



Does attention-deficit hyperactivity disorder medication reduce entrepreneurship?

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Abstract

Attention-deficit hyperactivity disorder (ADHD) is a highly inheritable condition with a rather stable prevalence over time and geography, and it is associated with a broad range of negative life outcomes. Increasing knowledge on the condition has led to a growing trend of dampening ADHD symptoms through medication. Although this development has led to many positive outcomes, the broader societal implications are still poorly understood. In particular, person-level studies suggest that ADHD-like behavior may possess some advantages for engaging in entrepreneurship and the initiation of new businesses, which is considered a key activity for economic development. Using recent panel data from 11 countries and one special administrative region (SAR), we investigate if the increasing use of ADHD medication in adults is associated with an unintended outcome of reducing entrepreneurship. We find that a roughly one unit increase in the prevalence of adult ADHD medication is associated with a one unit decrease in limited liability company registrations per working age population. In practical terms, the effect of a one within-country/SAR standard deviation increase of adult ADHD medication prevalence corresponds to a decrease in new business formation of 20% of its mean in the sample.

KEYWORDS

ADHD, attention-deficit hyperactivity disorder, entrepreneurship, new business, stimulant medication

1 | INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by a persistent pattern of inattention, hyperactivity, and impulsivity that is pervasive across settings and leads to various degrees of functional impairment (Biederman & Faraone, 2005). ADHD is associated with various negative life outcomes, such as low social skills and self-esteem, substance and alcohol abuse, unemployment, criminal activity, and elevated mortality (Hamed, Kauer, & Stevens, 2015). The first line of ADHD treatment is medication with stimulants, which has increased dramatically around the world among both children and adults (Raman et al., 2018). While medicating ADHD has been

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linked to many positive short-term outcomes (Chang et al., 2019), little is known about its broader economic and societal consequences, especially as many ADHD medication users do not have an ADHD diagnosis (Sibley, 2018). For example, recent research has found a positive relationship between entrepreneurial actions, including business formation, and both diagnosed ADHD (Lerner, Verheul, & Thurik, 2019) and the degree of displaying ADHD-like symptoms (e.g., Thurik, Khedhaouria, Torrès, & Verheul, 2016; Verheul et al., 2015, 2016; Wiklund, Yu, Tucker, & Marino, 2017). Therefore, we examine if increased prevalence of ADHD medication use can have an unintended consequence of impeding new business formation, with potentially broader economic implications (Wennekers & Thurik, 1999).

Recent panel data covering 13 countries and one special administrative region (SAR) (Raman et al., 2018) document the strong and steady increase of ADHD medication around the world from 2001 to 2015, albeit at different paces in different locations. The authors report that the absolute increase of ADHD medication users among adults per year ranged from 0.0006% to 0.12%. In 2010, the regional prevalence was highest in North America (1.42%) and lowest in Western Europe (0.03%) (Raman et al., 2018). Yet ADHD is a highly inheritable condition (Bolea-Alamañac et al., 2014) with a rather stable prevalence over time and geography (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014). The prevalence among adults is approximately 2.5% (Simon, Czobor, Bálint, Mészáros, & Bitter, 2009), suggesting that the growth trend in medicating adult ADHD is likely to continue. There is broad evidence that the most commonly prescribed adult ADHD medications are often effective in dampening its symptoms (Faraone & Glatt, 2010) leading to positive behavioral outcomes (Chang et al., 2019). However, ADHD and the level of ADHD-like symptoms have also been positively associated with entrepreneurial intentions, self-employment, and business start-up on the person level (Lerner et al., 2019; Verheul et al., 2015, 2016; Wiklund et al., 2017).

To empirically examine the association between ADHD medication and entrepreneurship, we estimate country/SAR-level fixed-effects panel regression models where the dependent variable is new business formation, that is, the number of limited liability companies registered in a country/SAR year per 1,000 working age persons. The main explanatory variable is the prevalence of ADHD medication among adults. With our preferred specification, we find that a roughly one unit increase in the prevalence of adult ADHD medication is associated with a one corresponding unit decrease in new business formation. In more practical terms, the effect of a one within-country/SAR standard deviation increase of adult ADHD medication prevalence corresponds to a decrease in new business formation of 20% of its sample mean, or 26% of its standard deviation.

2 | METHODS

We use fixed-effects linear regression to control for time-invariant unobserved heterogeneity on the country/SAR level. We include year dummies to control for general time effects and various control variables to address time-varying heterogeneity.

With the exceptions of the United States and Hong Kong, our dataset consists of data combined from the World Bank and the Raman et al. (2018) dataset.¹ We obtain our main dependent variable new business formation, that is, the number of new limited liability business registrations per 1,000 people between the ages of 15 and 64 from the World Bank's Entrepreneurship Database (new business density), which is available since 2006. The variable captures both a central and economically relevant action in the entrepreneurial process, and it has high coverage (Cumming, Johan, & Zhang, 2014). We obtain our main independent variable, ADHD medication prevalence among adults (aged 19 and above), from the supplement to Raman et al. (2018).² The Raman et al. (2018) dataset is an unbalanced country/SAR panel spanning the years 2001–2015 generated through the automated capture of patient-level electronic data from either administrative clinical records or administrative claims records.

Our macroeconomic control variables are based on the World Bank's World Development Indicators (WDI) dataset and include indicators that are associated with broader entrepreneurship, economic and institutional conditions. These include gross domestic product based on purchasing power parity (GDP PPP) per capita (current USD, thousands) and GDP growth (%) (cf. Boudreaux, Escaleras, & Skidmore, 2019; Dutta & Sobel, 2016). We also control for working age population (ages 15–65, in millions) as both the dependent and independent variables use a similar denominator. The

¹Despite being included in the Raman et al. (2018) dataset, we drop Taiwan from our analyses because of the unavailability of comparable government spending and self-employment rate statistics.

²The data include both MarketScan (private health care) and Medicaid (public health care) data for the United States. We use MarketScan data because of its higher temporal coverage in our main analysis but run robustness checks also with Medicaid data.

size of the public sector (total government expenditure as percent of GDP) and unemployment rate (International Labour Organization [ILO] operationalization, %) capture labor market conditions and related institutional settings.

We also control for current health expenditure (percent of GDP) and domestic private health expenditure (% of current health expenditure), as the properties of the health-care system may be jointly associated with ADHD medication use and entrepreneurship. For example, health expenditure correlates with the size of the public sector, which may in turn correlate with the entrepreneurship rate in a country (Aidis, Estrin, & Mickiewicz, 2012; Bjørnskov & Foss, 2008; Nyström, 2008). Health expenditure or policies may also affect entrepreneurship directly (Fairlie, Kapur, & Gates, 2011; Heim & Yang, 2017; Holtz-Eakin, Penrod, & Rosen, 1996).

In the cases of the United States and Hong Kong, we utilize additional data sources to increase overlap with the Raman et al. (2018) dataset. The dependent variable is unavailable for the United States, and we proxy for it by using the new business application counts from the US census (United States Census Bureau, 2019), which we denominate with the size of the 15–65 population (in thousands). Data on government and health-care expenditure for Hong Kong are obtained from its Census and Statistics Department (2019) and the Food and Health Bureau (2018), respectively.

This results in our main dataset, an unbalanced panel of 95 yearly observations from 11 countries and one SAR.³ For additional robustness checks, we use all overlapping country/SAR years for data from the Global Entrepreneurship Monitor (GEM) survey (Bosma & Kelley, 2019) and the Organization for Economic Cooperation and Development (OECD)'s Business Demography Indicators (OECD, 2020).

3 | RESULTS

Table 1 summarizes our primary estimates. The second column implies that a one unit increase in the prevalence of ADHD medication is associated with an absolute unit decrease of 1.05 units in new business formation. As we utilize within-country/SAR variation for estimation, we rely on the within-country/SAR standard deviation of ADHD

TABLE 1 Main estimates

	Baseline		Robustness checks		
	(1)	(2)	(3)	(4)	(5)
ADHD medication prevalence (%)		−1.045*** (0.311)	−0.938** (0.303)	−0.612*** (0.149)	−0.872*** (0.206)
GDP PPP per capita	0.893* (0.485)	0.722* (0.356)	0.806** (0.317)	0.313** (0.116)	0.531** (0.195)
GDP growth	−0.060 (0.202)	−0.046 (0.154)	−0.027 (0.173)	0.060 (0.148)	0.055 (0.129)
Working age population	0.153 (0.267)	0.902** (0.299)	0.682** (0.278)	0.881 (0.526)	0.666*** (0.179)
Total government expenditure	−0.179 (0.161)	−0.243* (0.119)	−0.212* (0.118)	−0.180* (0.092)	−0.277** (0.096)
Unemployment rate (%)	0.001 (0.021)	−0.008 (0.126)	−0.004 (0.129)	−0.000 (0.073)	−0.005 (0.082)
Current health expenditure	0.920 (0.825)	0.527 (0.661)	1.081 (0.866)	1.405*** (0.422)	0.885* (0.420)
Private current health expenditure	0.168 (0.104)	0.090 (0.055)	0.609 (0.425)	0.120 (0.286)	0.049 (0.030)
Country/SAR FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes
Country/SAR years	95	95	91	76	89
Countries/SARs	12	12	12	10	12
Within-VIF	n/a	3.87	2.17	2.35	4.06
Within-R ²	0.474	0.633	0.67	0.653	0.701
Within-R ² (adjusted)	0.366	0.551	0.594	0.559	0.629

Note: Linear within-country/SAR regression estimates with a constant in all models. New business formation (%) as dependent: (1) control model with main sample, (2) main sample, (3) MarketScan data substituted with Medicaid data for the United States, (4) United States and Hong Kong removed, and (5) extreme residual tails (±2.5%) removed. Standard errors clustered by country/SAR in parentheses.

Abbreviations: ADHD, attention-deficit hyperactivity disorder; FEs, fixed effects; GDP, gross domestic product; PPP, purchasing power parity; SAR, special administrative region; VIF, variance inflation factor.

**p* < 0.1.

***p* < 0.05.

****p* < 0.01.

³Please refer to the Supporting Information for the descriptive statistics.

medication prevalence to contextualize this result. This standard deviation is 1.75‰ points, a fraction of its pooled counterpart (5.01‰ points). Consequently, a one within-country/SAR standard deviation increase in ADHD medication prevalence corresponds an absolute decrease of 1.80‰ points (1.05×1.75) in new business formation, which is 20% of its (pooled) sample mean. The adjusted within- R^2 increase of 0.185 from the control model (column 1) also points towards practically relevant variation.

We also perform a number of robustness checks. First, we use Medicaid data instead of MarketScan data for the United States resulting only in small changes (column 3). Second, we removed both the United States and Hong Kong because of the limited availability of World Bank data and their relatively high private health-care expenditures, which preserved the sign and significance level (column 4). Third, the results remain robust to dropping the $\pm 2.5\%$ idiosyncratic residual tails as a basic robustness check of outliers (column 4).

Fourth, we use alternative dependent variables to further examine robustness and possible mechanisms (Table 2). The main findings are robust to using the survey-based new business ownership variable (‰) from GEM as the dependent (column 6). Using the OECD-based birth rate of new enterprises (the ratio of enterprise births and the number of active enterprises, ‰) as the dependent results in a negative coefficient on the $p = 0.126$ significance level despite a severe drop in available data (column 7).⁴ However, we fail to find statistically significant associations with the GEM-based established business ownership rate (column 8) and the WDI-based self-employment rate (column 9). This suggests that the changes are too small to be detected in our study setting and/or that the observed ADHD medication effects may be changing the nature of business activity, not its total amount. To investigate the matter, we ran regressions with several GEM-based variables as the dependent variable. We observe a statistically significant negative effect of ADHD medication prevalence on the motivation index—the ratio of opportunity and necessity-driven early stage entrepreneurial activity (column 10), but not with other GEM variables.⁵

Fifth, we additionally examined logarithmic functional form specifications for both the independent and dependent variables (not reported), but the linear specification was preferred. The within-variance inflation factor (VIF) values of ADHD medication prevalence suggest that multicollinearity is an unlikely concern.

TABLE 2 Additional robustness checks

	Business entry		Established business		Other
	(6)	(7)	(8)	(9)	(10)
ADHD medication prevalence (‰)	−1.663** (0.739)	−3.544 (2.039)	−0.646 (0.892)	−0.386 (0.839)	−1.069** (0.484)
GDP PPP per capita	−0.361 (0.520)	0.354 (1.708)	−1.326* (0.647)	−1.503 (0.858)	0.129 (0.349)
GDP growth	0.403 (0.287)	0.786 (1.822)	0.027 (0.668)	1.220** (0.395)	−0.212 (0.156)
Working age population	0.755 (0.608)	−14.818 (8.100)	1.604** (0.649)	−0.394 (0.494)	0.876* (0.468)
Total government expenditure	−0.691* (0.317)	−1.484 (1.635)	−1.305** (0.428)	0.881 (0.755)	−0.104 (0.331)
Unemployment rate (‰)	−0.120*** (0.028)	0.006 (0.083)	0.015 (0.034)	−0.089 (0.060)	−0.017 (0.014)
Current health expenditure	−0.637 (0.998)	8.492* (4.428)	−1.835 (1.072)	2.914 (1.725)	−0.553 (0.894)
Private current health expenditure	0.137 (0.195)	5.674** (1.627)	0.344* (0.172)	−0.058 (0.198)	−0.070 (0.041)
Country/SAR FEs	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes
Country/SAR years	108	56	108	128	86
Countries/SARs	12	8	12	12	12
Within-VIF	6.14	5.24	6.14	4.54	5.37
Within- R^2	0.294	0.622	0.427	0.488	0.392
Within- R^2 (adjusted)	0.121	0.388	0.287	0.381	0.240

Note: Linear within-country/SAR regression estimates with a constant in all models. Tests with alternative dependent variables: (6) new business ownership rate (GEM, ‰), (7) birth rate of all enterprises (Organization for Economic Cooperation and Development, ‰), (8) established business ownership rate (GEM, ‰), (9) self-employment rate (World Development Indicators, ‰), and (10) motivation index (GEM). Standard errors clustered by country/SAR in parentheses.

Abbreviations: ADHD, attention-deficit hyperactivity disorder; FEs, fixed effects; GDP, gross domestic product; GEM, Global Entrepreneurship Monitor; PPP, purchasing power parity; SAR, special administrative region; VIF, variance inflation factor.

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

4 | DISCUSSION

Our results point to a significant unintended outcome of the increasing global trend of ADHD medication among adults. The entrepreneurship-dampening relationship of ADHD medication we uncovered using both country/SAR-level registry and survey-based datasets also supports a positive relationship between ADHD and entrepreneurship (cf. Lerner et al., 2019; Thurik et al., 2016; Verheul et al., 2015, 2016; Wiklund et al., 2017). We encourage further work to examine this association.

The strong negative association and high variance explained suggest that the ADHD medication effect is unlikely to only reflect the ADHD-medicated individuals' lower probabilities of carrying out business start-up. In addition, we believe it is plausible that dampening ADHD-like symptoms also lowers the demand for some products and services that any other prospective entrepreneur might provide. For example, ADHD has been linked to impulsive consumption habits and alcohol abuse (Black, Shaw, & Allen, 2016; Black, Shaw, McCormick, Bayless, & Allen, 2012; Brook, Zhang, Brook, & Leukefeld, 2015), both of which can create business opportunities also for entrepreneurs without ADHD. Both of these entrepreneur "supply" and "demand" side mechanisms are consistent with the negative association between ADHD medication and the opportunity-to-necessity ratio among individuals involved in early stage entrepreneurial activity, which in turn may harm entrepreneurship-driven economic development (cf. Fredström, Peltonen, & Wincent, 2020).

Despite including country/SAR fixed effects and several control variables, we caution against overly strong causal interpretations. For example, the simultaneous proliferation of unobserved health-care practices or beliefs propagating through similar mechanisms as ADHD medication prescription practices may confound our results. However, time-varying unobserved heterogeneity not related to health care may be less likely, as the mechanisms that spread clinical practices are likely to operate rather independently of significant drivers of entrepreneurship. Additional research on the person level may help untangle these effects. Replications using finer grained geographical data and longer panels should also be carried out to overcome the limitations of the small sample size and to investigate the temporal dynamics of the phenomenon (e.g., Thurik, Carree, van Stel, & Audretsch, 2008).⁶ Our analyses also do not distinguish between the consumers of ADHD medication with and without ADHD diagnoses, though latter cases may be common (Sibley, 2018). Thus, the extent to which the proper or overmedication of ADHD is driving the results should be studied.

We conclude that the broader health and workplace implications of ADHD medication and entrepreneurship deserve more attention but strongly caution against drawing clinical recommendations from our study, including ceasing to take prescribed ADHD medication in hopes of higher entrepreneurial success.

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⁴Additional analyses of enterprise population effects using OECD data are reported in the Supporting Information.

⁵Please refer to the Supporting Information for additional details.

⁶Please refer to the Supporting Information for sensitivity analyses with varying time differences between the dependent variable and independent variables.

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