Journal of Business Venturing Insights 8 (2017) 78–86

Contents lists available at ScienceDirect

Journal of Business Venturing Insights

journal homepage: www.elsevier.com/locate/jbvi

Two are better than one: Cortisol as a contingency in the association between epinephrine and self-employment

Marcus T. Wolfe[a,*], Pankaj C. Patel[b]

[a] University of Oklahoma Price College of Business, 307 W. Brooks St., Norman, OK 73069, United States
[b] Villanova University, 800 E. Lancaster Ave., Villanova, PA 19085, United States

ARTICLE INFO

Keywords:
Cortisol
Dual hormone theory
Epinephrine
Self-employment

ABSTRACT

In the context of self-employment, which is characterized by risk and uncertainty, epinephrine could elicit a "fight or flight" response. However, little attention has been given to what factors could differentiate those who 'fight' (i.e. pursue self-employment) versus those who 'fly' (i.e. forgo pursuing self-employment). Moving from individual and social explanations on drivers of self-employment as an occupational choice, we propose that the association between epinephrine and self-employment could be conditional on levels of a second hormone, namely cortisol. Based on a sample of 273 individuals from the Midlife in the United States (MIDUS 2) study, 2004–2006, and controlling for a wide variety of factors, epinephrine is not associated with self-employment on its own, however, it is associated with self-employment at low levels of cortisol. We are among the first to demonstrate a link between the dual influence of epinephrine and cortisol and self-employment.

1. Introduction

The influence of biological factors on self-employment is at the core of a growing stream of research. A number of recent studies have examined various potential biological links to self-employment, ranging from genetic factors (Nicolaou and Shane, 2009; Shane et al., 2010) to mental health conditions (Verheul et al., 2016; Wiklund et al., 2016). Of late, there has been a growing interest in the neuroendocrinology of self-employment and entrepreneurial activity. For example, evidence suggests that individual differences in testosterone can influence entrepreneurial activity (White et al., 2006) and that greater exposure to prenatal testosterone can benefit new venture performance (Guiso and Rustichini, 2011). However, most of this stream of research has focused on the influence of a single hormone. Motivated by recent work on the dual hormone hypothesis from the field of neurophysiology (Mehta and Prasad, 2015), we develop and test a model intended to further our understanding of the joint association of hormones with self-employment as an occupational choice.

Our proposition that cortisol modulates the association between epinephrine and self-employment is based on that logic that specific stress conditions, along with the way that individuals appraise those conditions, can produce distinct emotional and physiological responses (referred to as the integrated specificity model) (Kemeny, 2003). Evidence suggests that cortisol and epinephrine control opposing circadian systems, which results in markedly different effects with regards to the immune system response to stress (Dimitrov et al., 2009), and could suggest a similar deviation with regards to their association in terms of the neuroendocrinological response to self-employment related stress as well. Because both cortisol and epinephrine can influence memory and learning (Cahill and Alkire, 2003) as well as emotional regulation and activity (Lanau et al., 1997), uncovering how specific levels of each are

* Corresponding author.
E-mail addresses: mtwolfe@ou.edu (M.T. Wolfe), pankaj.patel@villanova.edu (P.C. Patel).

http://dx.doi.org/10.1016/j.jbvi.2017.07.002
Received 9 May 2017; Received in revised form 23 June 2017; Accepted 11 July 2017

associated with self-employment could provide important insights, and could shed light onto a relatively understudied neuroendocrinological predictors of self-employment.

This article makes several important contributions. First, we extend the literature regarding the potential relationship between hormones and self-employment (Sapienza et al., 2009; White et al., 2006). While previous research has focused primarily on the influence that testosterone might have on self-employment, our study provides evidence that self-employment could also be related to other hormones, namely epinephrine and cortisol, and that these relationships are potentially complex in nature. Second, we respond to recent research calling for the need to allocate more attention to human physiology across a wide range of management phenomena (Heaphy and Dutton, 2008). Finally, we extend research regarding the dual hormone hypothesis from the field of neurophysiology, and demonstrate that this perspective could have important implications for the study of entrepreneurship.

2. Epinephrine, cortisol, and self-employment

Despite the limited research on the topic, evidence suggests that epinephrine, also known as adrenaline, can play a key role in self-employment as an occupational choice. Epinephrine has been linked to risk taking (Kreek et al., 2005) and impulsivity (Evenden, 1999), particularly as it relates to voluntary actions and behaviors associated with self-employment (Lupton and Tulloch, 2002). Moreover, sensation-seeking personality traits have been shown to be associated with elevated levels of epinephrine (Gerra et al., 1999). Thus, higher levels of epinephrine could be associated with individuals who crave more novel, higher risk experiences, and one way to discover such experiences is through self-employment. It is important to note that epinephrine is commonly associated with "fight or flight" behavior (Black, 1994), and while some individuals will likely seek out and thrive on self-employment as associated with levels of epinephrine it is possible that for others, the response could result in a rapid "flight" away from such stressful activities. As such, it is important to understand the conditions that could facilitate either the "fight" or "flight" response elicited under such circumstances, with one potential influence being the presence of other hormones.

Based off the dual hormone hypothesis in neurophysiology (Mehta and Prasad, 2015), we propose that the association between epinephrine and self-employment could be conditional on levels of a second hormone, namely cortisol. The dual hormone hypothesis by Mehta and Prasad (2015) states that the influence of testosterone on human behavior can be conditional, in part, on cortisol levels. In a similar vein, we extend this logic to explain how the association between epinephrine and self-employment could be modulated by cortisol levels – for epinephrine to be positively associated with self-employment, cortisol levels must be lower. From a physiological perspective, elevated cortisol and epinephrine levels have been linked to increased stress and high risk behavior (Schmitt et al., 1998), elevated levels of anxiety (Lederman et al., 1978), and the likelihood of experiencing post-traumatic stress disorder (PTSD) after traumatic events (Delahanty et al., 2005). However, while substantial evidence has established the potential for unilateral increases in both cortisol and epinephrine in association with stress, relatively less attention has been given to the differential responses that can be elicited from the underlying systems responsible for cortisol and epinephrine regulation.

This is important to note because epinephrine and cortisol represent hormonal components of the two primary brain stress-response systems; namely the sympathetic nervous system (epinephrine) and the hypothalamic–pituitary–adrenal (HPA) axis (cortisol). Thus, it is possible for both epinephrine and cortisol to be stimulated by similar events, although not necessarily in a uniform, consistent manner. The Integrated Specificity Model (ISM) states that the specific conditions of stress events, along with the unique way an individual appraises those conditions, can produce qualitatively distinct emotional and physiological responses (Kemeny, 2003). Therefore, it is possible that while production of both epinephrine and cortisol are likely to be stimulated by similar events, the relative levels of each can vary depending upon individual and situational variances. Furthermore, since the predominant effects of each hormone can vary, it is imperative that we develop a more comprehensive understanding of the nuanced relationship between self-employment and both epinephrine and cortisol. As such, we expect that epinephrine will have a differential relationship with self-employment depending upon the levels of cortisol present.

Research question 1: Will epinephrine have a differential relationship with self-employment at low versus high levels of cortisol?

3. Materials and methods

3.1. Participants

To test for the proposed associations, we drew on data from the National Survey of Midlife Development in the United States 2004–2006 (MIDUS II) (Swann et al., 2013), a comprehensive study of individuals between 35 and 86 years of age. MIDUS II measures a variety of behavioral and psychological characteristics, including biomarkers. A detailed description of sampling and data collection procedures are available at http://midus.colectica.org/.

The first wave of MIDUS started in 1995. The data was gathered from non-institutionalized individuals in the contiguous United States, and the participants were between the ages of 25 and 76. The next wave, MIDUS II, was conducted between 2004 and 2006. In addition to survey and phone interviews, 3308 participants were recruited for providing biomarker samples. Among the 3308 participants 338 were ineligible, and of the remaining individuals 1054 completed the biomarker component. For the biomarker component, individuals completed two-day visits to one of three clinics located on the either the East coast, Midwest, or West coast of the United States. The examination included a health assessment, fasting blood draw, and overnight 12-hour urine collection (from 19:00 on the previous day to 7:00 on the next day). Additional analyses conducted by MIDUS II collaborators indicates no significant difference between biomarker and non-biomarker participants on the dimensions of age, sex, race, marital status, income, and health

(Dienberg Love et al., 2010). We used no filters, and based on casewise deletion, our final sample for analyses included 273 individuals with complete data for all variables included in the analysis.

3.2. Measures

The outcome variable is whether an individual is self-employed. In the current sample, based on casewise deletion, 22.63% of the respondents were self-employed. Our two key hormone measures are Urine Epinephrine (adjusted for Urine creatinine) [ug/g] and Urine Cortisol (adjusted for Urine creatinine) [ug/g]. The values are standardized for diuretic effects by dividing the raw values by the level of urinary creatinine.

To limit the influence of alternate explanations, we include a wide variety of controls. As health conditions can influence hormone levels, we include a count measure of the number of major health events reported. To control for the influence of additional hormones, we include Urine Dopamine adjusted for Urine Creatinine (ug/g), Urine Norepinephrine adjusted Urine Creatinine (ug/g), and the Ratio of Serum Creatinine to Urine Creatinine. The first two hormones were standardized for diuretic effects by dividing the raw values by the level of urinary creatinine. The ratio of serum to urine creatinine is included to control for metabolic and inflammatory activity (Coresh et al., 2001).

Additionally, we control for gender (1 = Male; 2 = Female), age (year of response minus date of birth), highest level of education (ranging from 1 = no school or some grade school to 12 = PH.D., ED.D., MD, DDS, LLB, LLD, JD, or other terminal degree), respondent's total income, household total income and whether respondent was married or living with a partner. As perceived life satisfaction and job demands could influence hormone levels (Eskelinen et al., 2007), we include these measures as controls. Life satisfaction was measured with the MIDUS II scale based on a six-item measure ($\alpha = 0.65$),[1] asking participants to rate satisfaction with life overall, health, work, relationship with spouse/partner, and children (Prenda and Lachman, 2001). Participants used an 11-point scale ranging from (0) *the worst possible* to (10) *the best possible.* Job demands were measured using a five-item scale ($\alpha = 0.73$) from the job characteristics scale (Karasek et al., 1988). *Positive affect* (4-items; $\alpha = 0.86$) and *negative affect* (5-items; $\alpha = 0.80$) were each measured with items from the PANAS instrument (Watson et al., 1988).

The social context of an individual's environment can also influence self-employment (Mair and Marti, 2006). As such, we also include family (8-items; $\alpha = 0.82$), friendship (8-items; $\alpha = 0.77$), and spousal (12-items; $\alpha = 0.91$) affectual solidarity (Walen and Lachman, 2000) controls in our analyses. Furthermore, personality (Zhao et al., 2010) is associated with self-employment. To control for these factors, we include the Big-Five personality items (Turiano et al., 2011) in our analyses. The Big-Five personality dimensions include Agreeableness (5-items; $\alpha = 0.80$), Extraversion (5-items; $\alpha = 0.76$), Neuroticism (4-items; $\alpha = 0.74$), Conscientiousness (5-items; $\alpha = 0.68$), and Openness to Experience (7-items; $\alpha = 0.77$).

Because depression could influence hormonal balance (Almeida et al., 2009), we include the CES-D scale to control for depression based effects. Finally, as the industry sector could influence the nature of self-employment demands, we include controls for the following sectors: agriculture, forestry, fishing, and mining; construction; manufacturing; transportation, communications; wholesale trade; retail trade; finance, insurance, and real estate; business and repair services; personal services; entertainment and recreational services; professional and related services; and public administration.

4. Results

Table 1 lists the descriptives for all variables used in our analyses. As the outcome variable is dichotomous, we use the *logit* regression function in Stata 14.1 to test for the proposed hypothesis. Based on recommendations from MIDUS II collaborators, we use the weighting variable 'B1PWGHT9′ which is the sample weight for Gender × Race × Age × Education. In Model 1, in Table 2, we include the control variables, followed by the direct effects of epinephrine and cortisol in Models 2 and 3, respectively. Supporting the 'dual' effects of the two hormones, in Models 2, 3, and 4 the direct effects of epinephrine or cortisol on self-employment are not significant.

Supporting the joint effects of the two hormones (Table 2; odds ratio = −0.0729, $p < 0.01$), Fig. 1 provides an interpretation of the effects of epinephrine at minimum (as mean minus one standard deviation, based on Table 1, would result in a negative value), average (mean = 17), and high (mean plus one standard deviation = 51) levels of cortisol. With increasing epinephrine levels, lower levels of cortisol increase the odds of self-employment whereas higher levels of cortisol lower the odds of self-employment. As such, epinephrine is positively associated with the odds of self-employment at lower levels of cortisol. Interestingly, our results also indicated low levels of epinephrine were positively associated with the odds of self-employment at higher levels of cortisol. Although not specifically hypothesized, this is a finding which we will discuss further in subsequent sections.

5. Discussion

Our main findings suggest that elevated levels of epinephrine in combination with low levels of cortisol are associated with self-employment. These findings extend recent results regarding the link between biological factors and self-employment (Nicolaou and

[1] The reported Cronbach's alphas are based on full sample data, as reported in the Inter-University Consortium for Political and Social Research (Ryff C. *et al.*, 2012). The alpha for Life Satisfaction is based on five-item measure (B1SATIS), instead of B1SATIS2, a six-item measure used for the analysis. The Inter-University Consortium for Political and Social Research (2010.) does not provide alpha specifics for B1SATIS2.

Table 1
Sample descriptives.

		N	Mean	sd	Min	Max	Iqr	1	2	3
1	Self-employed	495	0.2263	0.4188	0	1	0	1		
2	Urine Epinephrine adjusted for Urine Creatinine [ug/g]	495	1.9467	1.1541	0.328	9.787	1.218	−0.0367	1	
3	Urine Cortisol adjusted for Urine Creatinine [ug/g]	495	17.0459	34.4068	1.1	725	11.6	0.0541	0.1441*	1
4	Total number of major health events reported	495	1.0929	1.2708	0	4	2	−0.0396	−0.0214	−0.0418
5	Urine Dopamine adjusted for Urine Creatinine (ug/g)	495	148.8206	64.0990	8.152	849.057	61.538	−0.0529	0.3015*	0.1929*
6	Urine Norepinephrine adjusted for Urine Creatinine (ug/g)	495	25.5990	11.0113	6.885	84.211	13.537	−0.0826	0.4315*	0.1008*
7	Ratio of Serum Creatinine to Urine Creatinine	495	0.0145	0.0081	0.002	0.057	0.011	−0.0025	0.2671*	0.1330*
8	Gender	495	1.4747	0.4999	1	2	1	−0.0887*	0.1330*	0.1119*
9	Age	495	51.4404	9.2498	34	81	14	0.1524*	0.0965*	0.0678
10	Highest of level of to education completed	495	7.9778	2.4523	1	12	4	−0.0739	−0.0278	−0.0748
11	R's total income	495	58,625.76	45,800.01	0	200,000	45,250	0.0273	−0.0674	−0.0781
12	Household total income	495	99,581.12	65,769.67	0	300,000	66,450	−0.0223	−0.0505	−0.0716
13	Married or living with partner	495	1.0485	0.2150	1	2	0	−0.0322	−0.0083	0.0192
14	Job Demands scale (Job Characteristics)	495	14.5993	3.0928	6	24	4	−0.0752	−0.0222	−0.0920*
15	Life Satisfaction (6-item version)	495	7.6358	1.0717	2.8	9.8	1.4	0.0882*	0.0457	0.0782
16	Negative Affect (PANAS)	495	1.5305	0.4530	1	4	0.6	−0.0375	−0.0641	0.0008
17	Positive Affect (PANAS)	495	3.6475	0.6975	1	5	0.75	0.1419*	0.1227*	0.042
18	Family Affectual Solidarity	495	3.2786	0.4414	1.5	4	0.625	0.076	0.0365	0.0296
19	Friendship Affectual Solidarity	495	3.2562	0.4146	1.5	4	0.5	0.0307	0.0335	0.0696
20	Spouse Affectual Solidarity	495	3.1923	0.5332	1.167	4	0.666	0.0631	0.0153	0.0318
21	Agreeableness Personality Trait	495	3.4063	0.5027	1.8	4	0.8	0.0577	0.1109*	0.0151
22	Extraversion Personality Trait	495	3.1200	0.5685	1.4	4	0.8	0.1034*	0.0894*	0.0163
23	Neuroticism Personality Trait	495	2.0421	0.5995	1	4	1	−0.0299	0.0331	−0.0123
24	Conscientiousness Personality Trait	495	3.4271	0.4235	1.8	4	0.6	0.0847	0.0971*	0.0292
25	Openness Personality Trait	495	2.9692	0.5078	1.429	4	0.715	0.1230*	−0.0001	−0.0622
26	CESD: Center (Epidemiologic)	495	7.0990	6.7584	0	49	8	−0.0301	−0.0537	−0.0184
27	CONSTRUCTION	495	0.0444	0.2063	0	1	0	0.1411*	−0.0354	−0.0133
28	MANUFACTURING	495	0.1273	0.3336	0	1	0	−0.0327	−0.0286	−0.033
29	TRANSPORTATION, COMMUNICATIONS, AND PUB	495	0.0727	0.2600	0	1	0	−0.0957*	−0.0305	−0.0254
30	WHOLESALE TRADE	495	0.0364	0.1874	0	1	0	−0.0019	−0.0214	0.0025
31	RETAIL TRADE	495	0.0949	0.2934	0	1	0	−0.0104	0.0052	−0.0111
32	FINANCE, INSURANCE, AND REAL ESTATE	495	0.0747	0.2632	0	1	0	0.0299	−0.0144	−0.0363
33	BUSINESS AND REPAIR SERVICES	495	0.0465	0.2107	0	1	0	0.1329*	0.066	0.0318
34	PERSONAL SERVICES	495	0.0384	0.1923	0	1	0	0.0930*	−0.0377	0.2380*
35	ENTERTAINMENT AND RECREATIONAL SERVICES	495	0.0101	0.1001	0	1	0	−0.0063	0.0568	−0.0144
36	PROFESSIONAL AND RELATED SERVICES	495	0.3818	0.4863	0	1	1	−0.0871	0.0774	−0.0242
37	PUBLIC ADMINISTRATION	495	0.0485	0.2150	0	1	0	−0.1221*	−0.0552	−0.0183

		4	5	6	7	8	9	10	11	12	13
4	Total number of major health events reported	1									
5	Urine Dopamine adjusted for Urine Creatinine (ug/g)	−0.0899*	1								
6	Urine Norepinephrine adjusted for Urine Creatinine (ug/g)	−0.01	0.4706*	1							
7	Ratio of Serum Creatinine to Urine Creatinine	0.066	0.1787*	0.2111*	1						
8	Gender	−0.07	0.2763*	0.2819*	0.2135*	1					

(continued on next page)

Table 1 *(continued)*

		4	5	6	7	8	9	10	11	12	13
9	Age	0.048	−0.0662	0.1295*	0.1742*	−0.1053*	1				
10	Highest of level of to education completed	0.068	−0.0980*	−0.1208*	−0.005	−0.036	−0.0477	1			
10	R's total income	−0.03	−0.1059*	−0.1063*	−0.0777	−0.2450*	0.0571	0.2752*	1		
11	Household total income	−0.02	−0.0473	−0.0653	−0.0808	−0.0481	−0.0491	0.2864*	0.8444*	1	
12	Married or living with partner	−0.07	0.067	0.1014*	0.0675	0.0491	−0.0606	−0.0325	−0.017	−0.0609	1
13	Job Demands scale (Job Characteristics)	0.021	−0.0641	−0.0507	−0.0254	0.0172	−0.2313*	0.0695	0.1258*	0.0923*	0.0262
14	Life Satisfaction (6-item version)	−0.1167*	0.0145	0.0141	−0.0149	0.0184	0.1786*	0.1098*	0.1721*	0.2176*	−0.1024*
16	Negative Affect (PANAS)	−0.03	0.0642	0.0094	−0.002	0.041	−0.1688*	−0.0719	−0.0395	−0.0373	0.0762
17	Positive Affect (PANAS)	−0.05	−0.0213	0.0295	0.0735	−0.0183	0.1840*	0.0288	0.0299	0.0335	0.0298
18	Family Affectual Solidarity	−0.04	−0.0383	0.0146	−0.0106	0.0084	0.0774	0.0624	0.0536	0.0488	−0.0413
19	Friendship Affectual Solidarity	−0.07	0.0512	0.0902*	0.0152	0.1309*	0.0085	0.0788	−0.015	0.0613	−0.0914*
20	Spouse Affectual Solidarity	−0.07	−0.0216	0.0054	−0.0514	−0.066	0.0145	−0.0256	0.0112	0.0421	−0.1255*
21	Agreeableness Personality Trait	0.077	0.0747	0.1434*	0.0598	0.2218*	0.0943*	−0.0552	−0.071	−0.0399	0.0009
22	Extraversion Personality Trait	−0.01	−0.0198	0.0169	0.0608	0.0513	0.1161*	−0.0628	0.0325	0.0242	0.0451
23	Neuroticism Personality Trait	−0.07	0.0662	−0.0026	0.0246	0.0621	−0.1812*	−0.0979*	−0.0059	−0.013	0.0391
24	Conscientiousness Personality Trait	−0.04	0.0763	0	−0.049	0.1352*	0.0198	0.0134	0.0274	0.0658	−0.0322
25	Openness Personality Trait	0.0915*	−0.1068*	−0.0532	−0.0155	−0.1118*	0.0649	0.1423*	0.0489	0.0288	−0.0278
26	CESD: Center (Epidemiologic)	0.018	0.0711	0.0213	−0.0698	−0.0026	−0.0949*	−0.0398	−0.0202	−0.0675	0.065
27	CONSTRUCTION	0.023	0.0287	−0.0244	−0.0173	−0.0872	−0.0007	−0.1461*	−0.0638	−0.0343	−0.0487
28	MANUFACTURING	−0.06	−0.0323	−0.0237	−0.031	−0.1567*	−0.0772	−0.0930*	−0.004	−0.0506	0.0549
29	TRANSPORTATION, COMMUNICATIONS, AND PUB	0.078	−0.036	−0.0684	−0.0787	−0.1572*	−0.0538	−0.0641	0.0728	0.0411	0.0092
30	WHOLESALE TRADE	−0.01	−0.0189	0.0606	0.0721	−0.0334	0.0445	−0.0599	0.0351	0.0231	0.0064
31	RETAIL TRADE	0.047	−0.0288	−0.0439	0.0154	−0.0595	0.0867	−0.1377*	−0.0903*	−0.056	−0.041
32	FINANCE, INSURANCE, AND REAL ESTATE	−0.01	−0.0501	0.027	−0.0429	−0.0087	0.087	−0.0633	0.1675*	0.1252*	−0.0284
33	BUSINESS AND REPAIR SERVICES	0.007	0.1705*	−0.0348	−0.0188	0.0016	−0.0261	−0.0842	−0.005	−0.0096	−0.0051
34	PERSONAL SERVICES	−0.1057*	−0.0021	0.0711	−0.0088	0.1259*	−0.0107	−0.1184*	−0.1214*	−0.1107*	0.0528
35	ENTERTAINMENT AND RECREATIONAL SERVICES	−0.07	−0.0102	0.0292	0.0388	0.0253	−0.0026	0.0092	−0.021	−0.0552	−0.0228
36	PROFESSIONAL AND RELATED SERVICES	0.018	0.0496	0.0561	0.1118*	0.2937*	0.0089	0.3822*	0.0055	0.07	−0.0419
37	PUBLIC ADMINISTRATION	0.021	−0.0999*	−0.0205	−0.0938*	−0.0828	−0.0413	0.0635	0.0032	−0.0267	0.1242*

		14	15	16	17	18	19	20	21	22	23	24	25	26
14	Job Demands scale (Job Characteristics)	1												
15	Life Satisfaction (6-item version)	−0.3072*	1											
16	Negative Affect (PANAS)	0.2401*	−0.3852*	1										
17	Positive Affect (PANAS)	−0.1308*	0.4457*	−0.4488*	1									
18	Family Affectual Solidarity	−0.1973*	0.3638*	−0.3216*	0.2497*	1								
19	Friendship Affectual Solidarity	−0.1491*	0.3171*	−0.2196*	0.2800*	0.4138*	1							
20	Spouse Affectual Solidarity	−0.1659*	0.4711*	−0.2212*	0.2401*	0.3185*	0.2178*	1						
21	Agreeableness Personality Trait	−0.08	0.2085*	−0.1634*	0.2460*	0.2143*	0.3341*	0.1021*	1					
22	Extraversion Personality Trait	−0.07	0.2824*	−0.2424*	0.4732*	0.1644*	0.2545*	0.1180*	0.4768*	1				
23	Neuroticism Personality Trait	0.2456*	−0.3348*	0.5665*	−0.3680*	−0.2682*	−0.2316*	−0.1388*	−0.1668*	−0.1918*	1			
24	Conscientiousness Personality Trait	−0.03	0.1985*	−0.1597*	0.2832*	0.1338*	0.1426*	0.1715*	0.2110*	0.1927*	−0.0542	1		
25	Openness Personality Trait	−0.04	0.1854*	−0.1738*	0.3388*	0.0873	0.1528*	0.0897*	0.2700*	0.4480*	−0.1962*	0.2654*	1	
26	CESD: Center (Epidemiologic)	0.2032*	−0.3819*	0.4061*	−0.3834*	−0.2943*	−0.2404*	−0.1931*	−0.1577*	−0.2545*	0.3843*	−0.1592*	−0.1477*	1
27	CONSTRUCTION	−0.03	−0.0182	0.0548	0.0141	0.011	−0.0003	0.074	−0.0534	−0.0076	−0.0356	−0.0648	−0.0053	−0.0656
28	MANUFACTURING	0.024	−0.0286	0.0024	−0.083	−0.0282	−0.0533	0.0139	−0.1206*	−0.0636	0.0212	−0.0495	−0.0656	0.0617
29	TRANSPORTATION, COMMUNICATIONS, AND PUB	−0.04	−0.0733	0.0189	−0.0900*	−0.049	−0.0347	−0.1083*	−0.0809	−0.0236	−0.0197	−0.029	0.0309	0.0754

(continued on next page)

Table 1 *(continued)*

		14	15	16	17	18	19	20	21	22	23	24	25	26
30	WHOLESALE TRADE	−0.01	0.059	−0.0179	0.0286	0.0241	0.0231	0.0227	−0.0497	0.016	−0.0091	−0.043	−0.0247	−0.0652
31	RETAIL TRADE	0.004	−0.0641	−0.0051	−0.0018	0.0337	−0.017	0.0383	−0.0123	0.0189	0.0319	−0.0069	−0.0222	−0.0282
32	FINANCE, INSURANCE, AND REAL ESTATE	−0.01	0.1053*	−0.0684	0.0749	0.0948*	0.0769	0.0837	0.0515	0.0482	−0.0488	0.0762	−0.0001	−0.0497
33	BUSINESS AND REPAIR SERVICES	−0.01	0.0041	0.0169	0.0221	−0.0361	−0.0091	−0.0632	−0.0142	0.0108	0.0406	−0.0039	−0.0136	−0.016
34	PERSONAL SERVICES	−0.0898*	−0.0123	−0.0158	0.0483	−0.0398	−0.0252	0.025	0.0059	0.0689	0.0211	0.017	−0.056	0.0703
35	ENTERTAINMENT AND RECREATIONAL SERVICES	−0.05	0.0451	0.0066	−0.0359	−0.0123	−0.0137	−0.0143	0.0229	0.0356	0.0351	0.0508	0.0289	0.0195
36	PROFESSIONAL AND RELATED SERVICES	0.046	0.0379	0.0196	0.05	0.0295	0.0992*	−0.0228	0.1980*	−0.0167	−0.0159	0.0387	0.0890*	−0.0109
37	PUBLIC ADMINISTRATION	0.026	−0.0216	−0.0609	−0.014	−0.0573	−0.0744	−0.0476	−0.1227*	0.0318	−0.008	0.0078	−0.0181	−0.0451

		27	28	29	30	31	32	33	34	35	36	37
27	CONSTRUCTION	1										
28	MANUFACTURING	−0.08	1									
29	TRANSPORTATION, COMMUNICATIONS, AND PUB	−0.06	−0.1069*	1								
30	WHOLESALE TRADE	−0.04	−0.0742	−0.0544	1							
31	RETAIL TRADE	−0.07	−0.1237*	−0.0907*	−0.0629	1						
32	FINANCE, INSURANCE, AND REAL ESTATE	−0.06	−0.1085*	−0.0796	−0.0552	−0.0921*	1					
33	BUSINESS AND REPAIR SERVICES	−0.05	−0.0843	−0.0618	−0.0429	−0.0715	−0.0627	1				
34	PERSONAL SERVICES	−0.04	−0.0763	−0.056	−0.0388	−0.0647	−0.0568	−0.0441	1			
35	ENTERTAINMENT AND RECREATIONAL SERVICES	−0.02	−0.0386	−0.0283	−0.0196	−0.0327	−0.0287	−0.0223	−0.0202	1		
36	PROFESSIONAL AND RELATED SERVICES	−0.1695*	−0.3001*	−0.2201*	−0.1527*	−0.2546*	−0.2234*	−0.1735*	−0.1570*	−0.0794	1	
37	PUBLIC ADMINISTRATION	−0.05	−0.0862	−0.0632	−0.0439	−0.0731	−0.0642	−0.0498	−0.0451	−0.0228	−0.1774*	1

Note.

As the epinephrine and cortisol interaction variable is not included in the above table the sample size equated to N = 495, this is compared to N = 273 in the final model which included the interaction effect variable of Table 2.

* $p < 0.05$ (two-tailed).

Table 2
Logit regression estimates.

VARIABLES	(1) Self_employed	(2) Self_employed	(3) Self_employed	(4) Self_employed	(5) Self_employed
Urine Epinephrine adjusted for Urine Creatinine [ug/g]		−0.0913		−0.0467	1.028**
		(0.184)		(0.191)	(0.399)
Urine Cortisol adjusted for Urine Creatinine [ug/g]			−0.0144	−0.0134	0.133***
			(0.0136)	(0.0143)	(0.0464)
Epinephrine × Cortisol					−0.0729***
					(0.0235)
Total number of major health events reported	−0.0862	−0.0922	−0.0852	−0.0887	−0.101
	(0.138)	(0.137)	(0.138)	(0.137)	(0.143)
Urine Dopamine adjusted for Urine Creatinine (ug/g)	−0.00107	−0.000730	−9.40e−05	7.63e−05	0.00154
	(0.00459)	(0.00459)	(0.00451)	(0.00450)	(0.00452)
Urine Norepinephrine adjusted for Urine Creatinine (ug/g)	−0.0205	−0.0174	−0.0203	−0.0192	−0.0270
	(0.0221)	(0.0235)	(0.0225)	(0.0245)	(0.0265)
Ratio of Serum Creatinine to Urine Creatinine	1.783	3.128	7.113	7.246	35.05
	(24.70)	(25.18)	(25.29)	(25.71)	(25.80)
Gender	−0.0349	−0.0438	−0.0422	−0.0458	−0.188
	(0.522)	(0.519)	(0.524)	(0.521)	(0.540)
Age	0.0395*	0.0400*	0.0387*	0.0393*	0.0440**
	(0.0207)	(0.0207)	(0.0205)	(0.0206)	(0.0197)
Highest of level of to education completed	0.00589	0.00747	0.000687	0.00323	−0.0197
	(0.0868)	(0.0872)	(0.0854)	(0.0858)	(0.0902)
R's total income	1.25e−05	1.23e−05	1.26e−05	1.23e−05	1.13e−05
	(9.90e−06)	(1.00e−05)	(1.00e−05)	(1.01e−05)	(1.08e−05)
Household total income	−8.08e−06	−8.21e−06	−8.42e−06	−8.45e−06	−7.60e−06
	(5.91e−06)	(5.91e−06)	(5.89e−06)	(5.88e−06)	(6.17e−06)
Married or living with partner	0.866	0.850	0.855	0.847	0.967
	(1.044)	(1.037)	(1.100)	(1.087)	(1.150)
Job Demands Scale (Job Characteristics)	−0.0222	−0.0140	−0.0246	−0.0184	−0.0384
	(0.0606)	(0.0604)	(0.0596)	(0.0589)	(0.0625)
Life Satisfaction (6-item version)	0.114	0.132	0.129	0.143	0.124
	(0.246)	(0.255)	(0.247)	(0.254)	(0.240)
Family Affectual Solidarity	−0.530	−0.554	−0.659	−0.656	−0.774
	(0.645)	(0.634)	(0.681)	(0.673)	(0.682)
Negative Affect (PANAS)	0.402	0.408	0.422	0.418	0.498
	(0.351)	(0.349)	(0.348)	(0.347)	(0.362)
Positive Affect (PANAS)	−0.429	−0.419	−0.453	−0.439	−0.249
	(0.451)	(0.445)	(0.445)	(0.443)	(0.443)
Friendship Affectual Solidarity	0.732	0.724	0.735	0.728	0.605
	(0.472)	(0.468)	(0.480)	(0.476)	(0.483)
Spouse Affectual Solidarity	−0.148	−0.158	−0.129	−0.133	−0.255
	(0.432)	(0.432)	(0.425)	(0.427)	(0.408)
Agreeableness Personality Trait	0.350	0.355	0.339	0.341	0.422
	(0.459)	(0.456)	(0.460)	(0.458)	(0.441)
Extraversion Personality Trait	−0.233	−0.218	−0.205	−0.194	−0.284
	(0.418)	(0.414)	(0.419)	(0.416)	(0.436)
Neuroticism Personality Trait	−0.135	−0.0855	−0.0778	−0.0478	−0.0768
	(0.429)	(0.418)	(0.443)	(0.434)	(0.448)
Conscientiousness Personality Trait	0.0280	0.0295	0.0383	0.0389	−0.153
	(0.426)	(0.423)	(0.420)	(0.418)	(0.425)
Openness Personality Trait	0.619	0.627	0.605	0.613	0.572
	(0.468)	(0.467)	(0.458)	(0.459)	(0.459)
CESD: Center (Epidemiologic)	0.0293	0.0301	0.0335	0.0328	0.0351
	(0.0348)	(0.0348)	(0.0345)	(0.0344)	(0.0401)
CONSTRUCTION	1.075	1.117	1.165	1.172	1.474
	(1.175)	(1.190)	(1.226)	(1.228)	(1.312)
MANUFACTURING	−0.591	−0.566	−0.568	−0.561	−1.073
	(1.086)	(1.095)	(1.130)	(1.130)	(1.238)
TRANSPORTATION, COMMUNICATIONS, AND PUB	−2.963**	−2.870**	−2.911**	−2.863**	−3.271**
	(1.399)	(1.414)	(1.432)	(1.441)	(1.650)
WHOLESALE TRADE	−1.302	−1.294	−1.256	−1.261	−1.381
	(1.290)	(1.291)	(1.293)	(1.293)	(1.420)
RETAIL TRADE	−1.510	−1.467	−1.423	−1.418	−1.367
	(1.224)	(1.250)	(1.254)	(1.267)	(1.378)
FINANCE, INSURANCE, AND REAL ESTATE	−1.291	−1.235	−1.323	−1.296	−1.644
	(1.239)	(1.236)	(1.298)	(1.290)	(1.550)
BUSINESS AND REPAIR SERVICES	1.737	1.791	1.856	1.864	1.652
	(1.386)	(1.402)	(1.402)	(1.406)	(1.521)

(continued on next page)

Table 2 *(continued)*

VARIABLES	(1) Self_employed	(2) Self_employed	(3) Self_employed	(4) Self_employed	(5) Self_employed
PERSONAL SERVICES	−0.0976	−0.0569	0.128	0.116	−0.227
	(1.225)	(1.241)	(1.309)	(1.313)	(1.402)
ENTERTAINMENT AND RECREATIONAL SERVICES	0.245	0.255	0.102	0.104	−0.237
	(1.355)	(1.365)	(1.395)	(1.399)	(1.460)
PROFESSIONAL AND RELATED SERVICES	−1.157	−1.087	−1.088	−1.057	−1.302
	(1.079)	(1.097)	(1.118)	(1.126)	(1.254)
Constant	−6.797*	−7.200**	−6.876*	−7.199**	−8.151**
	(3.548)	(3.647)	(3.556)	(3.639)	(3.846)
Observations	274	273	274	273	273
Wald Chi-square	58.60	59.42	58.78	59.19	61.26
df	33	34	34	35	36
Pseudo R-square	0.237	0.238	0.240	0.241	0.282

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

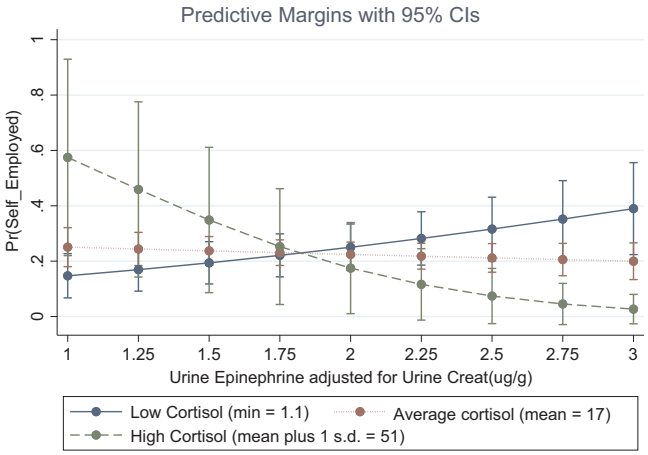

Fig. 1. Moderation effects.

Shane, 2014; Shane and Nicolaou, 2015), represent an initial attempt to move beyond previous work which focused primarily on single-hormone effects such as testosterone, and examine alternative links between endocrinological factors and self-employment.

Elevated levels of epinephrine could provide key benefits in the form of increased focus (Mann and Ward, 2007), learning (Phelps and LeDoux, 2005), and memory (Cahill and Alkire, 2003) all of which could increase the overall performance of individuals who are self-employed. Interestingly, the association between self-employment and epinephrine was prominent with decreasing presence of cortisol, which suggests a possible effect analogous to the dual hormone hypothesis (Mehta and Prasad, 2015), with regards to self-employment. It is possible that the results of our study represent complementary findings, and that endocrinological factors could drive self-employment, which provides support for the integrated specificity model of stress response (Kemeny, 2003). These low levels of cortisol could in turn be linked with increased levels of aggression (McBurnett et al., 2000), which could explain why certain individuals "fight" while others choose "flight" with regards to experiencing elevated levels of epinephrine when engaged in self-employment.

Curiously, our results also indicated a positive association with self-employment for low levels of epinephrine in the presence of high levels of cortisol (i.e., the left-side of Fig. 1), suggesting additional nuances to this potential dual hormone relationship that warrant further investigation. Elevated levels of cortisol have been associated with euphoria, sensation-seeking behavior, and elevated preferences for risk taking (van den Bos et al., 2009). Indeed, it has been suggested that individuals with elevated levels of cortisol are more sensitive to immediate rewards (van den Bos et al., 2009), and are more likely to engage in risky decision making particularly in scenarios where risk taking could result in substantial rewards (Putman et al., 2009). So, whereas high levels of epinephrine in the presence of low levels of cortisol could increase the likelihood that individuals will "fight" against adversity and therefore remain self-employed, low levels of epinephrine in the presence of high levels of cortisol could increase the odds of self-employment via a distinctly different contingency. In this scenario, it is possible that because individuals are more apt to pursue risky decisions in hopes to capture potentially substantial rewards, they are more likely to engage in self-employment rather than pursue more predictable and stable opportunities afforded them in wage-based employment. In Fig. 1, as the mean cortisol line is almost flat, and as the overall interpretation is based on the influence of increasing epinephrine levels at different contingency levels of cortisol

on the likelihood of self-employment, our preliminary interpretation provided here focuses primarily on the slopes of the cortisol levels. We call on future research to further test for this relationship.

In conclusion, our analysis indicates that the positive association between epinephrine and self-employment is contingent upon levels of cortisol being low. Future research will need to examine the nuances of these relationships, as well as what, if any, association key hormones have with other important dimensions of self-employment, such as the level of risk taken with regards to the choice of the opportunity to pursue or even overall performance of individual new ventures. We believe that this research could further develop our understanding of the neuroendocrinological factors that influence self-employment, and could extend the growing stream of research focused on the link between biology and self-employment.

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