operationalize AL following the measurement used by Karlamangla et al. (2014) who also used MIDUS II data. In their study, Karlamangla et al. (2014) used a sum of standardized scores of the seven systems included in the study. A detailed listing of all biomarker scores is listed in Table B2 in Appendix B.

Table 6
Sample Descriptive Statistics – MIDUS I and II (Study 3).

		Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9
1	Allostatic load	0.2375	6.4775	−11.2183	28.1504	1								
2	Log of household total income	10.9935	0.8758	6.9078	12.6115	−0.1299	1							
3	Education	7.6839	2.3206	2	12	−0.0758	0.2440*	1						
4	Year of birth	1950	11.13	1922	1969	−0.0692	0.1503*	0.0567	1					
5	Sex (1-male; 2-female)	1.5977	0.4918	1	2	−0.0151	−0.0897	−0.2083*	0.0089	1				
6	White (1-white; 0-all other races)	0.9598	0.1971	0	1	−0.0294	0.0807	0.1364	0.0388	−0.1083	1			
7	Self-employed in MIDUS 1 (1-self-employed; 0-employed)	0.1379	0.3458	0	1	0.0248	−0.1468	−0.0462	−0.0905	−0.1477	0.0819	1		
8	Self-employed in MIDUS 2 (1-self-employed; 0-employed)	0.0919	0.2897	0	1	−0.047	−0.1348	0.0005	0.0289	−0.0228	0.0652	0.6225*	1	
9	Problem-Focused coping	37.4279	5.4506	16	48	−0.1603*	0.0805	0.0907	−0.044	0.2432*	−0.0162	−0.01	0.0225	1
10	Emotion-focused coping	21.5502	5.2160	12	45	0.1681*	−0.1976*	−0.1829*	0.1086	0.0552	0.0104	0.025	0.0161	−0.3501*

Notes.
$N = 174$ twins.
* $p < 0.05$ (two-tailed).

Table 7
ACE models.

	Coef.	Std. err.	z	$P > \|z\|$	[95% CI]	
A (additive genetic variance)	21.644	8.692	2.490	0.013	9.852	47.552
C (common environmental factors)	0.000	0.000	0.000	1.000	0.000	
E (specific environmental factors)	19.692	4.887	4.030	0.000	12.107	32.028
A + C + E	41.336	7.655	5.400	0.000	28.754	59.424
A% (additive genetic variance)	52.362	21.027	2.490	0.013	33.347	70.716
C% (common environmental factors)	0.000	0.001	0.000	1.000	0.000	100.000
E% (specific environmental factors)	47.638	11.822	4.030	0.000	35.872	59.673
_cons	0.267	0.525	0.510	0.611	−0.762	1.295
N	174					
Log pseudolikelihood	−566.515					

6.2.2. Length of self-employment

Consistent with our baseline arguments that AL is a long-term outcome, we use self-employed in both waves of MIDUS (variable: A1PB3B [1 = self-employed; 0 = employed] from MIDUS 1 completed in 1996; and variable: B1PB3B [1 = self-employed; 0 = employed] from MIDUS II survey completed between 2004 and 2006) as our key predictor for the length of self-employment. In the current sample based on case-wise deletion, 13.79% of the respondents were self-employed in MIDUS 1 and 9.19% were self-employed in MIDUS II.[4] These prevalence rates of self-employment are in line with those in the United States as a whole.[5]

The measure predictor— 'self-employment in 1995 wave × self-employment in 2004-2006 wave'— proxying length of self-employment is somewhat, albeit noisily, in line with Study 2. The self-employment status was measured in 1996 (MIDUS 1) and 2004–2006 (MIDUS 2) waves, the control variables are from the MIDUS 2 wave, and the biomarkers were measured between 2004 and 2009. Because AL is not immediately manifested but is a result of long-term wear-and-tear, the gaps in measurement may bias estimates. However, due to the long-term development of AL, such bias may not be significant due to the slow- and long-term processes associated with AL.

6.2.3. Coping measures

Coping styles in MIDUS II are based on the widely-used scales proposed by Carver et al. (1989). Problem-focused coping is measured using a 12-item scale (MIDUS II variable name: B1SPRCOP; $\alpha = 0.90$). Emotion-focused coping is measured using a 12-item scale (MIDUS II variable name: B1SEMCOP; $\alpha = 0.83$).

6.2.4. Controls

To limit the effects of alternate explanations we included several controls. As a proxy for a broad range of life outcomes, we include a log of for household income. We also control for education (1-no school or some grade school to 12-PH.D., ED.D., MD, DDS, LLB, LLD, JD, other terminal degrees), year of birth, gender (1-male; 2-female) and race (1-white; 0-all other races).

6.3. Study 3 results

In Table 6 we display the descriptive statistics for the Study 3 variables.

6.3.1. ACE model estimates

Because we draw on a sample of twins, we begin by exploring the relative effects of genetic, environmental, and individual factors on allostatic load. That is, we test the A.C.E. model factors: (A) additive genetic variance; (C) common environmental factors; and (E) specific environmental factors. We use the approach proposed by Rabe-Hesketh et al. (2008), which constrains variances equally to identify two random effects. The first random effects vary at the twin-pair level and are weighed 1 for monozygotic (MZ) twins and weighed as the square root of 0.5 for dizygotic (DZ) twins. The A.C.E. model in this method uses a random intercept at the twin pair level to identify C. This approach decomposes A as a random effect varying between twin pairs as well as a random effect varying within DZ twin pairs. Therefore, we use the *acelong* routine in Stata 15 to estimate the A.C.E. model. In Table 7 we show that A and E explain the majority of variance, whereas C, or the shared environmental factors between twins, explains virtually no variance. This inference is also supported in previous work by Johnson and Krueger (2005:169), who also use MIDUS 2 data and find near zero and non-significant effects for shared environmental variance on chronic illness and body mass index.

We used the multilevel model specification (Stata 15: *mixed*, *robust*) with zygosity at level-2; that is the additive genetic variance component, A, at level-2 modeled using zygosity and the individual variance component, E, as the random effect at the individual level to test our hypotheses. As a result of our analysis above, we do not model the shared environment component (C) as it does not explain meaningful variance. Our multilevel model controls for the shared errors between twins and is consistent with the actor–-partner interdependence model (APIM) in Schwartz (2017). Our choice of multilevel modeling is also based on Wang et al. (2011)

[4] Without casewise deletion, the number of self-employed twins were 61 in MIDUS 1 and 54 in MIDUS 2.
[5] Source: https://data.oecd.org/emp/self-employment-rate.htm

Table 8
Estimates from the multilevel model – Allostatic load.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Self-employed in MIDUS 1 (A)		0.198	17.84***	6.972		0.600	14.41***	8.482
		(1.920)	(3.305)	(5.446)		(1.431)	(2.375)	(5.807)
Self-employed in MIDUS 2 (B)		−3.851**	−7.485	−18.27***		−4.125***	−27.27***	−10.28***
		(1.563)	(8.140)	(3.684)		(0.928)	(2.008)	(2.014)
(A) × (B)		3.174**	−13.17***	22.71***		2.869***	6.546	14.79***
		(1.560)	(4.919)	(1.003)		(0.410)	(5.123)	(5.267)
Emotion-focused coping			0.204***				0.207**	
			(0.0531)				(0.0982)	
(A) × emotion-focused coping			−0.801***				−0.641***	
			(0.173)				(0.0629)	
(B) × emotion-focused coping			0.179				1.143***	
			(0.351)				(0.140)	
(A) × (B) × emotion-focused coping			0.717***				−0.242	
			(0.174)				(0.268)	
Problem-focused coping				−0.112				−0.135**
				(0.0728)				(0.0553)
(A) × problem-focused coping				−0.180**				−0.206*
				(0.0910)				(0.117)
(B) × problem-focused coping				0.351***				0.156***
				(0.0768)				(0.0481)
(A) × (B) × problem-focused coping				−0.496***				−0.316**
				(0.0357)				(0.123)
Log of household total income					−0.829***	−0.807***	−0.492***	−0.664***
					(0.0649)	(0.142)	(0.152)	(0.149)
Education					−0.143	−0.138	−0.0609	−0.108
					(0.389)	(0.392)	(0.327)	(0.327)
Year of birth					−0.0282***	−0.0229**	−0.0374***	−0.0343***
					(0.00719)	(0.0109)	(0.00732)	(0.00633)
Sex					−0.488	−0.348	−0.249	0.206
					(0.486)	(0.332)	(0.505)	(0.449)
White					−0.510***	−0.415	−0.659	−0.424***
					(0.172)	(0.444)	(0.517)	(0.0921)
Constant	0.0756	0.202	−4.210**	4.372	66.69***	55.93**	75.76***	80.41***
	(0.531)	(0.890)	(1.888)	(3.602)	(14.75)	(22.27)	(18.46)	(11.61)
Observations	186	186	186	186	174	174	174	174
Number of groups	3	3	3	3	3	3	3	3
LL	−610.3	−609.4	−605.6	−607.2	−569.5	−568.8	−565.5	−566.1
Wald test for the introduced variables		$p < 0.10$	$p < 0.001$	$p < 0.001$		$p < 0.001$	$p < 0.001$	$p < 0.001$

Notes. Robust standard errors in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

who state that "using mixed-effect models to analyze twin and family data [is] a computationally more convenient and theoretically more sound alternative to the classical structure equation modeling."

6.3.2. *Multilevel model estimates*

Due to the strong negative correlation between emotion and problem-focused coping we do not test these coping modes in the full model. The chi-square values are not available for model significance testing due to the use of robust standard errors; therefore, we use Wald-test analysis.[6] As presented in Table 8, self-employment is significantly associated with AL in both waves (Model 6: $\beta = 2.869$, $p < 0.01$). We do not plot the interactions because both self-employment in MIDUS 1 and self-employment in MIDUS 2 are dichotomous variables; as such, the relative change in status cannot be inferred on a continuous scale. The positive estimate shows that individuals who were self-employed in both waves have a higher rate of increase in AL compared to other combinations of employment and self-employment.

As presented in models 4 and 8 in Table 7 and in Fig. 2, those who were self-employed in both waves and leveraged problem-focused coping realize significant decreases in AL. This provides support for Hypothesis 3. Self-employment and emotion-focused coping are not associated with AL (models 3 and 7). In Model 3 without controls, the interaction is significant, however, in Model 6 with controls the effects are not significant. To draw more conservative inferences, we do not find support for Hypothesis 4.

In summary, with Study 3, we confirm the findings from Study 2 and investigate the varying degrees of effectiveness of coping strategies on the relationship between self-employment and AL. This further expands on our overall contribution to better

[6] Source: https://www.stata.com/support/faqs/statistics/likelihood-ratio-test/

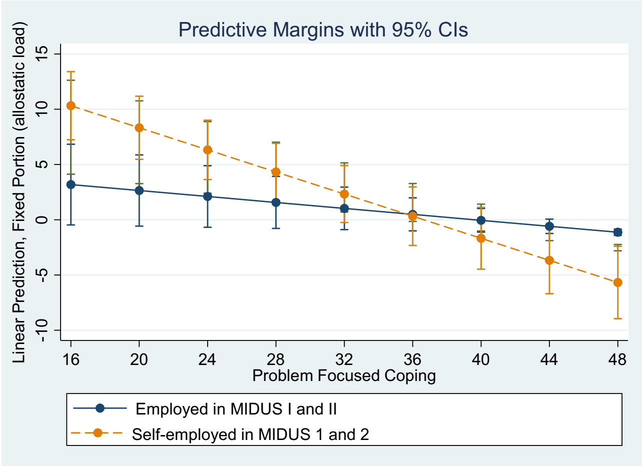

Fig. 2. Study 3–Problem-focused coping, allostatic load, self-employed.

understanding the relationship between self-employment and "stress." We provide preliminary insights and understanding into the role coping strategies play within the self-employment process by examining how specific coping strategies relate to AL within self-employed individuals.

7. General discussion

In this paper, we provide an empirical investigation of the relationship between self-employment and physiological outcomes — AL. We find evidence that self-employment via AL is negatively associated with physical (marginal significance), but not mental, health (Study 1). Furthermore, we find that self-employment over longer periods of time is positively related to AL, indicating a higher level of overall "wear-and-tear" for self-employed individuals (Study 2). Finally, self-employment for both waves (about eight years apart) combined with higher problem-focused coping was negatively associated with AL (Study 3). The results presented in this paper make several contributions to the existing literature.

7.1. Contributions to literature on health and wellbeing of the self-employed

Our study contributes to an important ongoing discussion about the relationship between self-employment and individual health and wellbeing. While recent evidence suggests that self-employment can reduce work-related stress (Hessels et al., 2017; Stephan and Roesler, 2010), our findings present evidence that self-employment could be negatively related to individual health and wellbeing via the relationship between self-employment and allostatic load. Rather than contradicting previous research on stress, health, and self-employment, however, we believe that our results offer a complementary perspective, and extend, clarify, and build upon prior findings.

As previously noted, the various forms of stress (e.g. threat versus challenge), have different cognitive and physiological antecedents (Tomaka et al., 1997) and produce distinct physiological responses (Seery, 2011). It is possible that previous studies that found potential benefits between self-employment and health (Stephan and Roesler, 2010) captured the reduction in "negative" forms of stress (i.e. harm and threat), that individuals experience as a result of self-employment while not incorporating the potential increase in "positive" stress (i.e. challenges) that might occur for individuals who are self-employed. By using AL as our outcome variable, we are able to extend prior findings and provide a more complete understanding of the relationship between self-employment and individual health and wellbeing.

7.2. Contributions to literature on coping with stress

We also contribute to prior research regarding coping with workplace stress. Prior evidence suggests that problem-focused coping can have a more homogeneous, positive influence with regards to addressing stressful situations, particularly in contexts where individuals perceive they have personal control over the situation (Folkman and Moskowitz, 2000). While previous evidence suggests that problem-focused coping can prove beneficial in regards to learning (Singh et al., 2007) and sensemaking (Ucbasaran et al., 2013), and that specific personality traits could influence these relationships (Grant and Langan-Fox, 2006), our results present another potential manner in which coping can influence key aspects of the entrepreneurial process. It is possible that individuals who employ higher levels of problem-focused coping could experience lower levels of AL, and as a result reap the benefits of improved overall health and wellbeing. While future research is needed to better understand the nuances and causal nature of these relationships, these results could represent an important step in furthering our understanding of pathways to improved health and wellbeing for individuals operating in an entrepreneurial context.

7.3. Contributions to literature on human physiology in management

Our work also contributes to the recent call for more research into the relationship between human physiology and key management phenomena (Heaphy and Dutton, 2008). We further this perspective by examining the relationship between self-employment and AL. By employing this novel, physiological measurement, we avoid one of the primary issues with previous work regarding self-employment and stress, which relied upon subjective interpretations based on self-reported survey measures (Ganster et al., 2001). Our findings suggest that more objective measures of health and wellbeing based on a physiological perspective could provide a better understanding of the nuanced relationship between self-employment and individual health and wellbeing. Therefore, while the primary focus of this research was on better understanding the relationship between self-employment and wellbeing, we anticipate that our findings can be a catalyst for additional research in the broader management academic community. That is, there are likely other conflicting findings relating to the work-stress relationships that could be better addressed using biological data. For example, AL measures could be used to assess relationships such as occupational change, attrition, or related topics where stress plays a role in workplace disruption. Similarly, the measures employed here could further inform decision-making, crisis management, and other critical management scenarios where physiological strain may be a factor.

7.4. Limitations and future research

As with all studies, our findings must be considered in the context of the limitations present in our research design. First, while the current study draws on three separate large-scale studies with reliable physiological measures, the data for our study is cross-sectional in nature and the dynamic evolution of AL cannot be empirically tested. Additionally, the standard deviation of AL as well as the estimates in the respective analyses varies across our three studies. This implies that measurement errors based on the availability of different types of biomarkers may be driving some variation in estimates and differences in standard errors. However, each of our operationalizations came from established research (referenced in the footnotes of Tables B1 and B2), where the measures were initially developed. Although we follow the well-received measures of AL for the respective datasets and included controls (including income, that could absorb many unobserved factors related to human capital), we call for additional research that employs a more uniform set of AL measures and a design that can infer causality.

Second, due to the cross-sectional nature of the datasets and due to lack of instruments directly explaining the choice of self-employment but not AL, we cannot control for self-selection into self-employment. In the moderation effects, the slope of the employed participants is steeper than that of self-employed participants, implying that the self-selection into self-employment may be present. Furthermore, evidence suggests that self-selection is an important component of the entrepreneurial process (Baron et al., 2016). From this perspective, individuals with personality traits that are particularly suited for entrepreneurship will be more likely to self-select into such employment, while those who lack in the requisite personality traits will forego pursuit of entrepreneurial opportunities. Therefore, it is possible that individuals who become entrepreneurs are uniquely capable of dealing with the pressures and demands placed upon them in these roles, and therefore are less likely to experience stress as a result of work demands.

In connecting the two previous limitations, causal inferences are neither stated nor implied. Possible future studies may include twin-control designs (where one twin is self-employed and the other employed). We are unable to employ such design in Study 3 due to sample size limitations. Similarly, self-selection related instruments coupled with twin-pair control design may provide better inferences. Additional investigations employing longitudinal samples could be undertaken to examine the causal direction between AL and self-employment. Causal studies would be necessary to tease out the potentially mutually reinforcing relationship between self-employment and AL.

Third, perceptions of threat and mobilization of specific allostatic mechanisms in response to stressors are influenced by a complex combination of individual differences in constitutional (e.g. genetics, development, experience), behavioral (e.g. mental and physical health habits), and historical (e.g. trauma, abuse, life events) factors that collectively determine an individual's experience of, and response to, stress (McEwen, 1998b). While we have done our best to include controls within the confines of data availability for as many such potential influences as possible, we acknowledge that we are unable to control for all such factors in a single study. As such, future research will need to specifically address this limitation and deliberately capture and examine how these diverse factors could possibly influence the relationship between self-employment and individuals' physiological stress response.

Fourth, since our measure of self-employment is restricted only to those who were actively engaged in self-employment at the time of being surveyed, it does not capture the entire spectrum of self-employment episodes. Future research could examine self-employment—AL relationships at multiple stages of the entrepreneurial life-cycle. Finally, while our measures of AL provide a more comprehensive view of individual health and wellbeing, they by no means represent a complete perspective of all potential physical and mental health outcomes that could be related to self-employment. As mentioned previously, other factors such as psychological capital (Baron et al., 2016), autonomy (Binder and Coad, 2013), perceptions of control (Hessels et al., 2017) can all influence the relationship between self-employment, health, and wellbeing. As such, we stress that our findings are an initial attempt to develop a more complete understanding of the relationship between self-employment, health, and wellbeing, and that future studies should incorporate additional factors that could clarify the relationship between entrepreneurship and wellbeing.

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The data in Study 2 is from NHANES III and provided by the National Center for Health Statistics.

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Appendix A. Measurement of allostatic load

The measurement of allostatic load is conditional on the availability of biomarkers in the respective samples. While the cut-offs for the levels of specific biomarkers that would contribute to allostatic load is generally agreed upon, except in a few cases, the type of biomarkers included in the operationalization of allostatic load varies from sample to sample. Collecting biomarker data is costly and requires significant resources to mobilize medical exam units. As such, there is a limited uniformity across biomarker studies in what biomarkers must be included in the index of allostatic load. This challenge is recently reviewed by Johnson et al. (2017) who studied 26 studies and concluded that:

"*no consistent method of operationalizing AL across studies. Individual biomarkers and biological systems included in the AL index differed widely across studies, as did the method of calculating the AL index. All studies included at least one cardiovascular- and metabolic-related biomarker in AL indices, while only half of studies included at least one hypothalamic-pituitary-adrenal (HPA) axis biomarker and approximately one third an immune response-related biomarker.*" (page 66).

The three samples used in the current study were collected with different objectives in mind. The Understanding Society sample in Study 1 collected data in two cross-sections, the NHANES III data in Study 2 also collected cross-sectional data but as a part of national cross-sectional survey, and the MIDUS data includes biomarkers from twins. The objectives and goals along with available resources led to variations in biomarkers that were available across these samples. Because allostatic load is calculated as an index, we do not assume it to constitute either a formative or a reflective construct. As indirectly confirmed in the 26 studies examined by Johnson et al. (2017), none of the studies included tests of scale reliability or typical scale validation tests. Furthermore, it would not be beneficial to conceive of AL as a formative construct, due to problems in combining units of measurement of biomarkers measured on different scales (Cadogan and Lee, 2013) and the challenges in the interpretation of effects (Edwards, 2011).

Based on the above discussion our aim is to ensure replication from previous studies using the same datasets in our respective studies. We start with Study 2, where we replicate operationalization of allostatic load from Seeman et al. (2008). This direct replication ensures that our operationalization is based on previously established, and widely cited, work. For Study 3, additional biomarkers are available, and we again, replicate the operationalization of allostatic load in Karlamangla et al. (2014). Related to Study 1, we draw on the above two cites, and used the biomarkers that overlap with those in Studies 2 and 3. In summary, while the operationalization of allostatic load does not lend to typical psychometric tests, the operationalizations for studies 2 and 3 are based on the respective samples used in well-established studies.

Appendix B

Table B1
Study 2 – Cut points for allostatic load.
Source: Seeman et al. (2008).

Variable	High-risk clinical
1. Albumin (g/dL)	< 3.8 g/dL (Visser et al., 2005)
2. C-reactive protein (mg/dL)	≥ 0.3 (Ridker, 2003)
3. Waist: hip	> 0.90 for men; > 0.85 for women (Alberti and Zimmet, 1998)
4. Total cholesterol (mg/dL)	≥ 240 (NCEP Expert Panel, 2001)
5. HDL (mg/dL)	< 40 (NCEP Expert Panel, 2001)
6. Glycated hemoglobin (%)	≥ 6.4 (Golden et al., 2003; Osei et al., 2003)
7. Resting heart rate (bt/min)	≥ 90 (Seccareccia et al., 2001)
8. Systolic BP (mm Hg)	≥ 140 (Chobanian et al., 2003)
9. Diastolic BP (mm Hg)	≥ 90 (Chobanian et al., 2003)

Table B2
Study 3 – Cut points for system-level and allostatic load scoring.
Source: Karlamangla et al. (2014).

Biomarker	Cut points
Cardiovascular	
1. Systolic blood pressure (mm Hg)	≥143
2. Resting pulse pressure (mm Hg)	≥65
3. Resting heart rate (beats/min)	≥77
Glucose metabolism	
4. Blood glycosylated hemoglobin (%)	≥6.1
5. Fasting blood glucose (mg/dL)	≥105
6. Homeostasis model assessed insulin resistance	≥4.04
Lipid metabolism	
7. Body mass index (kg/m^2)	≥32.3
8. Waist-to-hip circumference ratio	≥0.97
9. Low-density lipoprotein cholesterol (mg/dL)	≥128
10. High-density lipoprotein cholesterol (mg/dL)	≤41.4
11. Serum triglycerides (mg/dL)	≥160
Inflammation	
12. Serum C-reactive protein (mg/L)	≥3.18
13. Serum interleuken 6 (ng/L)	≥3.18
14. *E*-selectin (ng/mL)	≥50.6
15. Intracellular adhesion molecule (mg/L)	≥330
16. Fibrinogen (mg/dL)	≥390
Hypothalamicepituitaryeadrenal axis	
17. Urine cortisol (mg/g of creatinine)	≥21.0
18. Serum dehydroepiandrosterone sulfate (mg/dL)	≤51.0
Sympathetic nervous system	
19. Urine epinephrine (mg/g of creatinine)	≥2.54
20. Urine norepinephrine (mg/g of creatinine)	≥33.3
Parasympathetic (heart rate variability)	
21. Low-frequency power (ms^2)	≤114
22. High-frequency power (ms^2)	≤54.2
23. R-R interval standard deviation (ms)	≤23.5
24. Root mean square successive differences (ms)	≤11.8

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