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Motivation, Stress, and GPA

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Abstract---*Objective: This study examined the independent associations of academic motivation and financial stress with postsecondary GPA and tested whether motivation moderates the financial stress-GPA relationship. Methods Using Education Longitudinal Study of 2002 data, base-year motivation was linked with third follow-up financial stress and transcript-based GPA. A baseline regression included 6,568 students; an expanded model added socioeconomic status, parental education, sex, race/ethnicity, prior achievement, and the motivation by financial stress interaction. Results: The baseline model was significant, with motivation positively and financial stress negatively associated with GPA. Both associations held in the weighted expanded model (R^2 = .174) after adjusting for the covariates above, with prior achievement the strongest continuous predictor. Black participants had lower adjusted GPAs than White non-Hispanic participants. Conclusions: Motivation and financial stress were each independently related to GPA. Contrary to the hypothesized buffering effect, the financial stress-GPA relationship was slightly stronger, not weaker, at higher motivation, though the interaction was small and not robust to sensitivity analysis. Significance: These findings suggest motivation and financial stress are independently associated with GPA and may inform student support efforts. Future research should further examine the racial disparities identified here.*
Keywords---*grade point average, academic motivation, financial stress, postsecondary academic performance, multiple linear regression.*

Introduction

Grade point average (GPA) is one of the most common measures of academic achievement and is used to determine eligibility for scholarships and college admissions decisions. Academic success has traditionally been measured by student test scores, but it also depends on psychological factors that play important roles in grade point average beyond standardized test scores (Robbins et al., 2004; Richardson et al., 2012). Family socioeconomic status has been identified as one of the strongest predictors of academic achievement (Sirin, 2005). Financial stress and motivation may be associated with students' academic performance, as financial strain may interfere with students' focus and academic engagement.

Motivation is central to self-regulated learning, whereas financial stress is generally expected to make academic progress more difficult. Motivation's link to GPA is well established (Robbins et al., 2004), but most prior work has studied motivation and financial stress separately, has relied on self-reported rather than transcript-based GPA, and has not directly tested whether motivation moderates the effect of financial stress. This study addresses that gap by (a) examining motivation and financial stress together in the same model, (b) using transcript-based GPA for more accurate measurement of academic achievement, and (c) carefully excluding negative survey codes representing missing, skipped, or not-applicable responses before the analyses were conducted, while also testing whether motivation moderates the financial stress–GPA relationship.

The study is guided by the following research questions:

RQ1. To what extent are motivation and financial stress associated with postsecondary GPA before adjustment for covariates?
RQ2. Do these associations remain after adjustment for socioeconomic and demographic covariates?
RQ3. Does motivation moderate the association between financial stress and GPA?

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Literature Review

Motivation and Academic Performance

Motivation is recognized as one of the strongest psychological predictors of academic success. Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000) and Expectancy-Value Theory (Eccles & Wigfield, 2002) both hold that students who are driven by internal interest and confidence in their own ability invest more effort and engage more deeply in their studies. The Academic Motivation Scale (Vallerand et al., 1992) distinguishes intrinsic motivation, engagement driven by the enjoyment of learning itself, associated with deeper engagement and better performance from extrinsic motivation, which is driven by external rewards and tends to support short-term performance more than long-term learning. Robbins et al. (2004), found that motivation and self-efficacy were among the strongest psychological predictors of GPA across 109 studies. Similarly, Richardson et al. (2012) found that students' motivation and ability to manage their own learning were moderately related to academic performance.

Financial Stress and Academic Performance

Financial stress can be viewed as an obstacle to academic performance, and several studies have found evidence of this relationship. For example, Joo et al. (2008) found that financial stress was associated with difficulty focusing on academics and slower progress. Broton & Goldrick-Rab (2018), showed that students' financial difficulties can extend beyond tuition to food insecurity and unstable housing. Adams et al. (2016) and Potter et al. (2020) have linked financial hardship to poorer academic performance and social integration and worse mental health difficulties, particularly among first-generation students. However, this evidence is largely descriptive and correlational because the relationship between financial stress and academic performance is not always clear once other factors are considered. Britt et al. (2016) and Heckman et al. (2014) both found that association between financial stress and GPA became nonsignificant after accounting for other factors such as financial resources and knowledge. This suggests that some of the relationships found in earlier studies may be explained by other socioeconomic and financial factors rather than only focusing on financial stress. Wladis et al. (2015) similarly found that non-traditional students with substantial financial and personal responsibilities did not necessarily underperform because some students may be able to adapt themselves to these circumstances and challenges. Previous research suggests that greater financial stress is linked with lower GPA, but the strength of this relationship becomes less clear when other relevant factors are taken into account. This study addresses this issue by examining financial stress and GPA while also accounting for socioeconomic status and other important covariates.

Many researchers have suggested that motivation and financial stress may work together to influence academic success, but there is limited empirical evidence testing this relationship directly. Some scholars have suggested that motivated students, through greater engagement and self-regulation, are better able to manage external pressure, while others suggest that low motivation may intensify the negative effects of financial stress on academic outcomes (Koenka, 2020). However, few prior studies have directly tested for a statistical interaction between motivation and financial stress. This study addresses that gap by testing the interaction. Another important gap concerns racial and socioeconomic differences in GPA. Previous research has shown that socioeconomic status (SES) plays an important role in explaining racial gaps in academic achievement during primary and secondary education (Fryer & Levitt, 2004; Sirin, 2005; Hu & Morgan, 2024). Although few studies have directly examined the interaction between academic motivation and financial stress, motivation may help students to maintain their effort and engagement when facing financial strain. Therefore, the present study tests whether higher motivation reduces the negative association between financial stress and GPA.

The hypotheses tested were:

H1: Students with higher academic motivation are expected to have a higher GPA.
H2: Students who experience higher levels of financial stress are expected to have a lower GPA.
H3: Academic motivation is expected to reduce the negative effect of financial stress on GPA.

Materials and Methods

This study used a quantitative methodology, analyzing secondary data from the Education Longitudinal Study of 2002 (ELS:2002), a nationally representative longitudinal survey administered by the U.S. Department of Education's National Center for Education Statistics (U.S. Department of Education, National Center for Education Statistics, 2002). ELS:2002 followed a cohort of students who were in the 10th grade in 2002 (base year) through multiple follow-up surveys tracking their educational, occupational, and personal outcomes over time (Bozick &

Lauff, 2007). ELS:2002 used a stratified, two-stage sampling design (schools, then students within schools). The original study was designed to support nationally representative estimates of students who were in the tenth-grade cohort in 2002. The analytic sample used in this study experienced substantial attrition (see Limitations), which means it should not be considered nationally representative of the original ELS:2002 cohort.

Although the ELS:2002 includes several follow-ups (2004, 2006, and 2012), the present analysis uses data specifically from the base-year (2002) and third follow-up (2012) waves. The base-year data include measures of students' academic motivation and socioeconomic background covariates (socioeconomic status, parental education, sex, race/ethnicity, and prior achievement); while the third follow-up provides information on their postsecondary grade point average (GPA) and self-reported financial stress during early adulthood. Using these two waves allows for an examination of how early motivational and background factors are associated with academic and financial outcomes approximately a decade after high school. The present analysis uses base-year measures of motivation and background characteristics together with third follow-up measures of financial stress and postsecondary GPA, F3BYPNLWT was used for the weighted analyses. Unweighted models were also estimated as a sensitivity analysis to assess whether the substantive conclusions were sensitive to weighting. Weighted and unweighted estimates were generally similar. The dependent variable is cumulative grade point average (F3TZGPAALL, 0–4.0 scale). Independent variables include financial stress (F3D36, 1–5) and motivation (BYINSTMO).

The data extract used for this analysis included 16,197 records. Among these, 4,911 had an invalid or missing GPA value, 4,379 had an invalid or missing financial stress value, and 5,550 had an invalid or missing motivation score (categories overlap because some participants had missing or invalid values for more than one variable). After exclusion of invalid or missing values, the final analytic sample consisted of 6,568 participants, the same 6,568 complete cases were used in both the baseline and expanded regression models. Adding the additional covariates to the expanded model (SES, parental education, sex, race/ethnicity, and prior achievement) did not introduce further exclusions because all participants with valid baseline variables also had valid values for these covariates.

Measures

This section describes the study variables, the handling of missing data, and the specifications of the baseline and expanded models.

Data Cleaning and Missing-Value Handling

In the ELS:2002 data, missing, skipped, and not-applicable responses are represented by negative-value codes (e.g., −1, −3, −4, −6, −7, −8, and −9; Ingels et al., 2014), which were excluded before analysis. If not excluded, statistical software can consider them as actual numbers that seriously distort means, standard deviations, and regression coefficients without producing any error. In this analysis, only cases with valid values were retained. Cumulative GPA (**F3TZGPAALL**) was restricted to values falling in [0,4], standardized motivation score (**BYINSTMO**) was limited to valid range (approximately −2.0 to +2.0), and financial stress (**F3D36**) was restricted to values in [1,5]. The same logic was applied to all additional variables contained in the expanded regression model.

Baseline Model

Three main variables were central to the baseline model. Financial stress (F3D36) was measured using a self-reported item ranging from 1 (not at all stressful) to 5 (extremely stressful), based on students' stress about meeting their financial obligations during the previous year (Ingels et al., 2014). Higher scores indicated greater financial stress. Academic motivation (BYINSTMO) was measured using a standardized composite which was created from multiple base-year items rather than a single survey question. The dependent variable F3TZGPAALL, measured cumulative postsecondary grade point average (GPA) on a 0–4.0 scale. The baseline model examined the associations of academic motivation and financial stress that were related to GPA before accounting for other socioeconomic and demographic factors.

The model was specified as:

$$GPA_i = \beta_0 + \beta_1\, Motivation_i + \beta_2\, Financial\ Stress_i + \epsilon_i$$

Expanded Model

The expanded model included additional socioeconomic and demographic covariates, along with an interaction term between motivation and financial stress. The covariates were socioeconomic status (BYSES1), parental education (the average of BYMOTHED and BYFATHED, 1–8 scale), sex (indicator coded from BYSEX), race/ethnicity (six dummy variables based on BYRACE, with White non-Hispanic student serving as the reference category), and prior academic achievement (BYTXCSTD, standardized test score).

One of the covariates included in the original extended model—institution type and selectivity—was not available in the trimmed dataset used for this analysis. As a result, it could not be included in the model, which is considered a limitation of this study. In addition, the variables motivation and financial stress were mean centered before creating the interaction term. Mean-centering is a common practice because it makes the regression coefficients easier to interpret and helps reduce multicollinearity that can occur when interaction terms are created from raw scores (Bouri et al., 2018).

Expanded regression model:

$$GPA_i = \beta_0 + \beta_1\, Motivation_i + \beta_2\, FinancialStress_i + \beta_3(Motivation_i \times FinancialStress_i) + \beta_4\, SES_i + \beta_5\, ParentalEducation_i + \beta_6\, Female_i + \beta_7\, Prior\ Achievement_i + \beta_8 Aian + \beta_9 Asian_i + \beta_{10} Black_i + \beta_{11}\, HispanicNoRace_i + \beta_{12}\, HispanicRaceSpecified_i + \beta_{13}\, Multiracial_i + \varepsilon_i$$

Where GPA is cumulative postsecondary grade point average; Motivation and Financial Stress are mean-centered continuous variables; SES is socioeconomic status; Female is a binary indicator (1 = female, 0 = male); Prior Achievement is the standardized base-year achievement score; and AIAN, Asian, Black, Hispanic (No Race), Hispanic (Race Specified), and Multiracial are dummy variables for race/ethnicity. White, non-Hispanic served as the reference category and is therefore omitted from the model.

Estimation and Diagnostics

All statistical analyses were conducted using JMP version 18 (JMP Statistical Discovery LLC., 2024). The regression models were estimated using the Base Year–Third Follow-Up panel weight (F3BYPNLWT), while unweighted models were also examined as a sensitivity analysis. Overall, the main findings for focal predictors were generally similar in the weighted and unweighted analyses. Several diagnostic tests were used to evaluate the expanded regression model. Variance inflation factors (VIFs) were examined for possible multicollinearity (O'Brien, 2007). Cook's distance and leverage values were used to identify influential and high-leverage observations (Cook, 1977). The Breusch-Pagan test was used to assess for heteroskedasticity, and residual skewness, kurtosis, and the Shapiro-Wilk test were used to assess whether the residuals were normally distributed. Also, a sensitivity analysis was performed by re-estimation after excluding observations with high Cook's distances to assess whether these influential cases affected the study's findings.

Results

Descriptive Statistics

Descriptive statistics for the analytic sample are reported in Table 1, and bivariate correlations among the focal variables are reported in Table 2. Motivation and financial stress were weakly negatively correlated with each other ($r = -.046$, $p < .001$); with a sample of this size even a correlation these small reaches statistical significance, so bivariate correlation is not, by itself, a good test of collinearity. Multicollinearity among predictors was instead assessed directly using variance inflation factors (VIFs; see Diagnostics below), which indicated no problematic multicollinearity.

Baseline Model

The weighted baseline regression model indicated that motivation and financial stress were significantly associated with GPA, $F(2, 6565) = 90.79$, $p < .001$, $R^2 = .027$. Motivation was positively linked with higher GPA ($B = 0.079$, $SE = 0.010$, $\beta = .093$, $t = 7.63$, $p < .001$, 95% CI [0.059, 0.099]). In contrast, financial stress was negatively linked with lower GPA ($B = -0.085$, $SE = 0.008$, $\beta = -.129$, $t = -10.61$, $p < .001$, 95% CI [−0.101, −0.069]). Overall, students with greater motivation tended to have higher GPAs, while those experiencing greater financial stress tended to have lower GPAs.

Expanded Model

The F3BYPNLWT-weighted expanded model was estimated using 6,568 participants and was statistically significant, F (13, 6554) = 106.37, $p < .001$, $R^2 = .174$ (adjusted $R^2 = .173$). After accounting for the additional covariates, higher motivation remained significantly associated with higher GPA ($B = 0.049$, $SE = 0.010$, $\beta = .057$, $p < .001$). Financial stress also remained significant, with greater financial stress associated with lower GPA ($B =$

−0.060, *SE* = 0.008, β = −.092, *p* < .001). Prior academic achievement showed the strongest standardized association among the continuous predictors (B = 0.026, β = .283, p < .001). The corresponding unweighted model produced substantively similar results for motivation, financial stress, and the Black–White gap; two race/ethnicity coefficients (Hispanic, no race specified; Multiracial) that were not significant in the weighted model reached significance in the unweighted model, so those two estimates should be treated as less stable.

Effect Sizes and Practical Significance

After accounting for other variables, a one-unit increase in motivation measure was associated with about a 0.05-point increase in GPA (B = 0.049). In contrast, each one-point increase in financial stress was associated with about a 0.06-point decrease in GPA (B = −0.060). Among the continuous predictors, prior academic achievement showed the strongest standardized association with GPA (β = .283). Female and race/ethnicity variables were binary (0/1) predictors; therefore, standardized coefficients were not reported for these variables. Female participants had an estimated GPA 0.252 points higher than male participants, net of the other covariates (B = 0.252, p < .001). Black participants had an estimated GPA 0.340 points lower than White non-Hispanic participants, the reference category, after adjustment for the other variables in the model (B = −0.340, p < .001). The interaction between motivation and financial stress was significant but small (B = −0.017, SE = 0.007, p = .019, 95% CI [−0.031, −0.003]). Contrary to H3, higher motivation did not reduce the negative relationship between financial stress and GPA. Instead, the negative relationship became slightly stronger as motivation increased. However, the interaction was small in magnitude and was sensitive to the removal of influential cases in the unweighted analysis; this finding should be interpreted cautiously.

Diagnostics and Robust Standard Errors

Multicollinearity was not a concern after motivation and financial stress were mean-centered. All VIF values were below 5 (highest VIFs were for SES = 4.75, and parental education = 4.46), reflecting the expected relationship between these two variables. Overall, the VIF values were within accepted thresholds. As a sensitivity check rather than a change to the primary model, cases were flagged using the more liberal 4/n Cook's-distance guideline rather than the conservative D > 1.0 threshold (no case exceeded 1.0; max D = 0.034); this flagged 394 cases (6.0%) as comparatively influential. These cases were not identified as data-entry errors — they are valid observations that simply carry outsized leverage on the fitted coefficients. Re-estimating the unweighted expanded model after excluding these observations left the motivation and financial stress main effects essentially unchanged (both p < .001), but rendered the small motivation × financial stress interaction nonsignificant (p = .052).

Residuals showed heteroskedasticity (Breusch-Pagan LM (13) = 227.88, p < .001), left skew, and excess kurtosis. With N = 6,568, the Shapiro-Wilk test is sensitive enough to detect even trivial deviations from normality, so its significant result (p < .001) is not by itself informative about practical severity; the skewness and kurtosis values are more useful for judging how much the violation matters. As an additional sensitivity analysis, the unweighted expanded model was re-estimated using HC3 robust standard errors. Statistical significance remained unchanged for every predictor, including the interaction (p = .039). In contrast, the more stringent influential-observation sensitivity analysis described above rendered the interaction nonsignificant (p = .052). Given the large sample size, these diagnostic violations are unlikely to substantially alter the main conclusions, although the interaction finding should be interpreted cautiously.

Table 1
Descriptive Statistics for Grade Point Average, Motivation, Financial Stress, and Covariates Among Participants in the Retained Education Longitudinal Study of 2002 Cohort

Variable	*N*	*M*	*SD*	Min	Max
GPA (F3TZGPAALL)[a]	6,568	2.820	0.824	0.00	4.00
Motivation (BYINSTMO)[b]	6,568	0.143	1.00	−1.99	1.58
Financial Stress (F3D36)[c]	6,568	3.090	1.298	1	5
SES (BYSES1, raw z-score)[d]	6,568	0.242	0.711	−2.11	1.82

Variable	*N*	*M*	*SD*	Min	Max
Parental Education (avg, 1–8)	6,568	4.252	1.830	1.0	8.0
Prior Achievement (BYTXCSTD)[e]	6,568	54.385	9.059	20.91	81.04
Female (share)	6,568	0.575	—	0	1

Note. $N = 6{,}568$ for all variables; the same complete-case sample was used in both models.
[a] F3TZGPAALL = GPA (0–4.0). [b] BYINSTMO = base-year motivation composite. [c] F3D36 = financial stress (1–5). [d] BYSES1 = base-year SES composite. [e] BYTXCSTD = base-year achievement composite.

Table 2
Pearson Correlations Among Grade Point Average, Motivation, and Financial Stress for Participants in the Retained ELS:2002 Cohort

Variable	1	2	3
1. GPA	—	.112*	−.142*
2. Motivation	.112*	—	−.046*
3. Financial Stress	−.142*	−.046*	—

Note. $N = 6{,}568$. GPA = grade point average. * $p < .001$

Table 3
F3BYPNLWT-Weighted Baseline Regression of Grade Point Average on Motivation and Financial Stress Among Participants in the Retained ELS:2002 Cohort

Predictor	*B*	*SE B*	β	*T*	*P*	95% CI
Constant	3.037	0.027	—	111.92	< .001	[2.984, 3.090]
Motivation	0.079	0.010	.093	7.63	< .001	[.059, .099]
Financial Stress	−0.085	0.008	−.129	−10.61	< .001	[−0.101, −0.069]

Note. $N = 6{,}568$. *B*= unstandardized regression coefficient; *SE*= standard error; β= standardized regression coefficient; CI= confidence interval. Model: $F(2, 6565) = 90.79$, $p < .001$, $R^2 = .027$

Table 4
F3BYPNLWT-Weighted Expanded Regression of Grade Point Average on Motivation, Financial Stress, and Covariates Among Participants in the Retained ELS:2002 Cohort (N = 6,568)

Predictor	*B*	*SE*	β	*T*	*p*	95% CI	VIF
Constant	1.137	0.078	—	14.56	< .001	[.984, 1.290]	—
Motivation (centered)	0.049	0.010	.057	5.05	< .001	[.030, .068]	1.03
Financial Stress (centered)	−0.060	0.008	−.092	−8.03	< .001	[−.075, −.046]	1.05
Motivation × Financial Stress	−0.017	0.007	−.026	−2.34	.019	[−.031, −.003]	1.00
SES	0.006	0.029	.005	0.21	.837	[−.051, .063]	4.75
Parental Education	0.030	0.011	.063	2.76	.006	[.009, .051]	4.46
Female	0.252	0.020	—	12.89	< .001	[.214, .291]	1.02
Prior Achievement	0.026	0.001	.283	21.71	< .001	[.024, .029]	1.32
Race: AIAN (vs. White)	−0.213	0.126	—	−1.68	.092	[−.460, .035]	1.01
Race: Asian (vs. White)	0.042	0.048	—	0.88	.382	[−.052, .136]	1.07
Race: Black (vs. White)	−0.340	0.034	—	−10.00	< .001	[−.406, −.273]	1.16
Race: Hispanic (no race) (vs. White)	−0.028	0.046	—	−0.61	.541	[−.119, .062]	1.08

Predictor	*B*	*SE*	β	*T*	*p*	95% CI	VIF
Race: Hispanic (race spec.) (vs. White)	−0.098	0.041	—	−2.38	.017	[−.178, −.017]	1.06
Race: Multiracial (vs. White)	−0.058	0.050	—	−1.14	.253	[−.156, .041]	1.03

Note. N = 6,568. B = unstandardized regression coefficient; SE = standard error of B; β = standardized regression coefficient; CI = confidence interval; VIF = variance inflation factor. White non-Hispanic participants served as the reference category for race/ethnicity, and male participants served as the reference category for sex. Standardized coefficients were not reported for binary predictors. Model**:** $F(13, 6554) = 106.37$, $p < .001$, $R^2 = .174$, adjusted $R^2 = .173$.

Table 5
Unweighted Sensitivity Analysis Comparing Ordinary Least Squares and HC3 Robust Standard Errors for the Expanded Model Predicting Grade Point Average

Predictor	*B*	*SE* (OLS)	*t* (OLS)	*SE* (HC3)	*t* (HC3)	*p* (HC3)
Constant	1.175	0.075	15.61	0.080	14.61	< .001
Motivation (centered)	0.054	0.009	5.71	0.009	5.75	< .001
Financial Stress (centered)	−0.057	0.007	−7.88	0.008	−7.61	< .001
Motivation × Financial Stress	−0.015	0.007	−2.11	0.007	−2.07	.039
SES	−0.015	0.028	−0.54	0.029	−0.54	.592
Parental Education	0.038	0.011	3.57	0.011	3.54	< .001
Female	0.233	0.019	12.38	0.019	12.16	< .001
Prior Achievement	0.026	0.001	21.93	0.001	20.85	< .001
Race: AIAN (vs. White)	−0.257	0.133	−1.93	0.175	−1.47	.141
Race: Asian (vs. White)	0.035	0.031	1.11	0.028	1.24	.213
Race: Black (vs. White)	−0.323	0.034	−9.49	0.037	−8.84	< .001
Race: Hispanic (no race) (vs. White)	−0.102	0.045	−2.27	0.051	−2.01	.044
Race: Hispanic (race spec.) (vs. White)	−0.125	0.040	−3.12	0.044	−2.85	.004
Race: Multiracial (vs. White)	−0.119	0.046	−2.62	0.052	−2.29	.022

Note. N = 6,568. B = unstandardized regression coefficient; SE = standard error; OLS = ordinary least squares; HC3 = heteroskedasticity-consistent standard error. The F3BYPNLWT-weighted regression reported in Table 4 is the primary expanded model; Table 5 presents an unweighted sensitivity analysis (White, 1980; MacKinnon & White, 1985).

Discussion

Motivation and Financial Stress in the Expected Directions

The findings indicate that both psychological and financial factors were associated with academic performance, consistent with prior research. Students with higher levels of motivation tended to have higher postsecondary GPAs, consistent with Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000) and with evidence from previous meta-analyses showing that achievement motivation is among the strongest psychological correlates of students' grade point average (Robbins et al., 2004; Richardson et al., 2012). Overall, the results are consistent with motivation being an important factor associated with academic achievement. Even so, the motivation association observed in the baseline model here was smaller than the combined psychological-predictor associations reported in those meta-analyses, plausibly because this study relies on a brief standardized composite motivation index (BYINSTMO) rather than a broader, validated multi-item scale such as the Academic Motivation Scale (Vallerand et al., 1992).

Prior research shows that economic hardship is associated with worse academic performance (Joo et al., 2008), and another study indicates that financial difficulties increase stress, which makes it difficult for students to stay

focused academically (Broton & Goldrick-Rab, 2018). However, it is worth mentioning that not all previous research studies find a robust financial stress-grade point average link once financial knowledge and resources are modeled directly (Heckman et al., 2014; Britt et al., 2016). The effects of both motivation and financial stress in this study were relatively modest. This is broadly consistent with the moderate relationship between psychosocial-predictor effect sizes reported by Robbins et al. (2004).

A Small and Fragile Interaction

H3 was not supported: although the interaction was statistically significant in the full sample, its direction was opposite to the hypothesized buffering effect. The negative financial stress and GPA slope grew steeper, not shallower, as motivation increased, and the effect did not remain significant once influential cases were excluded. Rather than providing evidence that motivation protects students from the negative association between financial stress and GPA, the observed pattern suggests that the GPA advantage associated with higher motivation may narrow as financial stress increases. This finding raises new questions about how motivation and financial stress relate, rather than settling them. Given the interaction's small size and its sensitivity to a handful of influential cases, it should be treated as tentative and exploratory rather than firm evidence of either buffering or exacerbation. One plausible explanation is the way that financial stress was measured based on a single self-reported item, which may not have fully captured students' financial strain or the true interaction between financial stress and motivation. Although motivation was measured using a composite of several items, a more comprehensive validated scale might also provide a more precise measure.

Sex and Racial Disparities

Two additional patterns emerged after covariates were added in the model. The female students had higher GPAs than male students, which is consistent with previous research showing that younger women earn higher course grades than men, even when the two groups' performance on standardized test is similar (Voyer & Voyer, 2014). The Black–White adjusted GPA difference was also notable and remained statistically significant after socioeconomic status, parental education, prior achievement, and the other covariates were included. A smaller but still statistically significant gap was observed for Hispanic (race specified) participants relative to the White non-Hispanic reference group. This study did not measure other factors such as academic advising, financial aid access, discrimination, institutional quality, or campus climate, so it cannot explain why the observed gap remains. It is possible that institutional or structural factors such as those mentioned above contribute to the disparity. The findings suggest that family background and prior academic preparation alone do not fully account for the gap in this sample. Future research should directly confirm and measure institutional and structural factors to better understand their possible role (Sirin, 2005; Hu & Morgan, 2024).

Limitations

Substantial Sample Attrition

The analytic sample of 6,568 students represents about 41% of the 16,197 records in the original data extract. Students with missing or invalid values for any of the study variables were excluded. Findings mainly reflect the students who remained in the analytic sample rather than the full national sample. This study did not compare the characteristics of included and excluded students, so future research should examine whether sample attrition may have affected the findings.

Heteroskedasticity and Non-Normal Residuals

The analysis showed evidence of heteroskedasticity and non-normal residuals. In the unweighted sensitivity analysis, using HC3 robust standard errors did not change the statistical significance for any predictors, suggesting that heteroskedasticity did not substantially affect the main conclusions. However, when influential observations were removed, the interaction between motivation and financial stress was nonsignificant. Therefore, this small effect should be treated with caution.

Survey Design and Data Constraints

Several limitations are related to the trimmed data extract used in this study. Although the Base Year and Third Follow-Up panel weight (F3BYPNLWT) was applied, the analysis did not account for the full complex survey design, including stratification and clustering at the school level. Therefore, the standard errors and significance of the results should be interpreted with appropriate caution. Future studies should incorporate the full survey design when the required variables and appropriate statistical software capabilities are available.

Causal Inference and Measurement Limitations

Financial stress and GPA were both measured at the third follow-up, making it difficult to determine clear temporal precedence between them; only motivation was measured at base year. In addition, motivation was measured using a standardized composite index, while financial stress was assessed with a single self-reported item. Reliability estimates for these measures were not available in the current analysis and measurement limitations may have weakened the observed relationships and contributed to the modest R^2 values.

Longitudinal Design and Unexplained Racial Disparities

ELS:2002 supports growth models, cross-lagged panel models, or SEM tracing motivation, financial stress, and performance across its four waves (Bozick & Lauff, 2007). However, this study used data from only two waves, and financial stress and GPA were measured at the same third follow-up. Future research could use additional waves to better understand how motivation, financial stress, and academic performance change and relate to one another over time. In addition, this study does not explain the significant Black–White gap; future analysis should examine other factors such as institution type, financial aid, and campus climate before drawing conclusions about the sources of this disparity (Sirin, 2005; Hu & Morgan, 2024).

Conclusion

Motivation and financial stress were both related to students' postsecondary GPA, even after accounting for socioeconomic status, parental education, sex, race, and prior academic achievement. However, the interaction between motivation and financial stress was small and was no longer significant after exclusion of influential cases. The expanded model accounted for a modest share of the variance in GPA, underscoring that other academic, psychological, and environmental factors may also influence student outcomes. Given the sample attrition and diagnostic issues noted above, these findings should be interpreted with caution. Future studies should examine the impact of sample attrition, incorporate the full complex survey design, and further investigate the racial disparities in GPA identified in this study.

Declaration of Interest
No potential conflict of interest.

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Author Contribution Statement
The author designed the study, conducted the data analysis, interpreted the findings, and wrote the manuscript.

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Ethical statement
No new data were collected from human subjects for this study. The analyses were conducted using secondary data from the Education Longitudinal Study of 2002 (ELS:2002), collected and maintained by the National Center for Education Statistics (NCES), U.S. Department of Education.

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