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**HW0331**

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**5.13.a**

Beta1: If Bill departs from Carnegie at 6:30 AM under ideal conditions (no red lights or trains), his commute is expected to take approximately 20.87 minutes.

Beta2: Should Bill leave later than 6:30 AM, his travel time is projected to increase by around 3.7 minutes for every additional 10 minutes delay, assuming that the frequency of red lights and trains stays the same.

Beta3: With the departure time and train encounters held constant, every red light is anticipated to add roughly 1.52 minutes to his commute.

Beta4: Similarly, if his departure time and the occurrence of red lights remain unchanged, each train encountered is estimated to add about 3.02 minutes to his travel time.

**5.13.b**

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**5.13.c**

The computed t-statistic is  
  t = (β₃ – 2)/se(β₂) = –2.584, which is lower than –1.651.  
Thus, we conclude that the expected delay attributable to each red light is under 2 minutes.

**5.13.d**

The t-statistic is  
  t = (β₄ – 3)/se(β₄) = 0.037, a value less than 1.651.  
Therefore, we cannot reject the null hypothesis that β₄ is equal to 3 minutes.

**5.13.e**

With  
  t = (β₃ – 1/3)/se(β₂) = 0.991, which is below the critical value of 1.651,  
we do not have enough evidence to reject the null hypothesis that a 30-minute delay in departure results in an increase of at least 10 minutes in the expected travel time.

**5.13.f**

The t-statistic calculated as  
  t = (β₄ – 3β₃)/se(β₄ – 3β₃) = –1.825027 falls below –1.651.  
This result leads us to reject the null hypothesis (that β₄ is greater than 3β₃), indicating that the expected delay caused by a train is less than three times the delay from a red light.

**5.13.g**

H₀: β₁ + 30β₂ + 6β₃ + β₄ ≤ 45

To test this, we compute the test statistic:  
t = (b₁ + 30b₂ + 6b₃ + b₄) / SE(b₁ + 30b₂ + 6b₃ + b₄) = -1.725964

Since the calculated t-value (-1.725964) is less than the critical value (1.651), we fail to reject the null hypothesis H₀.

**5.13.h**

H₀: β₁ + 30β₂ + 6β₃ + β₄ ≥ 45

In this case, if the test statistic t > -1.651, we fail to reject H₀.  
However, since t < -1.651, we reject the null hypothesis.

This means there's sufficient evidence to conclude that Bill takes less than 45 minutes to get to the meeting.

**5.33.a**

All the estimated coefficients are statistically significant at the 1% level, except for the coefficient on EDUC², which is only significant at the 12% level.

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**5.33.b**

The marginal effect of education is given by:  
ME | Educ = β₂ + 2β₃ \* Educ + β₆ \* Expert

The estimated marginal effect is:  
ME\_EDUC = 0.089539 + 0.002916 \* Educ – 0.001010 \* Expert

This indicates that the marginal effect of education increases with higher levels of education, but decreases as experience increases.

**5.33.c**

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We find that the **marginal effects** range from **0.036 to 0.148**, with the majority falling between **0.085 and 0.13**.  
The **5th, 50th (median), and 95th percentiles** of the marginal effects distribution are, respectively.

**5.33.d**

the **marginal effect of experience** is given by:  
**ME | Exper = β₄ + 2β₅ \* Exper + β₆ \* Educ**

The estimated marginal effect is:  
**ME\_EXPER = 0.044879 – 0.000936 \* Exper – 0.001010 \* Educ**

This shows that the **marginal effect of experience declines** both as **years of experience increase** and as the **level of education rises**.

**5.33.e**

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Although **most of the marginal effects of experience are positive**, their overall range spans from **-0.025 to 0.034**.  
The **5th, 50th (median), and 95th percentiles** of these marginal effects are, respectively

**5.33.f**

**H₀: β₁ + 17β₂ + 289β₃ + 8β₄ + 64β₅ + 136β₆ ≤ β₁ + 16β₂ + 256β₃ + 18β₄ + 324β₅ + 288β₆**

Simplifying both sides by subtracting common terms, the hypothesis becomes:

**H₀: β₂ + 33β₃ – 10β₄ – 260β₅ – 152β₆ ≤ 0**

The calculated test statistic is **t = -1.669902**, which is **less than the critical value tₐ = -1.6461**.  
Since **t < tₐ**, we **fail to reject the null hypothesis (H₀)**.  
This means there is **insufficient evidence to conclude that David's log-wage is greater**.

**5.33.g**

The null hypothesis is:  
**H₀: –β₂ – 33β₃ + 10β₄ + 420β₅ + 144β₆ ≥ 0**

The test statistic is **t = –2.062365**, which is **less than the critical value of –1.6461**.  
Since **t < tₐ**, we **reject the null hypothesis**.

This provides **evidence that David’s log-wage is greater**.

The observed difference in outcomes can be explained by **diminishing returns to experience**. Svetlana started with **18 years of experience**, so the additional years had **less impact** on her log-wage. In contrast, David initially had **only 8 years of experience**, so the **extra 8 years contributed more significantly** to increasing his log-wage.

**5.33.h**

The marginal effect of experience is defined as:  
**ME | Exper = β₄ + 2β₅ \* Exper + β₆ \* Educ**

For Wendy:  
**ME = β₄ + 34β₅ + 12β₆**

For Jill:  
**ME = β₄ + 22β₅ + 16β₆**

To test whether their marginal effects differ, we form the null hypothesis:  
**H₀: β₄ + 34β₅ + 12β₆ = β₄ + 22β₅ + 16β₆**,  
which simplifies to: **12β₅ – 4β₆ = 0**

The test statistic is **t = -1.027304**, which is **greater than the critical value -1.96195**.  
Since **t > t\_cr**, we **fail to reject the null hypothesis**.

**Conclusion:** There is **insufficient evidence** to suggest that the marginal effect of experience differs between Jill and Wendy.

**5.33.i**

Assuming Jill gains more experience over time but does not pursue additional education, her marginal effect of experience evolves as:  
**ME = β₄ + 2β₅ \* Exper + 16β₆**

We're interested in finding when this becomes **less than 11**, so we solve:  
**β₄ + 2β₅ \* Exper + 16β₆ – 11 < 0**

Based on this condition, it will take approximately **19.667 more years** before Jill's marginal effect becomes negative.

A **95% confidence interval** for the number of years until her marginal effect turns negative is:  
**[15.96, 23.40]**