

The Future of Data Analysis



**20th European Conference on Research Methodology
for Business and Management Studies**

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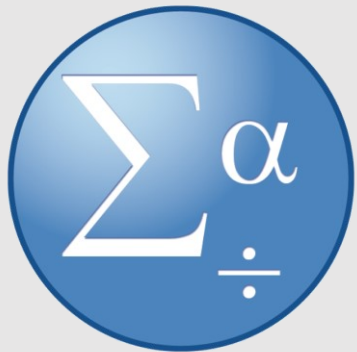
Ana Moreira

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Professor at ISMAT
**Work and Organizational Psychology,
Data Analysis,
Research Methods in Work Psychology
and Occupational Health
Organizational Diagnosis and Interventions**



SPSS historical background



Statistical Package for the Social Sciences (SPSS) appears in 1968, developed by Nie, Bent and Hul, becoming a great help for studies developed in social sciences.



SPSS historical background

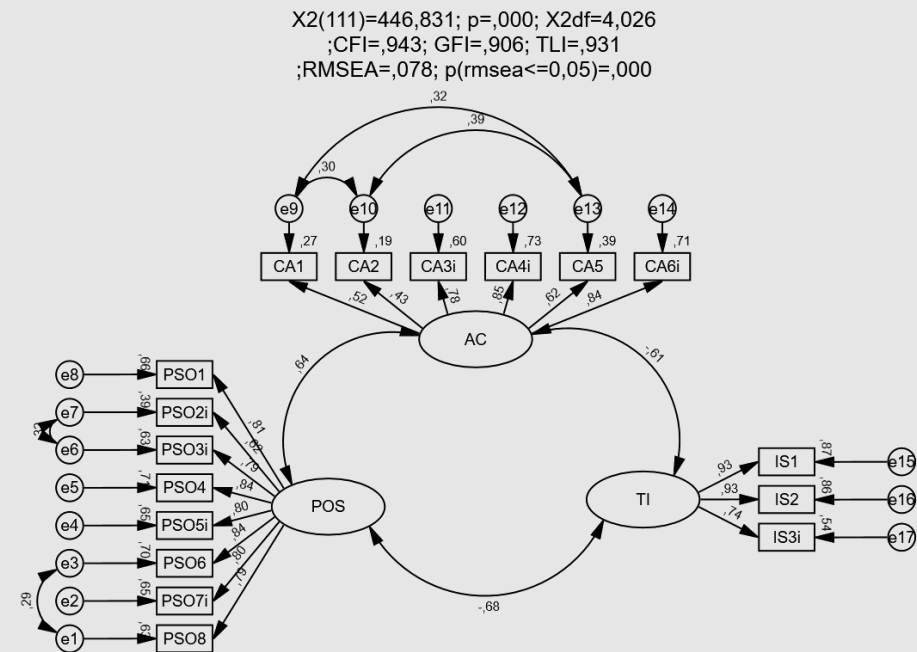


In 2009 the software was acquired by IBM.

New ways in data analysis

Structural Equation Analysis

SEA was developed in the first half of the 20th century.



What is Structural Equation Analysis?

At first, this was an obscure
modelling technique



Today it is increasingly used in
research and causal analysis in
Social Sciences



What is Structural Equation Analysis?

SEA application in the social sciences was democratized with the appearance of the software LISREL in the 70s (Jöreskog, 1978).



What is Structural Equation Analysis?

In 1994, the software AMOS (Analysis of Moments Structures), was developed by James Arbuckle.

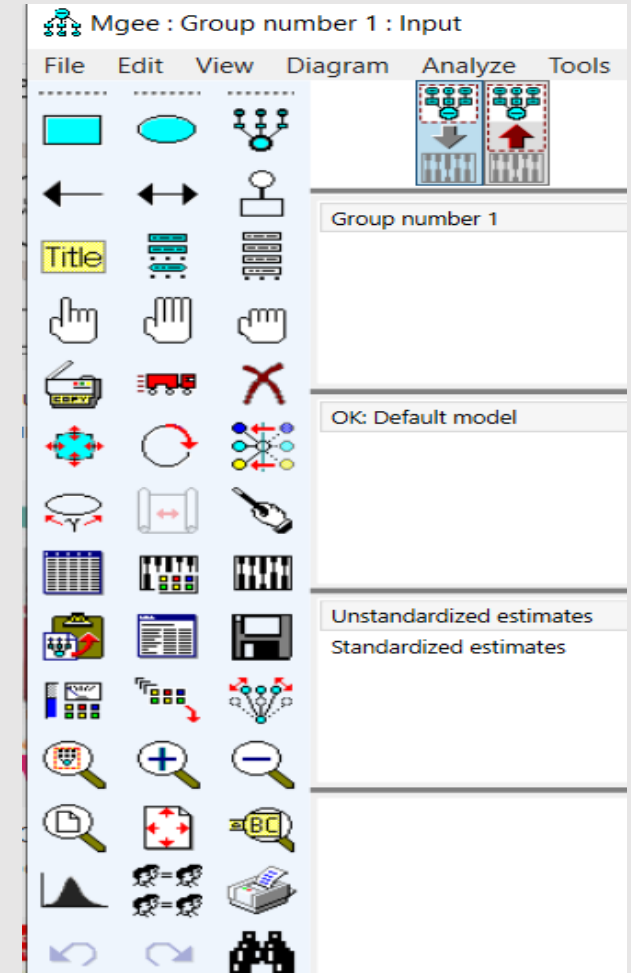


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What is Structural Equation Analysis?

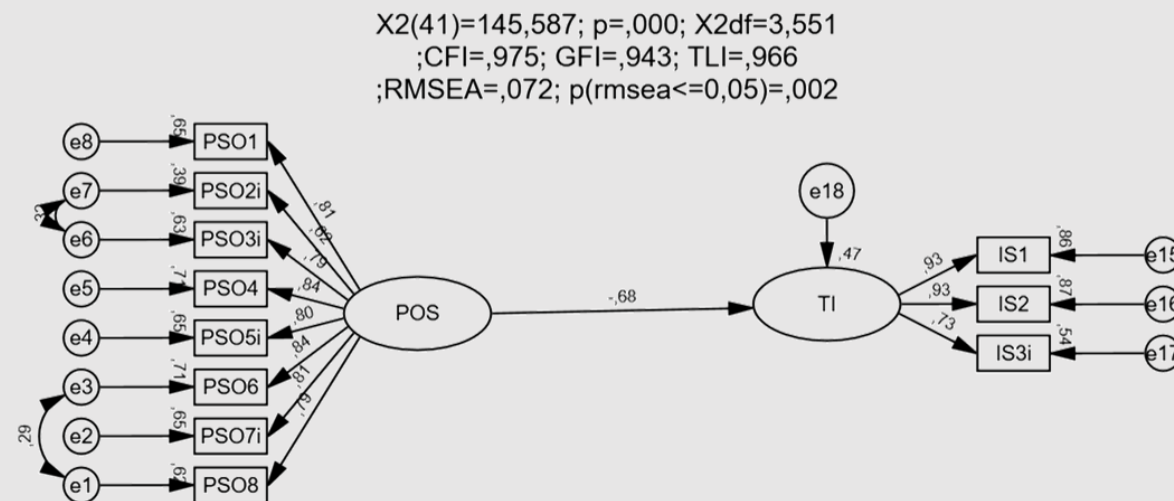
AMOS integrates since its first edition a graphical interface whose simplicity makes the teaching and understanding of structural equation models less complicated.



What is Structural Equation Analysis?



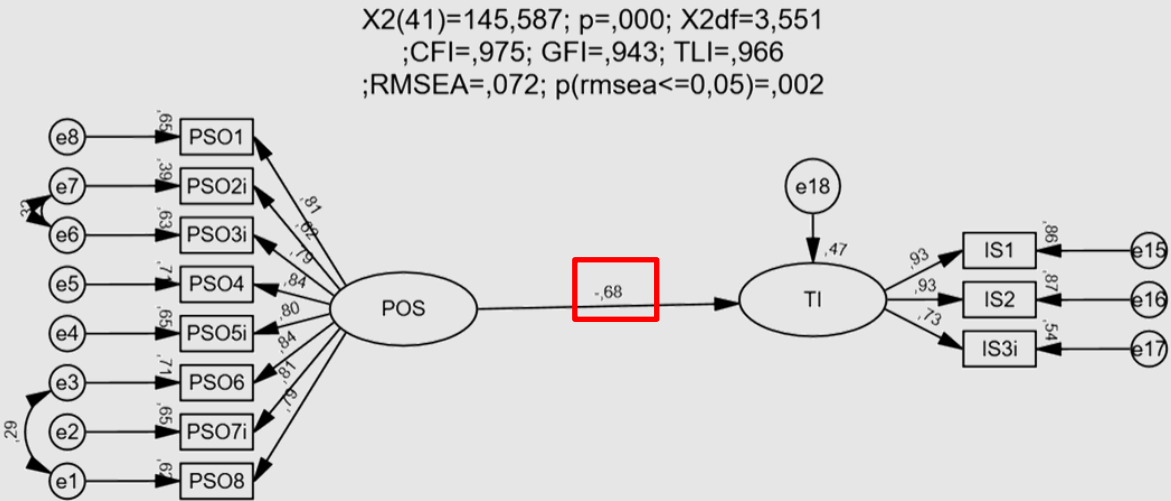
SEA is a generalised modelling technique whose purpose is to test the validity of theoretical models that define causal, hypothetical relationships between variables.





What is Structural Equation Analysis?

These relationships are represented by parameters that indicate the magnitude of the effect that independent variables exert on dependent variables, in a set composed of hypotheses about patterns of association between the variables in a model.



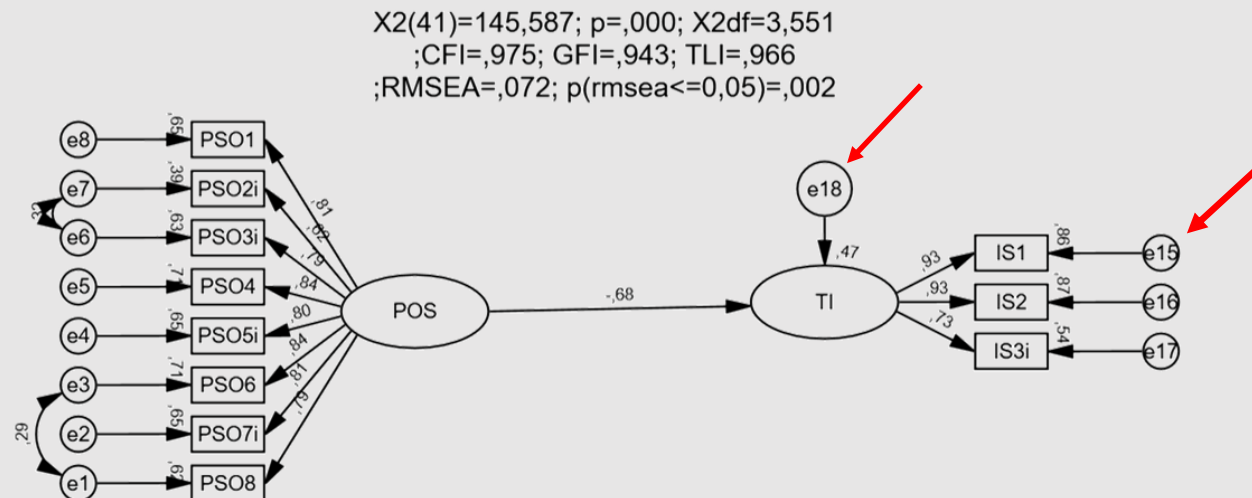
			Estimate	S.E.	C.R.	P	Label
TI	<---	POS	-,633	,042	-14,945	***	par_12



What is Structural Equation Analysis?



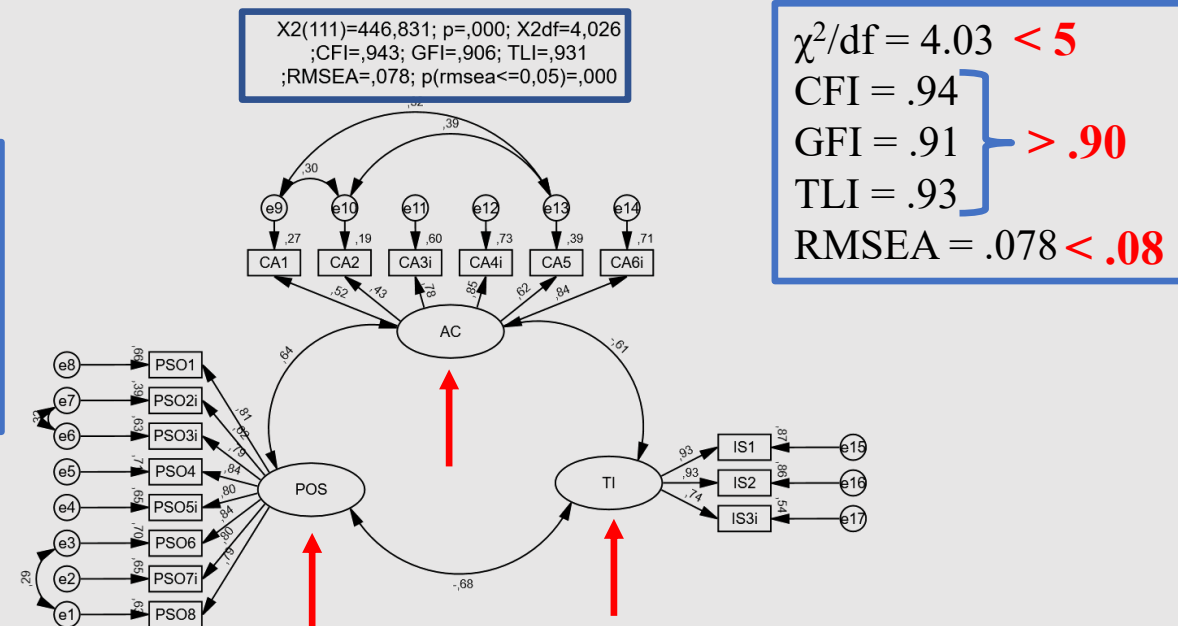
Structural equation analysis is an extension of generalised linear models that explicitly consider measurement errors associated with the variables under study.



What is Structural Equation Analysis?



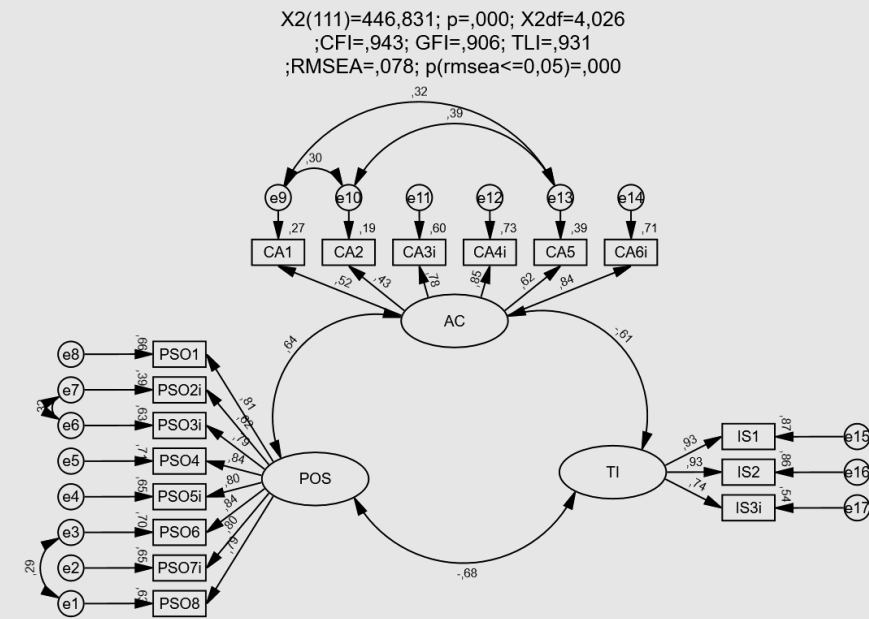
Structural equation analysis can be described as a combination of the classic techniques of Factor Analysis and linear regression.



What is Structural Equation Analysis?



SEA is used in diverse applications ranging from the psychometric adaptation of instruments, to testing longitudinal and cross-sectional causal models, analysis of invariance of models and parameters between groups.

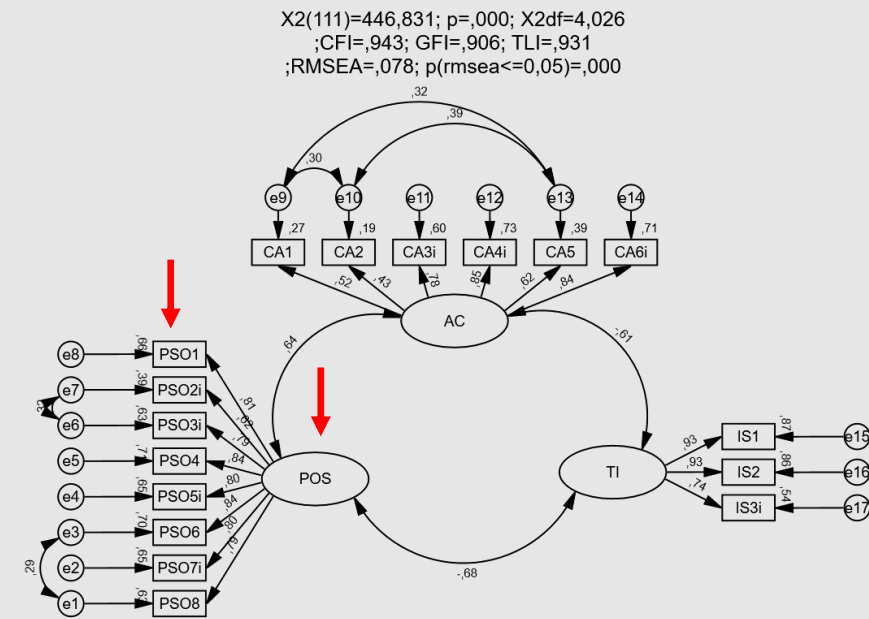


Why use Structural Equation Analysis?

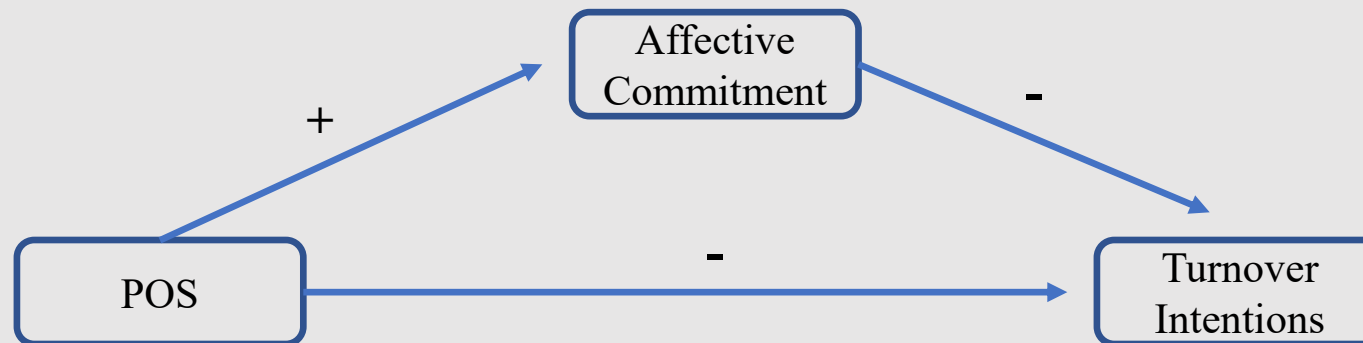


In social sciences, researchers are often faced with latent variables (not directly observable), which are felt through other variables or indicators.

This is the case of likert-type scales, which seek to operationalise variables or constructs that are not directly operational.



A Mediation Model using AMOS Graphics



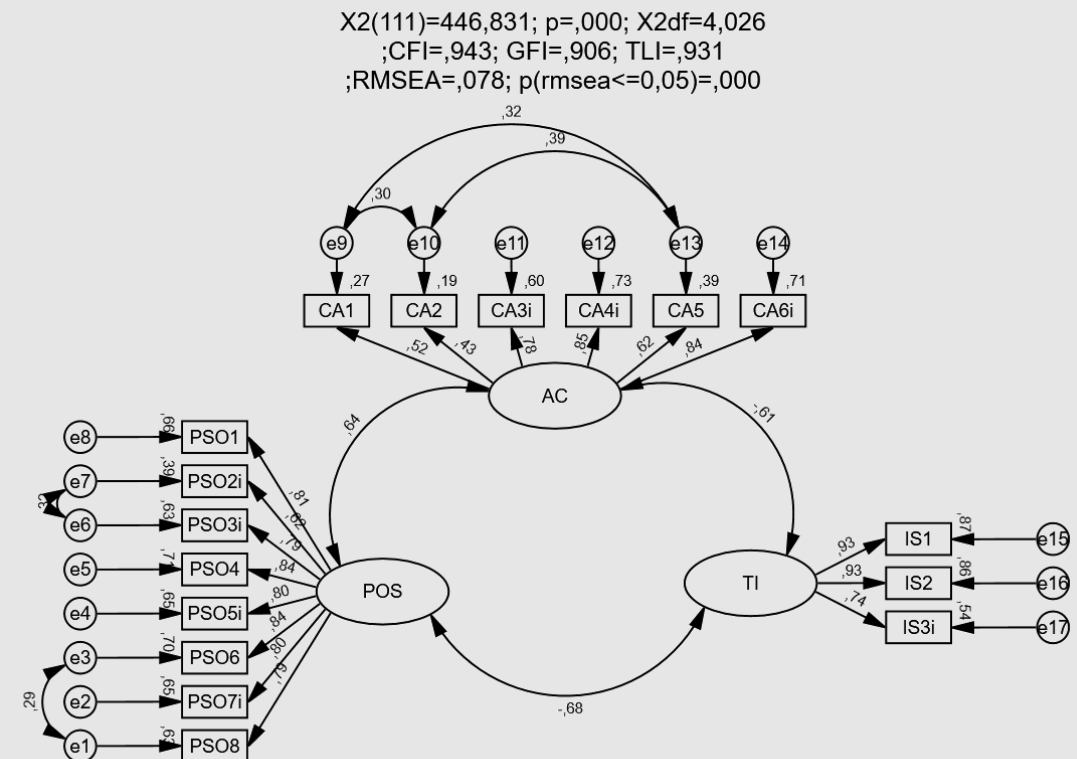
Hypothesis: Affective commitment has a mediating effect on the relationship between perceived organisational support and turnover intentions.

A Mediation Model using AMOS Graphics



In the first step, we checked the association between the variables under study.

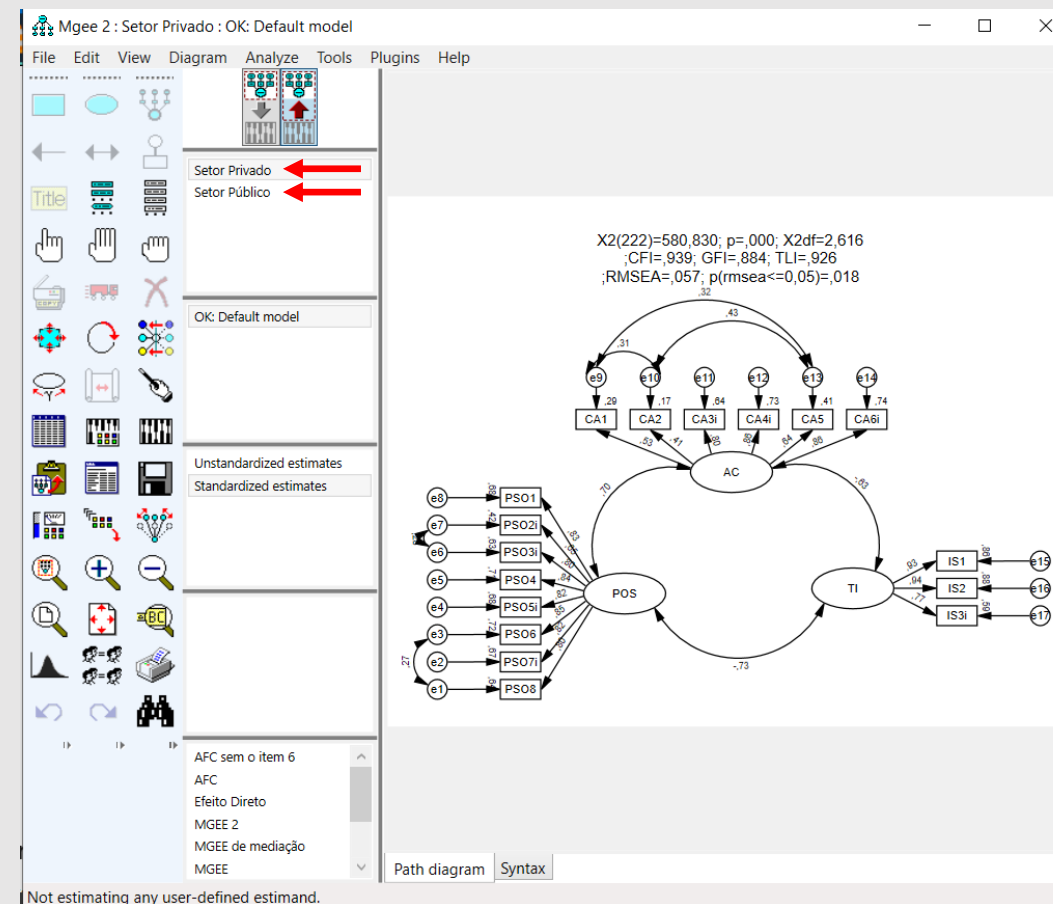
			Estimate	S.E.	C.R.	P
POS	<-->	AC	,886	,109	8,118	***
POS	<-->	TI	-1,213	,111	-10,882	***
AC	<-->	TI	-,787	,096	-8,213	***



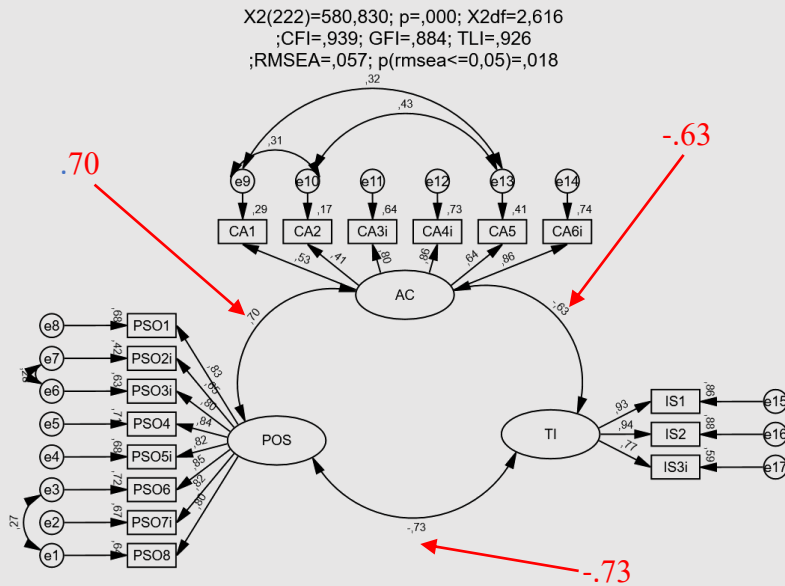
A Mediation Model using AMOS Graphics



As this sample includes employees from public and private sectors, we checked whether the intensity of these relations varies according to the sector of activity.

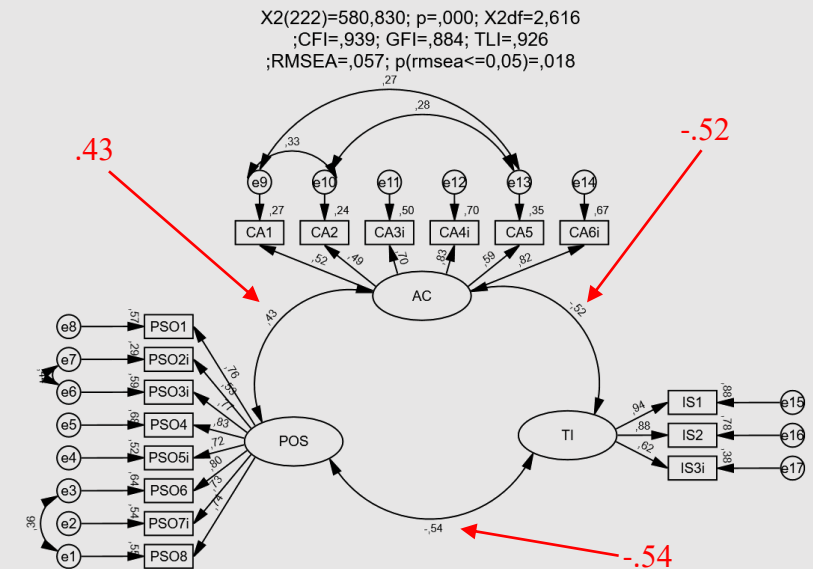


A Mediation Model using AMOS Graphics



Private Sector

The associations between the variables under study are stronger for the private sector than for the public sector.

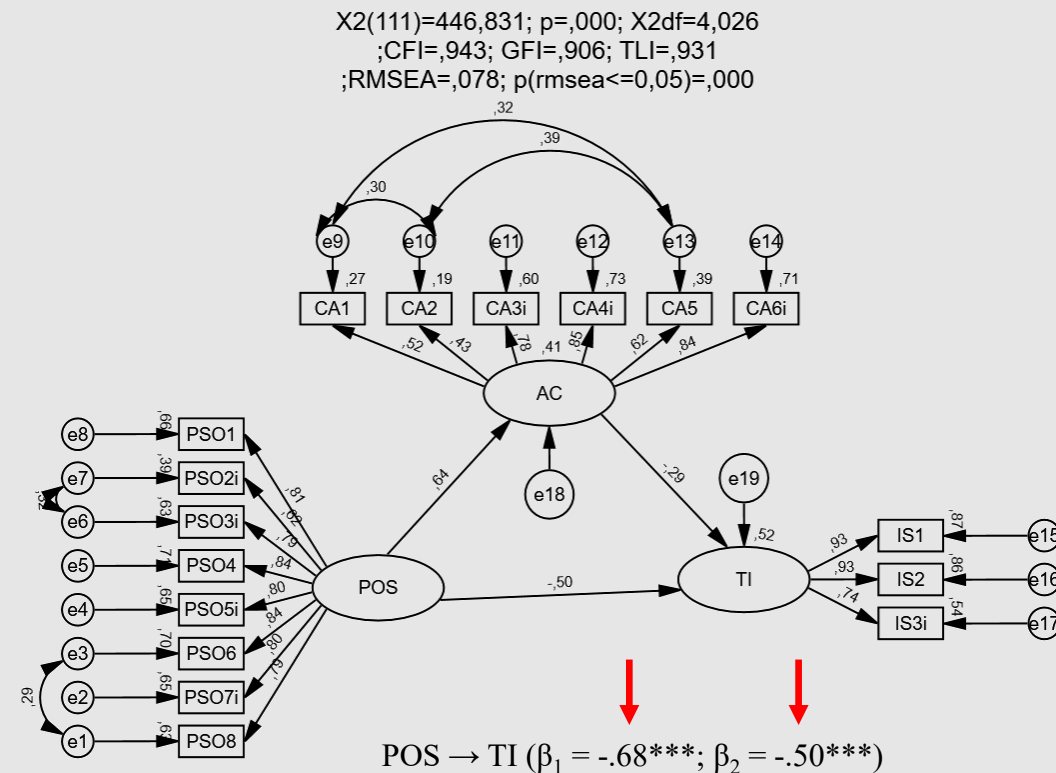


Public Sector

A Mediation Model using AMOS Graphics



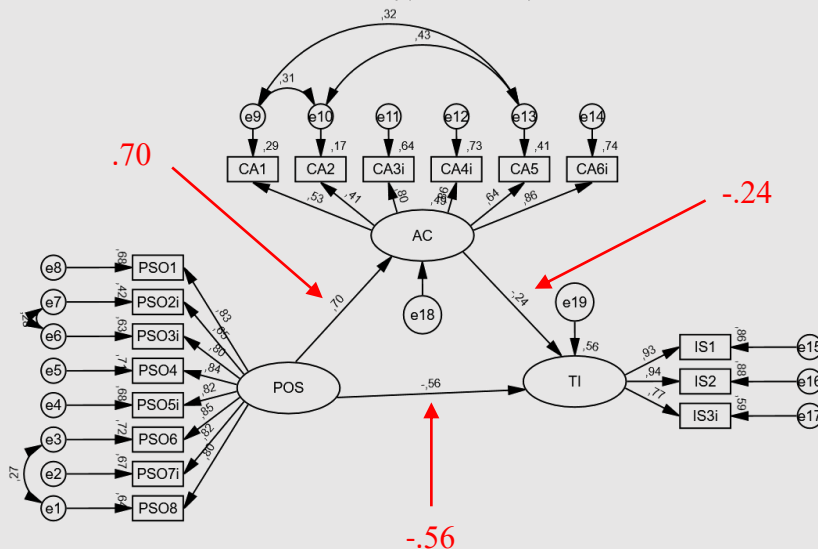
When we tested the mediation effect, we found that there is a partial mediation effect of affective commitment on the relationship between perceived organisational support and turnover intentions.



A Mediation Model using AMOS Graphics



$\chi^2(222)=580,830$; $p=,000$; $\chi^2 df=2,616$
; CFI=,939; GFI=,884; TLI=,926
; RMSEA=,057; $p(\text{rmsea} \leq 0,05)=,018$

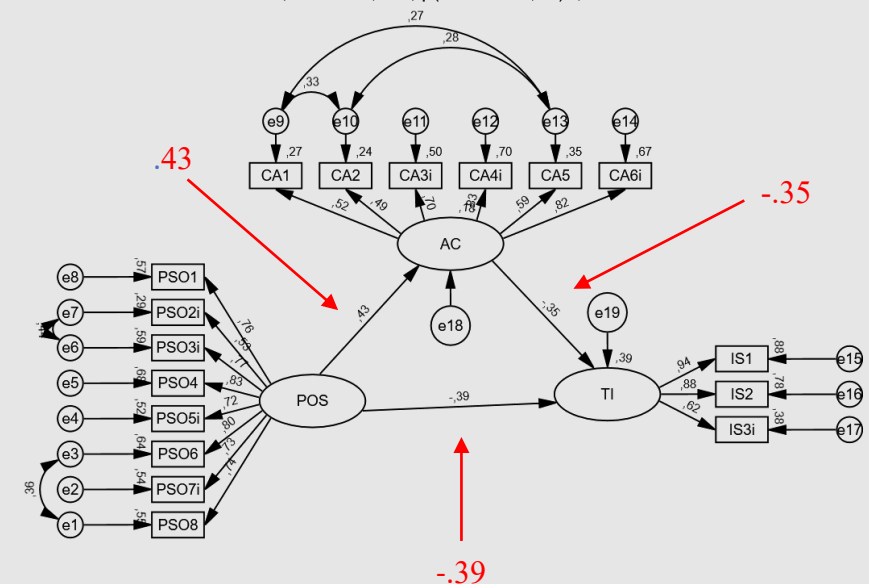


$Z = -7.28$

Private Sector

We can also verify whether the mediation effect is identical for both sectors or whether it differs in intensity depending on the sector.

$\chi^2(222)=580,830$; $p=,000$; $\chi^2 df=2,616$
; CFI=,939; GFI=,884; TLI=,926
; RMSEA=,057; $p(\text{rmsea} \leq 0,05)=,018$



$Z = -3.20$

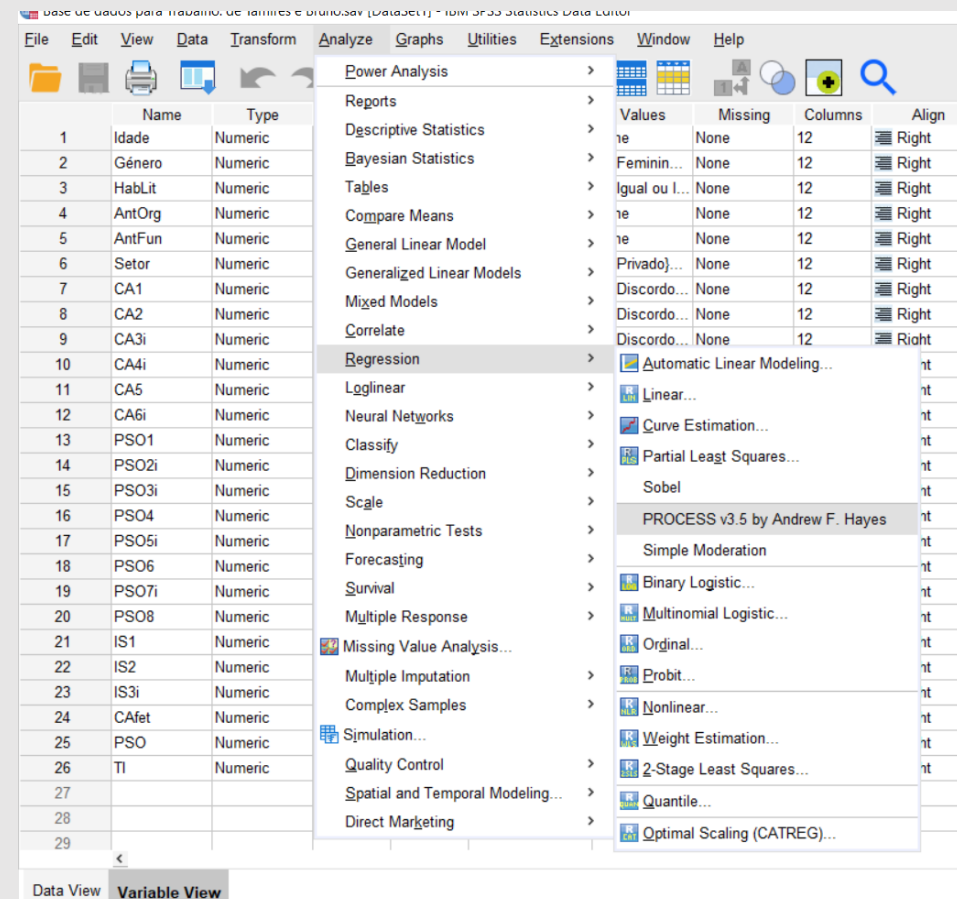
Public Sector

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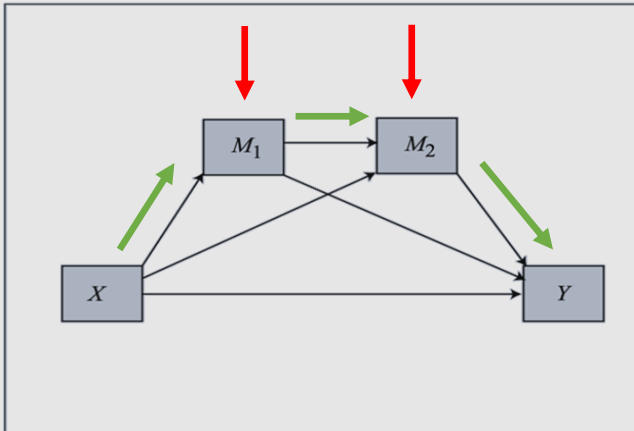
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Macro Process

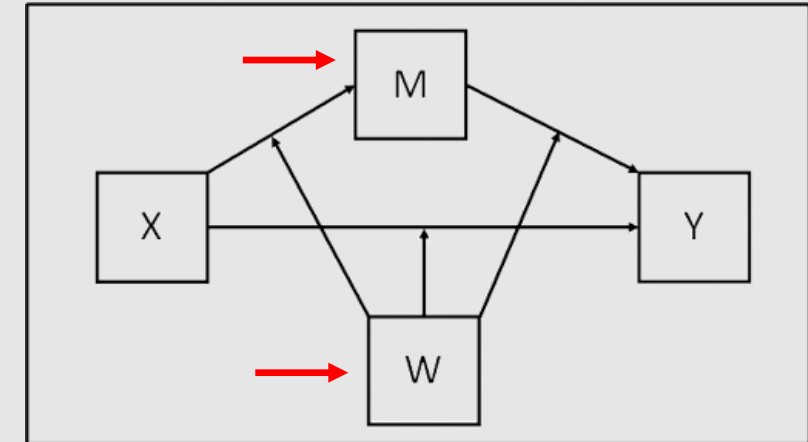
Now let's talk about a new application for data analysis, the Macro Process developed by Hayes (2013).



Macro Process



Macro Process allows us to test serial mediating effects, and moderated mediating effects.



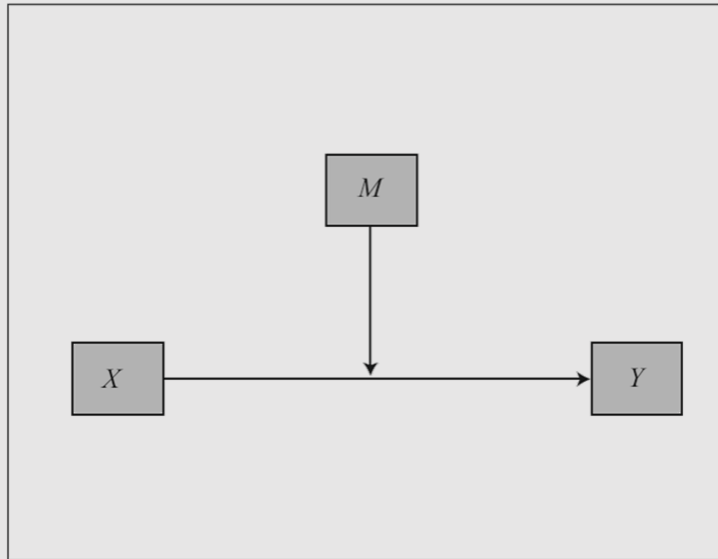
Serial Mediating effect

Moderated Mediating effect

Macro Process



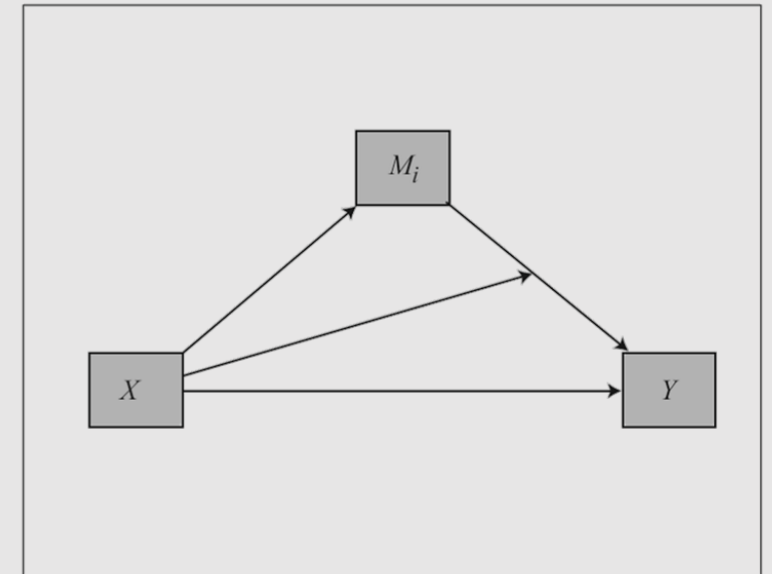
Conceptual Diagram



Model 1

Macro Process has 74 models, from the simplest to the most complicated.

Conceptual Diagram



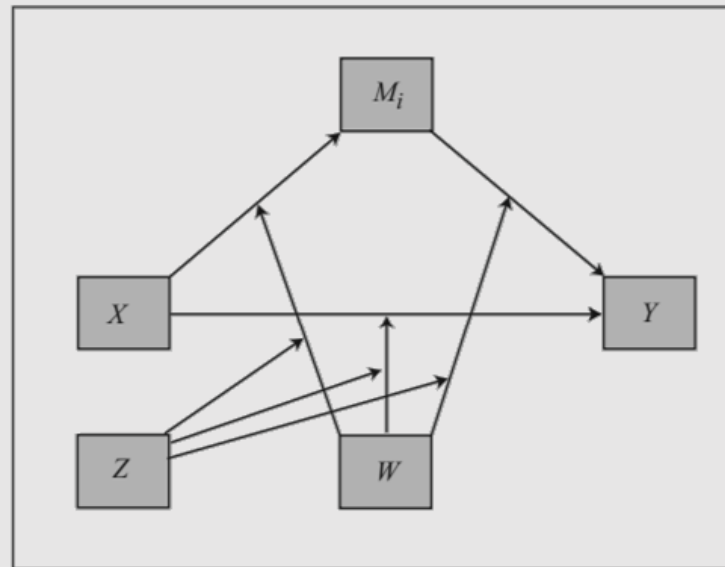
Model 74

Macro Process

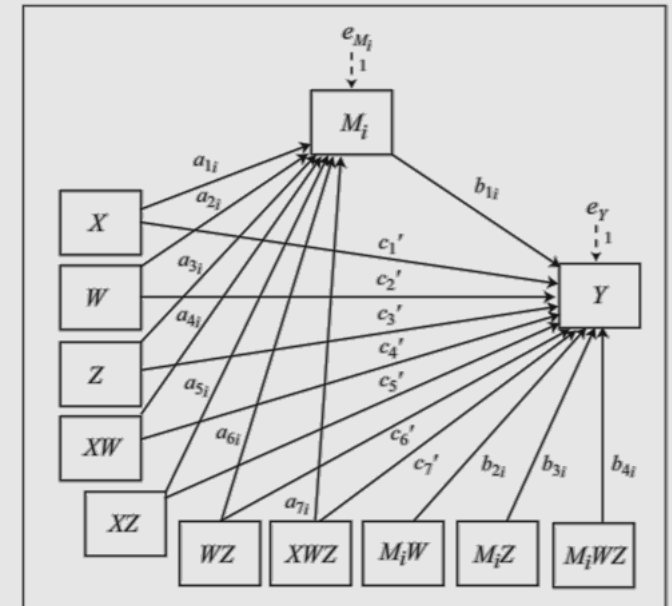


This is one of the most complicated models.

Conceptual Diagram



Statistical Diagram

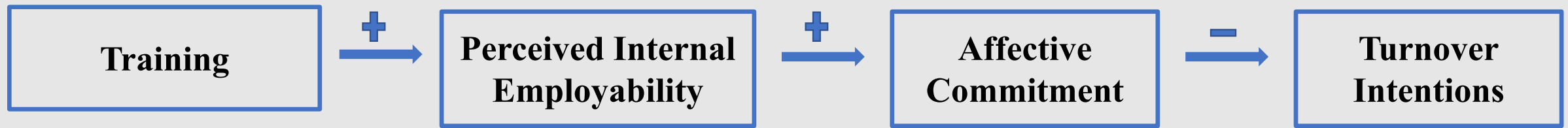


Conditional indirect effect of X on Y through $M_i = (a_{1i} + a_{4i}W + a_{5i}Z + a_{7i}WZ) \cdot (b_{1i} + b_{2i}W + b_{3i}Z + b_{4i}WZ)$

Conditional direct effect of X on $Y = c_{1'} + c_{4'}W + c_{5'}Z + c_{7'}WZ$

*Model 73 allows up to 10 mediators operating in parallel

A serial Mediation effect

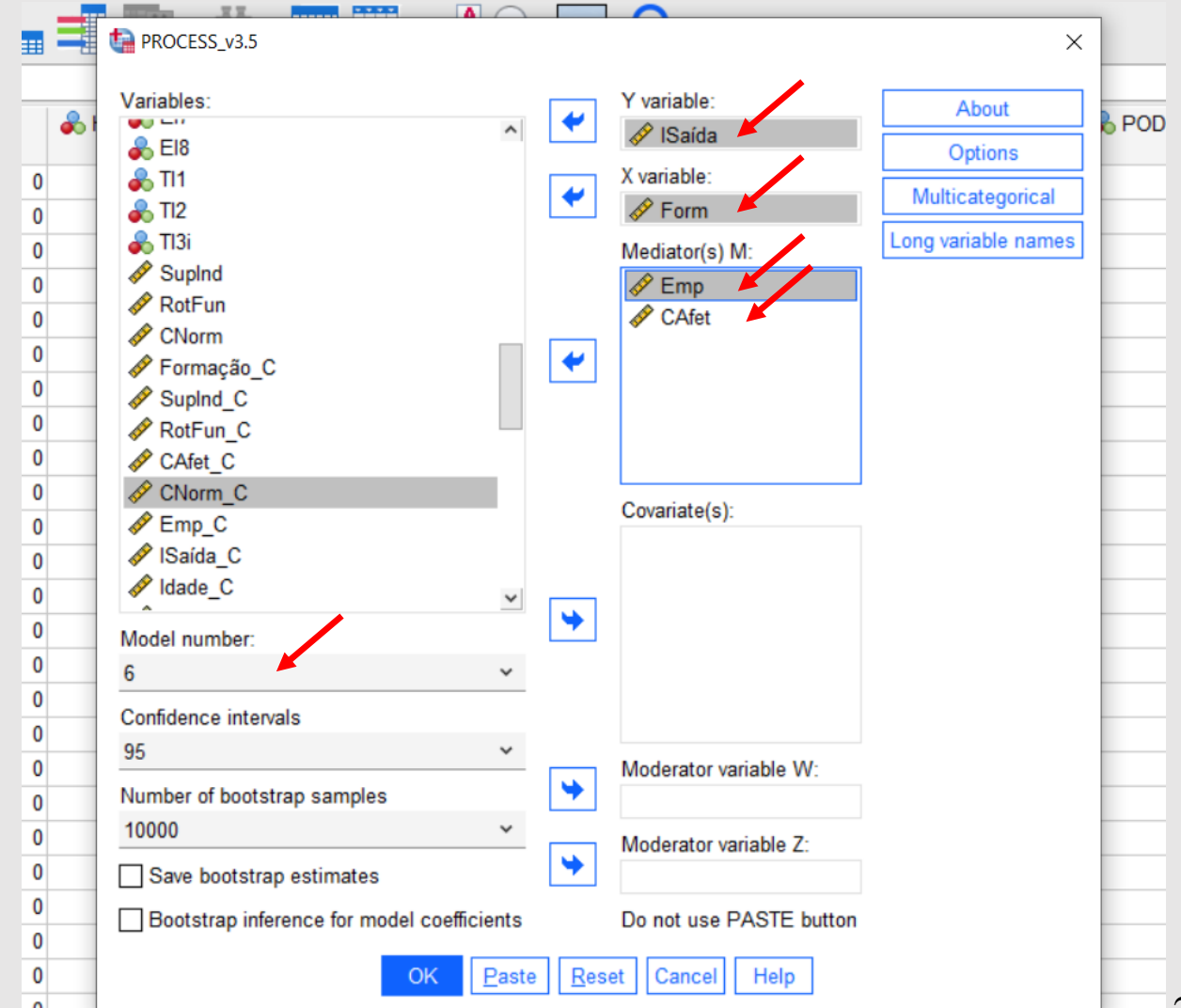


Hypothesis: Perceived internal employability and affective commitment both represent a serial indirect effect in the relationship between training and turnover intentions.

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**A serial Mediation
effect**



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A serial Mediation effect

In this output, we have the model results,
the direct effect and the indirect effects.

OUTCOME VARIABLE:
ISaida

Model Summary

R	R-sq	MSE	F	df1	df2	p
,7791	,6070	,6375	159,1099	3,0000	309,0000	,0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	6,1888	,1824	33,9390	,0000	5,8300	6,5476
Form	-,0388	,0585	-,6630	,5078	-,1538	,0763
Emp	-,3583	,0629	-5,6925	,0000	-,4822	-,2345
CAfet	-,4969	,0392	-12,6642	,0000	-,5741	-,4197

***** DIRECT AND INDIRECT EFFECTS OF X ON Y *****

Direct effect of X on Y

Effect	se	t	p	LLCI	ULCI
-,0388	,0585	-,6630	,5078	-,1538	,0763

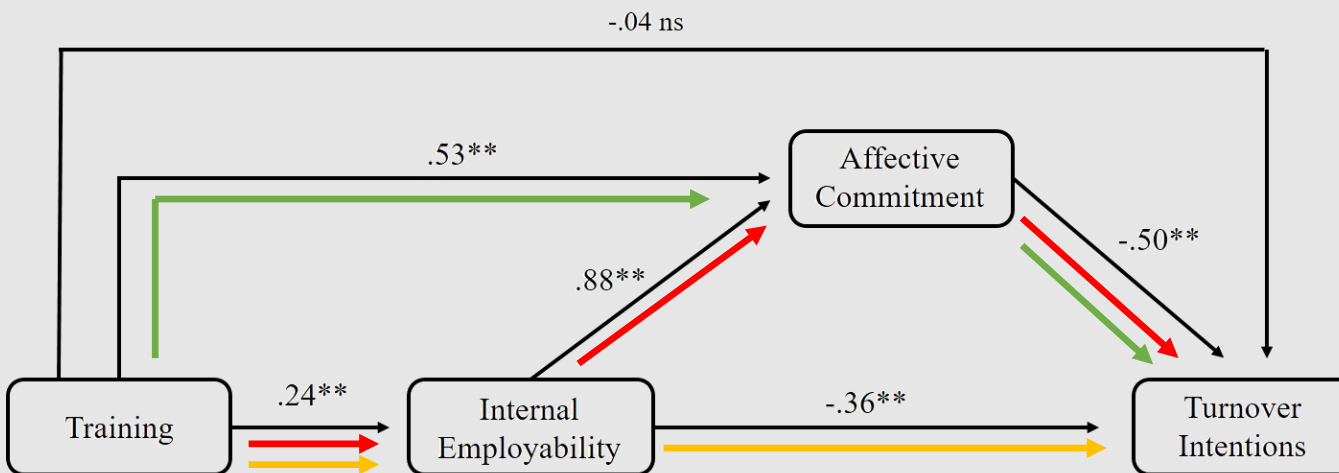
Indirect effect(s) of X on Y:

	Effect	BootSE	BootLLCI	BootULCI
TOTAL	-,4554	,0659	-,5863	-,3274
Ind1	-,0852	,0296	-,1513	-,0362
Ind2	-,2658	,0488	-,3652	-,1743
Ind3	-,1044	,0276	-,1608	-,0528

Indirect effect key:

Ind1 Form	->	Emp	->	ISaida
Ind2 Form	->	CAfet	->	ISaida
Ind3 Form	->	Emp	->	CAfet -> ISaida

A serial Mediation effect



The total indirect effect splits into three indirect effects:

- the serial indirect effect;
- the indirect effect in which perceived internal employability mediates the relationship between training and turnover intentions;
- the indirect effect in which affective commitment mediates the relationship between training and turnover intentions.

A serial Mediation effect

Table 1. Indirect effects of Model

	Indirect effects	
	Estimates	Confidence interval at 95% with Bootstrap correction
Model 1		
Total	-.46 (.07)	[-.59; -.33]
Training → IE → TI	-.09 (.03)	[-.15; -.04]
Training → IE → AC → TI	-.10 (.03)	[-.16; -.06]
Training → AC → TI	-.27 (.05)	[-.37; -.17]

Note: Total effect Training → EI = -.49 (.08). The standard error is in brackets
TI = turnover intentions; AC = affective commitment; IE = perceived internal employability

In this table, we find that the total indirect effect and the three indirect effects are significant because zero is not in the confidence interval.

A serial Mediation effect

Table 1. Indirect effects of Model

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Note: Total effect Training → EI = -.49 (.08). The standard error is in brackets
TI = turnover intentions; AC = affective commitment; IE = perceived internal employability

The strongest indirect effect is the one in which affective commitment mediates the relationship between training and turnover intentions.

Advantages of using Macro Process in Moderation Models

When we test a moderating effect in SPSS or AMOS Graphics, we have to standardize the independent variable and the moderator variable to create the interaction variable. In Macro PROCESS we do not need to do that.



PROCESS_v3.5

Variables:

- Idade
- Gênero
- HabLit
- AntOrg
- AntFun
- CA1
- CA2
- CA3i
- CA4i
- CA5
- CA6i
- PSO1
- PSO2i
- PSO3i
- PSO4
- PSO5i

Model number: 1

Confidence intervals: 95

Number of bootstrap samples: 10000

☐ Save bootstrap estimates

☐ Bootstrap inference for model coefficients

Y variable: TI

X variable: CAfet

Mediator(s) M:

Covariate(s):

Moderator variable W: Setor

Moderator variable Z:

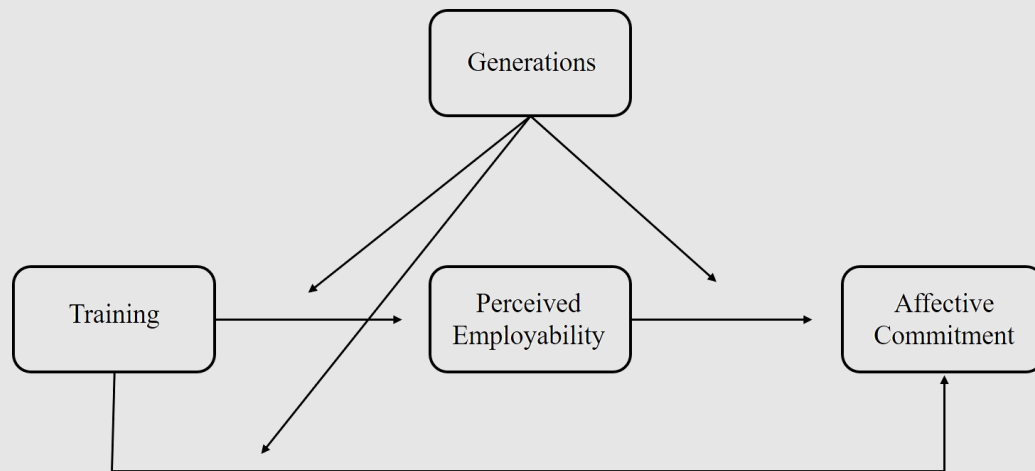
Do not use PASTE button

Buttons: About, Options, Multicategorical, Long variable names, OK, Paste, Reset, Cancel, Help

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Moderated Mediation Model



The screenshot shows the PROCESS_v3.5 software interface. The 'Variables' list on the left includes 'Idade', 'Sexo', 'Hab_Lit', 'Antiguidade', 'Contrato', 'PODC1', 'PODC2', 'PODC3', 'PODC4', 'PODC5', 'PODC6', 'PODC7', 'PODC8', 'PODC9', 'PODC10', and 'PODC11'. The 'Y variable' is set to 'CAfet', the 'X variable' is 'Form', and the 'Mediator(s)' is 'Emp'. The 'Model number' is set to 8, 'Confidence intervals' to 95, and 'Number of bootstrap samples' to 10000. The 'Moderator variable W' is 'Geraç'. The 'Save bootstrap estimates' and 'Bootstrap inference for model coefficients' checkboxes are unchecked. The 'About', 'Options', 'Multicategorical', and 'Long variable names' buttons are visible on the right. The 'OK', 'Paste', 'Reset', 'Cancel', and 'Help' buttons are at the bottom.

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