

A Three-Dimensional Production Possibility Frontier With Stress

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Abstract

We introduce a three-dimensional production possibilities frontier, the third axis of which measures the amount of psychological stress being generated in the economy. Stress, a negative externality, is the body's biological response to unpleasant external conditions. It is produced through countless pathways, much of it related directly or indirectly to financial pressure and insecurity. There is ample clinical evidence that mental illness has increased markedly in the U.S. We suggest that the same quantities of inputs can produce more or less output depending on the amount of stress experienced by the population. This crucial issue should be considered in the formulation of economic policy.¹

Keywords: Production Possibilities Frontier, Stress, Mental Health

JEL Codes: A10, A20, E19, I10

Introduction

That homo economicus has no emotion is common knowledge. Hence, psychological stress is under the radar of most, though not all, economists (Akerlof 2020, Flèche and Layard 2017, Rabin 2013). However, the overwhelming evidence of the accumulation of stress around the globe but especially in the U.S. should induce economists to explore ways to introduce the concept into economic theory (Marchese 2022). We propose such an innovation for the production possibilities frontier (PPF).

Stress is ubiquitous

Stress, the body's biological response to external threats, is generated in the economic system as a negative externality through countless pathways, that include long working hours, being underpaid, being evicted, income insecurity, unhealthy work environments, tight deadlines, being fired, long spells of unemployment, underemployment, low income relative to the median, reduction of earnings, unexpected medical expenses, college tuition, being victim of predatory loans, financial pressure, inadequate work-life balance, being underinsured, excessive child-care costs, inflation, incarceration, and inadequate government safety net programs, to name *some* contributing factors.

¹ Constructive comments by P.K. Chaubey, John E. McDonough, and Eytan Sheshinski are greatly appreciated.

The relevant literature is humongous: a search of the National Library of Medicine (PubMed) and of the IDEAS/REPEC websites found tens of thousands of articles in which stress and an economically relevant descriptor were *both* either in the title or in the abstract (Table 1). That these studies have increased exponentially in the 21st century is indicative of the increasing significance of this phenomenon. For instance, in the year 2000 there were 630 articles with “work” and “stress” in the title or abstract in the PubMed website while there were 4,986, or eight times as many (per annum) even before the Covid pandemic. In 2021 there were 7,299. This pattern obtained for all other keyword pairs investigated.

Table 1: The number of articles found in two databases with relevant keywords

	PubMed		Ideas/Repec	
	Found in		Found in	
Stress & ...	the Title	the Abstract	the Title	the Abstract
Work	2,396	60,306	304	3,958
Family	2,129	48,091	105	1,377
Mental Health	1,074	25,888	69	998
Job	1,306	8,854	283	1,451
Economic	233	9,827		a
Income	211	6,127	38	1,495
Financial	168	4,976		a
Discrimination	218	4,121	10	219
Socio-economic	23	1,326	8	476
Unemployment	37	1,581	10	535
Racism	53	579	11	180
Money	11	481		a

Date of search: June 10, 2022

Note: PubMed searches also include Economy, Finance, Finances.

Both searches included Unemployed and Race.

a) Ideas/repec database had too many studies about "stress testing banks" to be included.

No wonder that in an era characterized by mass shootings, deaths of despair, the rise of populism, declining labor’s share, stagnating wages for those without a college education, and a mental health crisis, stress would appear on our radar screen (Case and Deaton 2020; Sandel 2018; St. Louis Fed series LABSHPUSA156NRUG). Men in the U.S. without college in 2021 were earning about \$2/hour less than they did in 1973 (EPI 2022). Inadequate financial cushion to face an unexpected economic downturn also increases stress within the household (Board of Governors 2019; Financial Health Network 2019). Moreover, 40 percent of Americans evaluate their lives as “struggling” and another 3.5 percent evaluate it as “suffering” (Gallup 2022). So, stress is ubiquitous.

“Stress represents the main environmental risk factor for mental illness” (Cattaneo and Riva 2016). A mental illness is defined as an episode of behavioral or emotional distress, impairment in functioning, or behavioral or psychological dysfunction (SAMSHA 2020, Appendix A).² These

² More extensive literature on mental illness can be found in (American Psychiatric Association, 2022).

are diagnosed cases of depression, bipolar disorder, phobia, anxiety disorder, panic, obsessive-compulsive disorder, posttraumatic stress, anorexia nervosa, hallucinations, delusions, or suicidal thoughts, but do not include substance use disorders (SAMSHA 2020, Appendix A).

Forty million adults experienced a mental illness episode in 2008 while in 2019 their number rose to 51 million, an increase of 29% (SAMSHA 2020, Table 10.1A). That implies that 20% of adults suffer from an episode of mental illness annually. The increase in young adults between the ages of 18 and 25 was especially large. Their incidence increased in the interim 11 years by 63% (SAMSHA 2020, Table 10.1B). This high incidence indicates the fragile mental condition of the population.

A major pre-Covid study summarized these complex issues succinctly by concluding that “stress about money and finances is prevalent nationwide...” and added: “Nearly threequarters (72 percent) of adults report feeling stressed about money at least some of the time and nearly one quarter say that they experience extreme stress about money... during the past month... In some cases, people are even putting their health care needs on hold because of financial concerns” (American Psychological Association 2015, p. 2).

Poverty has also been linked directly to mental illness. “Children from impoverished families are more prone to mental illness... Poverty brings with it a number of different stressors, such as poor nutrition, increased prevalence of smoking and the general struggle of trying to get by. All of these can affect a child’s development, particularly in the brain, where the structure of areas involved in response to stress and decision-making have been linked to low socioeconomic status” (Reardon 2016; Swartz, Hariri, and Williamson 2017). No wonder that poor children generally underperform in school (Heckman 2006). Thus, the increase in mental illness is indicative of the increased stress experienced by the U.S. population.

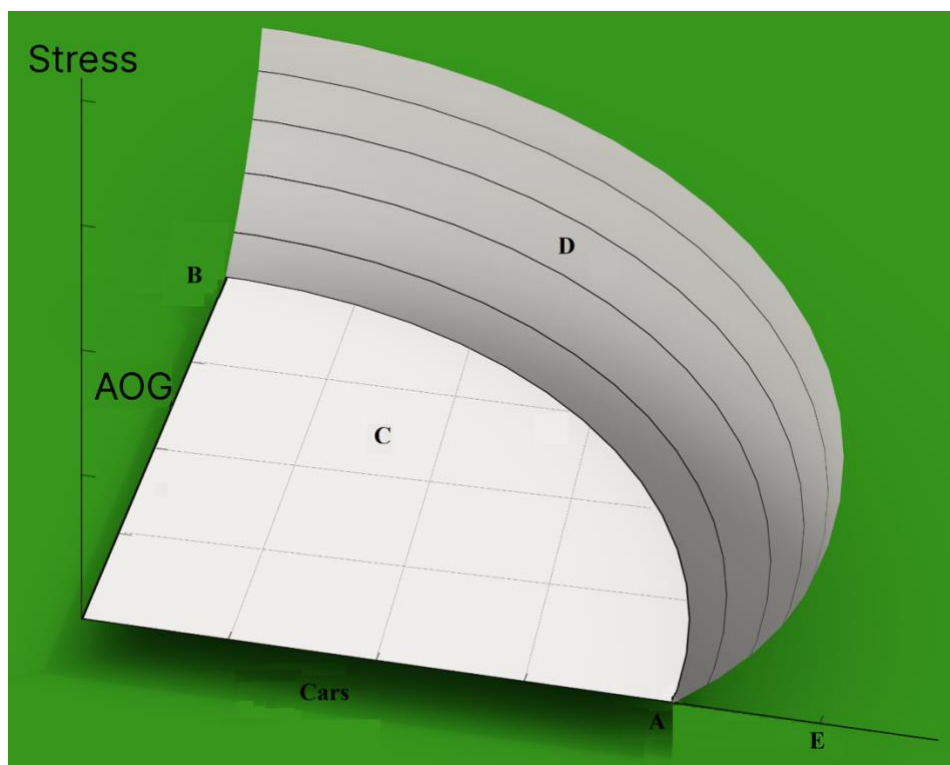
In other words, most of stress is related directly or indirectly to financial pressure (Brzozowski and Visano 2020; Friedline, Chen, and Morrow 2021; Wilkinson 2016). Stress is not a choice variable. It is a negative externality mostly imposed on the individual by the economic system, like the financial crisis or the federal minimum wage which is \$5 less in real terms than it was in 1968. Alternatively, it can also be a consequence of individual action that fails to take the long-term effects of stress into consideration. This can occur because the biological effects of stress are both uncertain and take decades to materialize. Hyperbolic discounting may make it desirable to work instead of taking a half-day off in order to go to the doctor but over an extended period of time such myopic decisions impact the biological system (Laibson 1998). Furthermore, financial considerations forced many low-income essential workers to work even during the Covid lockdown, generating stress in the process. So, stress is not a variable people consciously choose.

Three-Dimensional Production Possibilities Frontier

Hence, there are ample reasons to begin to think about incorporating this deleterious externality into economics. We do so for the concept of the PPF. Its standard conceptualization is the region of Figure 1 that encompasses the two-dimensional area designated C. The economy is assumed to produce two goods, Cars and AOG (all other goods) with maximum amounts A and B respectively. These quantities are being produced without appreciable psychological stress. That means that the stress is occasional and temporary so that coping mechanisms suffice to

limit its permanent biological impact and prevent it from causing mental health issues (Wälde 2018). We now introduce a third axis that measures the amount of *chronic* stress experienced by the population.³ The innovation is that it is possible to increase production beyond A and B with the same amounts of inputs if additional stress is generated in the production process. So, beyond the outer reaches of the region C chronic stress increases along the z-axis with deleterious biological consequences (Cohen, Janicki-Deverts, and Miller 2007).

Figure 1:



There are a myriad of ways to increase output at the expense of psychological stress. World War II is an example of a stressful era during which real GDP increased by 50% (1941-1945) although the unemployment rate in 1941 was just 10%.⁴ After the war, the 1945 level of real per capita GDP was not reached again until 1953.

Given the prevalence of mental health issues documented above, coupled with the opioid epidemic, it should be clear that during the course of the past decades the economy evolved from region C into region D where increasing levels of stress is indicated by the latitude, or rising parallels. In this region, increased output beyond point A is obtained at the cost of increased biologically-relevant stress experienced by the population (Figure 1).

³ Three-dimensional PPFs have been used in other contexts (Copeland and Taylor, 2005; Salter and Luther, 2016).

⁴ Bureau of Economic Analysis, National Income and product Accounts, Table 1.1.6 “Real Gross Domestic Product,” https://apps.bea.gov/iTable/index_nipa.cfm. Unemployment rate is from U.S. Bureau of Labor Statistics.

https://data.bls.gov/timeseries/LNU04023554&series_id=LNU04000000&series_id=LNU03023554&series_id=LNU03000000&years_option=all_years&periods_option=specific_periods&periods=Annual+Data; Population data are from the U.S. Census.

Although the role of this paper is not to discuss how the stress was generated in the economy, but to introduce the usefulness of thinking about stress in a three-dimensional PPF framework, we should mention in passing that at the macroeconomic level, the technological transformation of the economy to a post-industrial knowledge economy, the high degree of globalization that destroyed many jobs of low-skilled and medium-skilled workers without a college degree, the financial crisis, the low level of federal safety net in the U.S., the high degree of uncertainty associated with independent contractors and online platform workers, all increased GDP but simultaneously generated much stress in the population (Akerlof and Shiller 2015; Azar, Marinescu, and Steinbaum 2022; Blanchflower 2019; Colantone, Crinò, and Ogliari 2019; Corak 2013; Cutler and Glaeser 2021; Gilens and Page 2017; Krueger 2012, 2017; Rajan 2019; Rodrik 2016, 2018; Pierce and Schott 2016, 2020; Stevenson and Wolfers 2009; Temin 2017; Whybrow 2005; Wisman and Capehart 2010). Consequently, the U.S. became the 7th most stressed country in the world (Ray 2019).

In some sense these considerations are reminiscent of the notion of X-efficiency which raised the possibility that a given amount of input can produce different amounts of output, depending on the way factors of production were combined by management within the firm (Leibenstein 1966). Similarly, we suggest that the same quantities of inputs can produce a varying quantities of output depending on the amount of stress externality that has to be borne by the population.⁵ In other words, the PPF is not carved in stone but can expand at a psychological cost (Figure 1). Hence, it appears appropriate to begin incorporating this concept into economics. This implies that we should think about stress as a negative externality particularly when formulating economic policy. Hence, developing this concept further should be put on the agenda of economists (Aiginger and Rodrik 2020; Austin, Glaeser, and Summers 2018).

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⁵ Leibenstein intimates as much: "In situations where competitive pressure is light, many people will trade the disutility of greater effort, of search, and the control of other peoples' activities for the utility of feeling less pressure and of better interpersonal relations. But in situations where competitive pressures are high, and hence the costs of such trades are also high, they will exchange less of the disutility of effort for the utility of freedom from pressure" (1966, p. 413).

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SUGGESTED CITATION:

John Komlos, "A three-dimensional production possibility frontier with stress", *real-world economics review*, issue no. 101, 15 September 2022, pp. 76-82,
<http://www.paecon.net/PAEReview/issue101/Komlos.pdf>

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