Do poor countries grow faster than rich countries?

In this segment, we will provide an empirical example of **Partialling-out with Lasso** to estimate the regression coefficient β_1 in the high-dimensional linear regression model where:

$$Y = \beta_1 D + \beta'_2 W + \varepsilon$$

Specifically, we are interested in how the rates at which the economies of different countries grow (Y) are related to the initial wealth levels in each country (D), controlling for the country's institutional, educational and other similar characteristics (W).

This relationship is captured by the regression coefficient β_1. In the example, this coefficient is called the **speed of convergence or divergence**, as it measures the speed at which poor countries catch up ($\beta_1 < 0$) or fall behind ($\beta_1 > 0$) rich countries, after controlling for W.

So, our inference question here is this - **Do poor countries grow faster than rich countries controlling for educational and institutional characteristics?**
In other words, is the speed of convergence negative, namely **is β_1 negative?**

In economics this question is known as **the convergence hypothesis**, which was predicted by the Solow Growth Model. This growth model was developed by Professor Robert M Solow, a world-renowned MIT economist who won the Nobel Prize in Economics in 1987.

In this case study, we use data collected by the economists Robert Barro and John Wiley. In this dataset, **the outcome Y is the realized annual growth rate of a country's wealth** measured by the gross domestic product per capita.

The target regressor **D is the initial level of the country's wealth.**

The controls W include measures of education levels, quality of institutions, trade openness and political stability in the country.

The dataset contains 90 countries and about 60 controls.

So ‘P’ is approximately 60, and the ‘N’ is 90, a relatively small number.
P/N is hence not very small.

This means that we are operating in a high-dimensional setting. Therefore, we expect the least-squares method to provide a poor, very noisy estimate of β_1. And in contrast, we expect the method based on Partialling-out with Lasso to provide a high quality estimation of β_1.

We now present the empirical results in the table below:

The table shows the estimates of the speed of convergence of β_1, obtained by least squares and by Partialling-out with Lasso.

	Estimate	Std. Error	95% Conf. Interval
Least squares	-0.009	0.030	[-0.069, 0.050]
Partialling-out via lasso	-0.044	0.015	[-0.075, -0.014]

The table also provides standard errors and 95% confidence intervals for each model. As we expected, the least squares method provides a rather noisy estimate of the annual speed of convergence, and does not allow us to answer the question about the convergence hypothesis, due to a high standard error and the 95% confidence interval having a significant portion with positive numbers as well.

In sharp contrast, **Partialling-out via Lasso provides a much more precise estimate** (lower standard error) and **does support the convergence hypothesis**, since the range of the 95% confidence interval is entirely negative (below 0).

To explain the above statement, we see from the results that the **Lasso-based estimate of β_1 is -4.4% (-0.044).** And the 95% confidence interval for the annual rate of convergence, as we see from the table, is from **-7.5% to -1.4%**. Since this range is entirely comprised of negative values, this empirical evidence does support the convergence hypothesis that β_1 is negative.

To summarize, in this segment, we have examined **an empirical example in a high-dimensional setting.** Using least-squares regression in this setting gives us a very noisy estimate of the target regression coefficient, and does not allow us to answer an important empirical question. In sharp contrast, using the Partialling-out method with Lasso, does give us a precise estimate of the regression coefficient, and does allow us to answer that question. We have found significant empirical evidence supporting the convergence hypothesis of Solow.