*International Journal of Scientific Research and Engineering Development-– Volume 8 Issue 5, Sep-Oct 2025*
*Available at www.ijsred.com*

RESEARCH ARTICLE OPEN ACCESS

# Econometric Model Minimum Significance of Independent Variables and their Impact on the R-squared Value of the Dependent Variable

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## Abstract:

An econometric model is a statistical framework that uses economic theory, mathematics, and statistical inference to quantify economic relationships. Unlike the controlled experiments of the physical sciences, econometrics relies on observational data to analyse complex systems where many variables change simultaneously. A key tool is the multiple linear regression model, which estimates how changes in one or more independent (explanatory) variables affect a dependent (explained) variable. This is done while accounting for the influence of other factors. The model's validity and utility are assessed through measures like **R-squared ($R^2$)** and the statistical significance of its independent variables. These metrics are crucial for determining the model's explanatory power and the reliability of the estimated relationships, guiding economic policymaking and forecasting.

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## I. INTRODUCTION

### The Role of Independent Variable Significance and R-squared

#### Significance of Independent Variables

In an econometric model, the **significance** of an independent variable refers to the probability that its estimated relationship with the dependent variable is not due to random chance. This is determined by a hypothesis test, which yields a **p-value**. If the p-value is below a predetermined significance level (e.g., 0.05), we can reject the null hypothesis that the variable has no effect and conclude that it is statistically significant. A significant independent variable suggests a meaningful relationship with the dependent variable, even if the overall explanatory power of the model is low.

#### The Importance of R-squared ($R^2$)

**R-squared ($R^2$)**, also known as the coefficient of determination, is a goodness-of-fit measure that indicates the proportion of the variance in the dependent variable that is explained by the independent variables in the model.

It is expressed as a percentage, ranging from 0% to 100%. A higher $R^2$ value means the model's predictions more closely match the observed data.

However, $R^2$ has limitations:

- Adding more independent variables, even if they are not significant, will always increase the $R^2$. This can lead to **overfitting**, where the model fits the specific quirks of the sample data rather than the underlying population relationship.
- A high $R^2$ doesn't guarantee the model is good or that the variables are correctly specified. It simply shows how much of the dependent variable's variation is accounted for by the independent variables.
- Conversely, a low $R^2$ doesn't invalidate a model. For example, in social sciences or finance, where human behavior and external factors are hard to capture, a model with significant variables but a low $R^2$ can still

  

provide important insights into the relationships between variables.

**The Relationship Between Independent Variable Significance and R-squared**

While related, the statistical significance of independent variables and the overall $R^2$ of a model measure different things:

- **Significance** addresses the reliability of a single independent variable's effect. It tells us whether we can confidently say a variable has a non-zero impact.
- **$R^2$** addresses the overall explanatory power of all independent variables combined. It tells us how much of the dependent variable's variation is explained by the model as a whole.

A model can have:

- **Significant independent variables and a high $R^2$**: This is the ideal scenario, indicating that the model's variables are reliable predictors, and the model has strong explanatory power.
- **Significant independent variables and a low $R^2$**: This means the variables have a genuine, non-random effect on the dependent variable, but many other factors not included in the model are also influencing it. The coefficients of the significant variables can still be interpreted reliably.
- **Insignificant independent variables and a high $R^2$**: This is often a sign of multicollinearity (independent variables are highly correlated with each other) or overfitting. The model appears to have high explanatory power, but the individual variables' effects cannot be reliably distinguished.

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