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et de **gestion**
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Impact des depénses en Recherche et developpement sur la productivité

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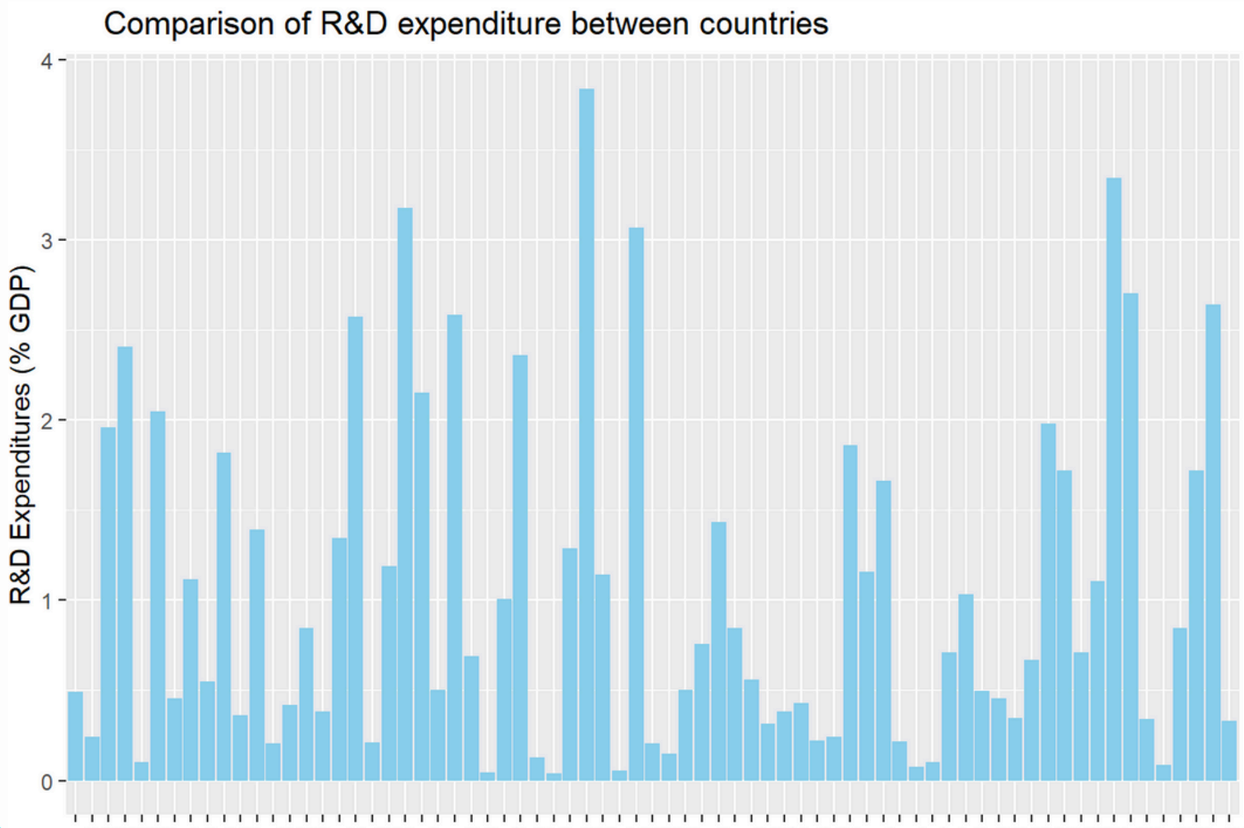
Sommaire

Introduction

- **Problématique de la R&D et de son lien avec la productivité.**
- **Objectif de l'étude : quantifier l'impact des dépenses en R&D sur la productivité.**
- **Focus sur l'innovation de procédé et la productivité totale des facteurs (PTF).**



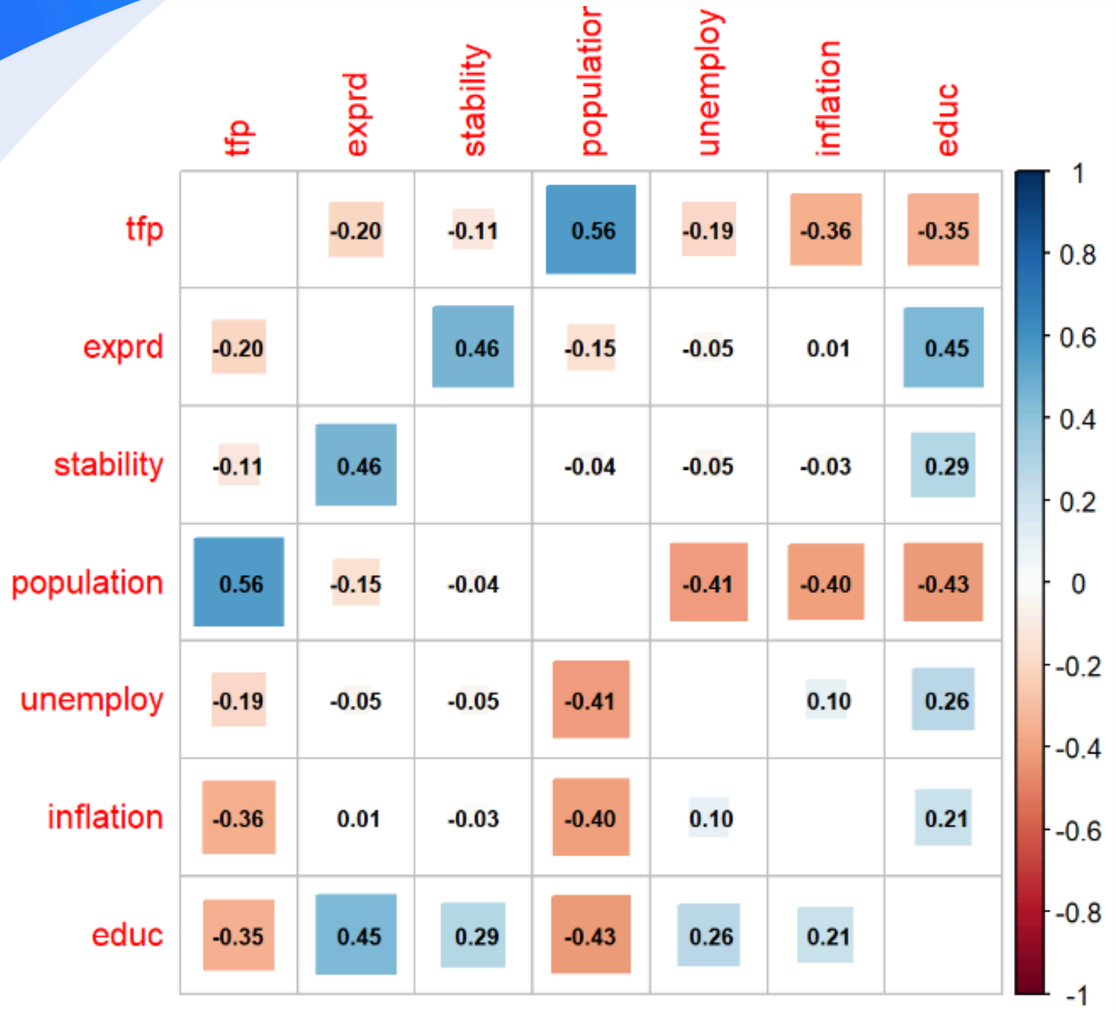
Variables, definitions, sources

Variables	Measures	Units	Sources
tfp	Total factor productivity measures the efficiency with which inputs (like labor and capital) are used to produce output in an economy. It reflects the overall productivity of all factors of production combined	non-specific (is typically measured as an index number)	Our World in Data (Feenstra et al. (2015), Penn World Table (2021))
exprd	Gross domestic expenditures on research and development (R&D). They include both capital and current expenditures.	% GDP	UNESCO Institute(WDI)
stability	Political Stability and Absence of Violence/Terrorism: Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank.	Percentile Rank	World Bank(WDI)
population	Annual population growth rate.	annual %	World Bank(WDI)
unemploy	Unemployment refers to the share of the labor force that is without work but available for and seeking employment	% of total labor force	World Bank(WDI)
inflation	Inflation as measured by the annual growth rate of the GDP implicit deflator	annual %	World Bank(WDI)
regulary	Regulatory Quality (Estimate), measures the government's ability to formulate and implement sound policies and regulations that promote private sector development.	a standardized scale ranging from -2.5 (low quality) to +2.5 (high quality)	World Governance Indicators
educ	School enrollment, tertiary	% gross	World Bank
export	Exports of goods and services	(constant 2015 US$)	World Bank(WDI)

Étude descriptive

Cette étude analyse 71 pays et révèle des tendances globales positives, comme une efficacité productive élevée et un fort investissement en R&D. Toutefois, elle met en lumière de fortes disparités en matière de stabilité politique, de croissance démographique, de chômage, d'inflation et d'éducation entre les pays.

```
##
## Table: Descriptive statistics of some variables
## ============================================================
## Statistic                   N    Mean   St. Dev.    Min      Max
## ------------------------------------------------------------
## Total Factor Productivity 71 0.998    0.059     0.899    1.242
## R&D expenditures          71 1.051    0.945     0.040    3.842
## Political stability       71 59.557   25.232    2.619   99.286
## Population growth rate    71 0.975    1.370    -0.900    8.539
## Unemployement             71 7.628    5.501     0.000   25.844
## Inflation                 71 1.923    6.738   -16.521   33.431
## Education level           71 55.140   26.966    0.000   119.679
## ------------------------------------------------------------
```



- La PTF est positivement corrélée à la croissance démographique (0,56) et négativement liée aux dépenses en R&D (-0,20) et au niveau d'éducation (-0,35).

- La stabilité et l'éducation montrent une corrélation modérée (0,46), tandis que l'éducation est également liée aux dépenses en R&D (0,45).

Model, Estimate and Results

La spécification du modèle est la suivante :

$$\ln(PTFi) = \beta 0 + \beta 1 Exprd\_i + \beta 2 Stability\_i + \beta 3 (Stability\_i)^2 + \beta 4 Population\_i + \beta 5 Unemploy\_i + \beta 6 Inflation\_i + \beta 7 Educi\_ + \epsilon i$$

```
Call:
lm(formula = log(tfp) ~ exprd + stability + I(stability^2) +
    population + unemploy + inflation + educ, data = our_data)

Residuals:
      Min        1Q    Median        3Q       Max
-0.086932 -0.022304 -0.001982  0.017916  0.188628

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    -5.678e-02  2.929e-02  -1.939   0.0570 .
exprd           3.090e-03  7.510e-03   0.411   0.6821
stability       2.388e-03  9.709e-04   2.460   0.0167 *
I(stability^2) -2.388e-05  9.014e-06  -2.649   0.0102 *
population      2.217e-02  5.128e-03   4.323 5.59e-05 ***
unemploy       -1.897e-05  1.124e-03  -0.017   0.9866
inflation      -9.856e-04  8.929e-04  -1.104   0.2739
educ           -2.132e-04  2.542e-04  -0.839   0.4047
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.04535 on 63 degrees of freedom
Multiple R-squared:  0.4168,    Adjusted R-squared:  0.352
F-statistic: 6.433 on 7 and 63 DF,  p-value: 1.005e-05
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Variables significatives :

- Stabilité politique (stability) : Lorsque la stabilité politique **augmente d’un rang,** toute chose égale par ailleurs, la productivité globale des facteurs augmente d’environ **0.24% ,** tandis que son terme au carré (stabilité²) a un effet négatif significatif.

==> L'impact positif de la stabilité diminue à des niveaux de stabilité plus élevés

- Croissance de la population (population) : Effet positif hautement significatif. Lorsque le taux de croissance de la démographie **augmente d’un pourcent,** le TFP augmente d’environ **2.2% ,** toute chose égale par ailleurs.

Variables non significatives : Dépenses en R&D, Chômage, Inflation, Éducation

Model, Estimate and Results

```
Call:
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Residuals:
      Min        1Q    Median        3Q       Max
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(Intercept)    -5.678e-02  2.929e-02  -1.939   0.0570 .
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I(stability^2) -2.388e-05  9.014e-06  -2.649   0.0102 *
population      2.217e-02  5.128e-03   4.323 5.59e-05 ***
unemploy       -1.897e-05  1.124e-03  -0.017   0.9866
inflation      -9.856e-04  8.929e-04  -1.104   0.2739
educ           -2.132e-04  2.542e-04  -0.839   0.4047
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```

- **$R^2 = 0,4168$** : Cela indique que 41,68 % de la variabilité de la productivité totale des facteurs (PTF) est expliquée par notre modèle.
- **R^2 ajusté = 0,352** : seulement 35,2 % de la variabilité de la PTF est expliquée par notre modèle
- **Statistique F = 6,433** : La valeur élevée de la statistique F et sa faible valeur p (1,005e-05) nous permettent de rejeter l'hypothèse nulle et donc les variables explicatives sont conjointement différents de zéro.

Model, Estimate and Results

```
t test of coefficients:

                  Estimate  Std. Error t value Pr(>|t|)
(Intercept)    -5.6783e-02  2.9992e-02 -1.8933 0.062914 .
exprd           3.0899e-03  5.0013e-03  0.6178 0.538916
stability       2.3883e-03  9.7553e-04  2.4482 0.017153 *
I(stability^2) -2.3875e-05  8.4673e-06 -2.8197 0.006419 **
population      2.2166e-02  5.4594e-03  4.0602 0.000138 ***
unemploy       -1.8971e-05  1.0898e-03 -0.0174 0.986166
inflation      -9.8559e-04  1.1587e-03 -0.8506 0.398223
educ           -2.1325e-04  3.3141e-04 -0.6434 0.522268
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’
```

Ecart-type robuste de white

Interprétation :

- La valeur de nos ecart-type change tandis que les coefficients ne sont pas affectés

- L'effet de « Instabilité^2) » est désormais statistiquement plus significatif

Pas de grandes différences

Conclusion

La non-significativité des dépenses en R&D dans notre modèle suggère que leur impact direct sur la productivité totale des facteurs (TFP) n’est pas clairement établi dans cet échantillon de 71 pays. Cela pourrait s'expliquer par des effets différés, des interactions complexes avec d'autres variables (comme l'éducation ou la stabilité politique), ou encore des différences structurelles entre les pays.

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The first hypothesis H1 is satisfied when we introduce a intercept in the model. this is the cas here. so it's automatically satisfied. no n

8.1 Homoscedasticity test : Breusch-Pagan test

As we have a not very large sample (N=71), it would be appropriate to do the BP test

```
bptest(model)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  model
## BP = 12.462, df = 7, p-value = 0.08636
```

Interpretation:

- The null hypothesis H0 is that there is no heteroscedasticity

We can conclude that apparently there is no heteroscedasticity with a threshold of 0.05. But with the plot of residual, we saw that there heteroscedasticity. This homoscedasticity result is therefore not totally correct. In addition, we see that there is a slight presence of heteroscedasticity at the threshold of 0.01.

So for more precaution we will calculate White's robust standard errors to solve the heteroscedasticity

10. Comparison of OLS estimates

We can use again the package 'stargazer' to facilitate comparison with the OLS estimates

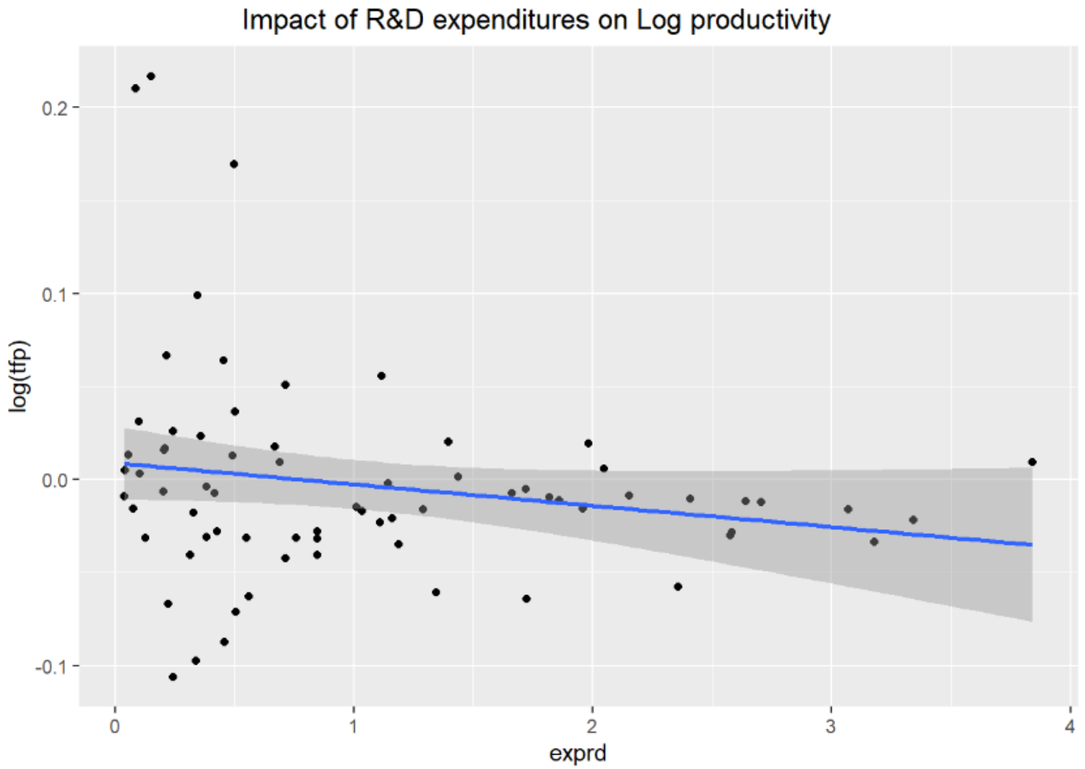
```
colSums(is.na(our_data)) #NA
```

```
##    Country        gdp population   unemploy     export  inflation
##          0          0          0          0          0          0
##  stability      exprd   regulary        tfp exprd_pred
##          0          0          0          0          0
```

```
stargazer(model, model_iv2, type = "text",
          dep.var.labels = c("Log of Total Factor Productivity"),
          covariate.labels = c("R&D Expenditures", "R&D Expenditures Inst
                               "Political Stability", "Squared Stability"
                               "Population Rate", "Unemployment",
                               "Inflation", "Education Level"),
          omit = c("Constant"))
```

```
##
## ===============================================================
##                                   Dependent variable:
##                               ------------------------------
##                               Log of Total Factor Productivity
##                                     (1)             (2)
## ---------------------------------------------------------------
## R&D Expenditures                   0.003
##                                   (0.008)
##
## R&D Expenditures Instrumented                       0.005
##                                                    (0.012)
##
## Political Stability              0.002**          0.002**
##                                   (0.001)          (0.001)
##
## Squared Stability               -0.00002**       -0.00002**
##                                  (0.00001)        (0.00001)
```

	Dependent variable:	
	Log of Total Factor Productivity	
	(1)	(2)
R&D Expenditures	0.003	
	(0.008)	
R&D Expenditures Instrumented		0.005
		(0.012)
Political Stability	0.002**	0.002**
	(0.001)	(0.001)
Squared Stability	-0.00002**	-0.00002**
	(0.00001)	(0.00001)
Population Rate	0.022***	0.022***
	(0.005)	(0.005)
Unemployment	-0.00002	0.00000
	(0.001)	(0.001)
Inflation	-0.001	-0.001
	(0.001)	(0.001)
Education Level	-0.0002	-0.0002
	(0.0003)	(0.0003)
Observations	71	71
R2	0.417	0.416
Adjusted R2	0.352	0.352
Residual Std. Error (df = 63)	0.045	0.045
F Statistic (df = 7; 63)	6.433***	6.424***
Note:		*p<0.1; **p<0.05; ***p<0.01



```r
### Modèle simple avec une seule variable explicative
lm_simple <- lm(log(tfp) ~ exprd, data = our_data)
#Estimation
summary_simple <- summary(lm_simple)
# R²
r2_simple <-  summary_simple$r.squared

### Modèle multiple avec plusieurs variables explicatives
lm_multiple <- lm(log(tfp) ~ exprd + stability + I(stability^2) + population + unemploy + inflation + educ, data = our_data)
#Estimation
summary_multiple <- summary(lm_multiple)
# R²
r2_multiple <- summary_multiple$r.squared


# Affichage des R²

cat("The R² of simple linear regression is : ", r2_simple, "\n")
```

```
## The R² of simple linear regression is :  0.03702427
```

```r
cat("The R² of multiple linear regression is : ", r2_multiple, "\n")
```

```
## The R² of multiple linear regression is :  0.416832
```

```r
Ftest <- ((r2_multiple - r2_simple) / 6) / ((1 - (r2_multiple)) / (73 - 8))
cat("The F-test is : ", Ftest, "\n")
```

```
## The F-test is :  7.055571
```

**H0: The coefficients of the additional variables in the multiple model are all equal to zero Ftest = 7.055571 > 2.18 (5%) We reject the null hypothesis (H0) because the F-test value (7.06) is greater than the Fisher critical value (2.18 at 5%). => The unrestricted model incorporates additional explanatory variables (e.g., stability, population..), allowing it to better capture the factors influencing productivity.