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Interaction Effects in Probit Models, Reinterpreting the Impact of Education on Attitudes towards Immigrants and Free-Trade

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Interaction effects in probit models, reinterpreting the impact of education on attitudes towards immigrants and free-trade

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Abstract

Economic literature has examined the impact of education and factors endowment on individual preferences towards free-trade and immigration by focusing on the sign of an interaction term between the educational level and the Gross Domestic Product per capita. The aim of this paper is to re-examine this issue by employing the new method proposed Ai and Norton (2003). Findings showed that attitudes are not fully in line with the Heckscher-Ohlin model. That is, high educated people in richer countries could be against immigration and free-trade if their overall disposition to these issues is bad.

Keywords: immigration, free-trade, globalization, cross-country research, probit models
JEL classification: C13, C51, D01, F11

Resumen

Existe un conjunto de estudios que examinan el impacto de la educación y la dotación de factores sobre las preferencias de los individuos por el libre comercio y la inmigración. En general, las conclusiones de estos estudios se basan en el signo de la variable que surge como la interacción entre el nivel educativo del individuo y el nivel de Producto Interno Bruto per cápita en el país de residencia. El objetivo de este trabajo es reestudiar este tema empleando un nuevo método propuesto por Ai y Norton (2003). Los resultados muestran que las actitudes individuales no están completamente en línea con el modelo Heckscher-Ohlin. Esto significa que las personas más educadas que residen en países relativamente más ricos podrían estar en contra de la inmigración o el libre comercio si su disposición general sobre estos temas es mala.

Palabras clave: inmigración, libre comercio, globalización, modelos probit
Clasificación JEL: C13, C51, D01, F11

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1. Introduction

There is a large body of research that examines whether more educated people's attitudes towards free-trade, immigration and globalization significantly vary depending on living in a relatively richer country or in a poorer country. If attitudes were in line with H-O model predictions, skilled workers are expected to support free-trade and immigration in skilled abundant countries while unskilled people would favor more restrictive policies related to international trade and immigration.

For doing so, it is common practice to estimate a probit (or logit) model and to include an interaction term between the educational level and the Gross Domestic Product (GDP) per capita because it is a good proxy for the education endowment of a country. If the interaction term results significant and it shows a positive sign; it is concluded that skilled workers tend to support free-trade or immigration in skilled abundant countries and vice versa. However, according to Norton, Wang and Ai (2004) and Ai and Norton (2003), this interpretation of results is not correct and wrong conclusions could be drawn. An accurate interpretation of these coefficients requires a more complex method in order to accurately compute interaction effects.

I apply a different method than previous authors to reexamine the role of individual and country skill levels on the individuals' attitudes towards free-trade and immigration. Findings indicate that high educated people in richer countries could be against immigration and free-trade if their overall disposition to these issues is bad. This could be mainly driven by nationalist feelings. This finding explains the support to restrictive policies in advance economies such as the European Union countries which may be exacerbated due to a global economic crisis.

For doing this, I employ the 2003 survey carried out by the International Social Survey Program (ISSP) and I estimate two probit models in which an interaction term between GDP per capita and education is included. After computing the marginal effects, I compute the interaction effect and examine its sign and significance for the whole sample. I conclude that more caution is needed when examining interaction effects because not only the sign could be different but also the correct interaction effect may be non-significant

even when the marginal effect indicates that it is significant. Finally, findings clearly show that non-economic factors have the preponderant role in determining people's attitudes.

The structure of the paper is as follows. Section two presents the theoretical background. Section three describes some previous researches that include interaction terms. The fourth section deals with empirical examples and results. Finally, the conclusions are drawn in section five.

2. Theoretical background

Many researches that assess public opinion views are based on (ordered) probit and logit models estimation in which the dependant variable is multinomial. I will focus on probit models for which the conditional mean of the dependent variable is:

$$E(Y / x_1, x_2 ... x_n) = \Phi(\beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n)$$

Where: Φ is the standard normal cumulative distribution function. It is well-known that in some cases, the effect of an independent variable, for example, the educational level, may depend on the magnitude of a different independent variable such as the GDP per capita. In these cases, the models include an interaction effect, a new variable that is computed as the product of the previous independent variables. If an interaction term is included, for example, between x_1 and x_2, the previous function could be expressed as:

$$E(Y / x_1, x_2 ... x_n) = \Phi(\beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + ... + \beta_n x_n) = \Phi(v)$$

Where v is: $\beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + ... + \beta_n x_n$

In these models, the estimated coefficients do not provide direct information about the impact of each independent variable, x_i, on the dependant variable, Y. Hence the marginal effects should be computed after estimating the models. For example, the marginal effect of the interaction term $x_1 * x_2$ is:

$$\frac{\partial \Phi(v)}{\partial (x_1 x_2)} = \beta_{12} \Phi'(v)$$

Norton et al. (2004) and Ai and Norton (2003) point out that there are two common errors when the incidence of the interaction term is interpreted. These errors are linked to the fact that analysts consider only the marginal effect of the interaction term instead of the cross-partial derivative of the expected value of the conditional mean of the dependent variable:

$$\frac{\partial^2 \Phi(v)}{\partial x_1 \partial x_2} = \beta_{12}\Phi'(v) + (\beta_1 + \beta_{12}x_2)(\beta_2 + \beta_{12}x_1)\Phi''(v)$$

Focusing exclusively on the marginal error of the interaction term may cause that an analyst argues that it is non-significant if the t-test associated to its coefficient indicates this result. In linear models this is true and the interpretation is straightforward, the interaction effect between two independent variables is β_{12} and a simple t-test provides information on its significance.

However, when the cross derivative is considered, it results that the interaction term could be relevant even when the above-mentioned coefficient results non-significant (β_{12} tends to zero) and *vice versa*. This may be the case because the cross-partial derivative depends also on the product of the coefficients of the two independent variables.

Moreover, even when the coefficient of the interaction term results significant, the impact of the interacted variable does not equal it. Hence, not only the whole effect may be very different in magnitude from the interaction term but also their sign may be the opposite.

Furthermore, the significance cannot be assessed with a t-test on the estimated coefficient of the interaction term. As Norton et al. (2004) point out, researchers should examine the statistical significance of the entire cross-derivate.

3. The traditional empirical verification of the H-O hypothesis

There is a large debate about who supports trade policies and immigration policies. Predictions are mainly based on comparative advantage models of trade and in particular, on H-O models or neo-factorial models. In this framework, international trade would have a different impact on people's welfare depending on their skill levels and on the relative abundance of skills of the country they are living in. Concretely, the prediction is that the

relatively abundant factor will benefit from the liberalization and the opposite is true in the case of the relatively scarce factor. For example, skilled workers in skilled abundant countries will support free-trade while unskilled workers tend to oppose to them. Numerous researches have focused on this issue by studying the interaction effect of education and GDP per capita in probit models.

On one hand, Facchini and Mayda (2009), Mayda (2008), Mayda and Rodrik (2005) and Sanz and Martínez i Coma (2008) verify the Heckscher-Ohlin (H-O) hypothesis (skilled workers in skilled abundant countries support free-trade and immigration while unskilled workers tend to oppose to them). On the other hand, O'Rourke and Sinnott (2006) show that skilled workers are more pro-trade regardless of their country's endowments. Finally, Mayda (2006) conclude that skilled individuals tend to support immigration in those countries where immigrants are relatively less skilled than natives and *vice versa*.

This group of papers (Facchini and Mayda (2009), Mayda (2008), Mayda (2006), Mayda and Rodrik (2005), O´Rourke and Sinnott (2006) and Sanz and Martínez i Coma (2008)) examine the effect of a country characteristics such as GDP per capita or labor skill ratio through the educational level on attitudes towards globalization, free trade and/ or immigration. However, the models do not include the three key independent variables (X_1, X_2 and X_1*X_2). As Norton et al. (2004) and Ai and Norton (2003) argue, this omission could lead to misunderstanding the partial effect and the results because even when the coefficient result non-significant it should be taken into account.

Moreover, even when the three variables are included, the second most frequent error is connected to interpretation. In general, the second partial derivative is not considered and the interaction term coefficient is assessed as the whole effect (Kessler and Freeman, 2005 and Scheve and Slaughter, 2001). Kessler and Freeman (2005) argue that anti-immigrant attitudes are positively associated to unemployment rates. Scheve and Slaughter (2001) conclude that over the relevant time-horizon, individuals consider high intersectoral labor mobility when evaluating trade policy and that not only the current factor incomes but also the asset values have a significant impact on preferences. Given this problem the sign of the whole effect could be different from the sign of the interaction term coefficient.

Moreover, the interaction effect could have different signs for different values of covariates.

Hence, in order to determine robustly the effect of personal and national skills on preferences towards trade and immigration, all the three variables should be included in the model (education, GDP per capita and the interaction term, education*GDP per capita). Secondly, inference cannot be made for an average value of the variables, nor considering the marginal effects without taking into account the level of other independent variables.

4. The correct empirical verification of the H-O hypothesis

In the previous section, I presented a group of studies that conclude that the educational level has a significant effect in people's attitudes toward globalization. Moreover, authors argue that this impact depends on a country attribute (in only one direction). To verify if the previous mentioned literature is right, especially those that verify the H-O model; I apply the *inteff* command in STATA 11 proposed by Norton et al. (2004). The command *inteff* computes the interaction effect, standard error, and z-statistic for each observation for either logit or probit models when two independent variables have been interacted.

Two probit models are estimated by employing the 2003 survey carried out by the ISSP. The survey is representative in each country where it is carried out. The sample considers the following group of European Union countries: Austria, Denmark, Finland, France, Germany, Great Britain, Ireland, Portugal, Spain and Sweden. The sample size is approximately 9,500 observations. The dependent variables refer to attitudes towards immigrants and free-trade. All included variables are described in table 1.

See the Annex - Table 1 - Description of variables

Following the literature on this field, I estimate two versions of the models. The first version includes a set of variables describing personal attributes, a country characteristic (the logarithm of the GDP per capita) and an interaction term between GDP per capita and the educational level. In the second version, the interaction term is not included. Table 2 reports the marginal affects after probit models estimation.

See the Annex - Table 2 – Marginal effects after probit models estimation

In line with previous findings, table 2 shows that personal attributes play a relevant role in shaping these attitudes [5, 7, 11] and results are maintained in the two versions of the models. Firstly, those that show nationalist feelings are less likely to favor these processes and the same is true in the case of women (considering trade liberalization). Secondly, older people are more likely to support immigrants. It is likely that immigrants are not considered as more competition in the labor market. Additionally, those who have not experienced disruptive family situations (married and single people) also show more favorable attitudes towards immigrants. Moreover, in both cases, richer people, self-employed people and those working in the private sector also show more favorable attitudes. Finally, while religious affiliation plays no relevant role, religiosity does matter but in opposite direction, it raises the probability of supporting immigrants while it reduces the probability of supporting free-trade.

Table 2 also shows that in both models, the interaction effect between GDP per capita and the educational level is significant and that it presents a positive sign. The estimated marginal effects indicate that high educated people that live in relatively richer countries tend to show more favorable attitudes than high educated people that live in relatively poorer countries. This would validate the H-O prediction and this conclusion was drawn by several previous researches.

Does it mean that the interaction between the educational level and GDP per capita is always positively related to attitudes towards immigrants and free-trade? If only these results are considered, an analyst may give an affirmative answer to this question.

However, figure 1 present two charts (one per model) that show the correct interaction effect and the incorrect marginal effect and they demonstrate that the interpretation of interaction terms is much more complex than examining the marginal effect.

See the Annex - Figure 1 – Interaction effects after probit model estimation

Considering pro-immigrants attitudes, figure 1.a shows that the interaction effect widely varies from -0.28 to 0.64 percentage points, (its average is 0.34). It is worth noting that interaction effects are not always positive (as the marginal effect shows, see table 2). The negative sign means that for individuals with a low predicted probability of favoring immigration the opposite could hold. That is, skilled people in richer countries could be against immigration if their overall disposition to these issues is bad. This is true because the interaction effect depends on other covariates.

In the case of pro-trade opinions, figure 1.b shows that the interaction effect is always positive and it varies from 0.006 to 1.06 percentage points (the mean interaction effect is 0.65).

Therefore, new evidence is provided not only on the relevance of including interaction terms but also on how to interpret these effects. This sheds light on how to avoid leading to wrong conclusions given that the impact of the interaction term cannot be inferred by considering the sign of the estimated coefficient.

Moreover, the significance of the interaction term should be assessed appropriately. As it was above-mentioned, table 2 reports that both education and GDP per capita are statistically significant at conventional levels and the same is true in the case of both interaction terms.

However, after computing the interaction affects for the whole sample and examining their significance, figure 2.a reveals that when considering pro-immigrants attitudes, the interaction effects are non-significant (in all cases, the z-statistic is very close to zero, it ranges from minus -0.01 to 0.71). Given this finding, the model is estimated without the interaction-term. Columns 1 and 2 of table 2 also show that the interaction-term largely distorts the estimated coefficients of the interacted variables. For instance, while in model 1.1 the educational level registers a significant negative impact (which may imply that the individual skill level reduces the probability of favoring immigration independently of countries endowments), in model 1.2 the opposite is true: the educational level has a positive impact in this attitude.

This result is in line with Mayda (2006) results who show that the educational level favors attitudes towards immigration and Hainmueller and Hiscox (2007) findings who argue that in Europe, regardless of immigrants´ attributes (skill level, origin, etc.), those who have achieved high educational levels are more likely to favor immigration.

Regarding pro-trade support, figure 2.b shows that, it is significant at the 1 percent for a small group of observations, only for 6.16 percent of the sample. Moreover, accepting significance at 5 or 10 percent, the ratio goes hardly up (to 8.51 and 10.77 percent, respectively). Given that the registered sign is positive, for this group of individuals, attitudes are in line with H-O model predictions while for other people, other (non-economic) factors prevail when forming their opinions. As it was done for the model explaining immigration preferences, the model explaining trade policies preferences is estimated without the interaction term. The positive sign of education remains significant but the coefficient of GDP per capita turns to be non-significant. As before, the result implies that those who have achieved high educated levels are more likely to favor trade liberalization regardless of country endowments. This finding may be connected to a lower job loss risks associated to liberalization for skilled people.

5. Conclusions

When estimating probit and logit models with interaction effects, it was showed that only examining the marginal effects (as the figures reported in table 2) can be misleading. Incorrect conclusions could be drawn for three reasons. Firstly, I provide evidence that no matter the sign of the estimated marginal effect of the interacted variable, the interaction effect could be positive for some individuals of the sample and negative for others because it may vary widely depending on other covariates. Secondly, it is also proved that the overall significance of the coefficient is not a good indicator since the interaction terms significance muss be studied using the z-statistic. Finally, the inclusion of interaction terms significantly affects the results of the interacted variables.

I also extend previous findings by providing econometric evidence on the preponderance of non-economic factors that seem to prevail among economic drivers. For instance, the impact of those factors that generate negative disposition to these processes such as prejudice or nationalism seem to be much more important. Hence even when skilled workers may benefit from the liberalization process they are likely to prefer restrictive policies according to their overall ideology, even against their personal economic interest.

Accepting that this phenomenon is likely to be exacerbated in times of economic crisis and that individuals´ preferences play a relevant role in determining policy outcomes, the previous finding may explain the resurgence of restrictive policies applied in European countries since the beginning of the current economic global crisis which are responses of the governments to voters´ demands.

Finally, if our study shed some doubts on the traditional interpretation of the interaction terms between individual and country skills but it doesn't conduce to opposite results to the previous literature though it nuances them. In particular, the positive predisposition of more skilled people towards immigration appears clearly here as in other studies. The educational level exerts a positive influence on attitudes towards free-trade and immigrants. One direct implication of this result is that increasing education efforts would reduce the ratio of people who opposes to immigrants and trade liberalization.

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Annex

Table 1 – Description of variables

Name	**Label**	**Mean**	**St. dev.**
AGE	Respondent's age	47.0	17.2
CATHOLIC	1 if identifying with Roman Catholic religious group	0.4	0.5
EDUYRS	Years of schooling	11.5	3.6
EDUGPD	EDUYRS * GDP per capita		
FEMALE	0 for men and 1 for women	0.5	0.5
GDP per capita	Gross Domestic Product per capita, in logs, (Atlas method, 2002)	26.8	1.1
MARRIED	1 if married or living as married	0.6	0.5
NATIONALISM	1 if agreeing with 'your country is a better country than most other countries'	0.7	0.5
PATRIOTISM	1 if feeling proud of the country	0.9	0.3
PRIVATE_SECTOR	1 if working in the private sector	0.4	0.5
PRO_IMM	1 if considering that immigrants are good for the economy	0.3	0.5
PRO_TRADE	1 if considering that respondent's country' should limit the import of foreign products in order to protect its national economy	0.2	0.4
RELIGIOSITY	1 if respondent attends to religious services once a week or more frequently	0.1	0.3
S_INCOME	Auto-definition in a scale from 1 to 10	5.1	1.9
SELF_EMPLOYED	1 if being self-employed	0.1	0.3
SINGLE	1 if being single	0.2	0.4
UNEMPLOYED	1 if being unemployed	0.1	0.2

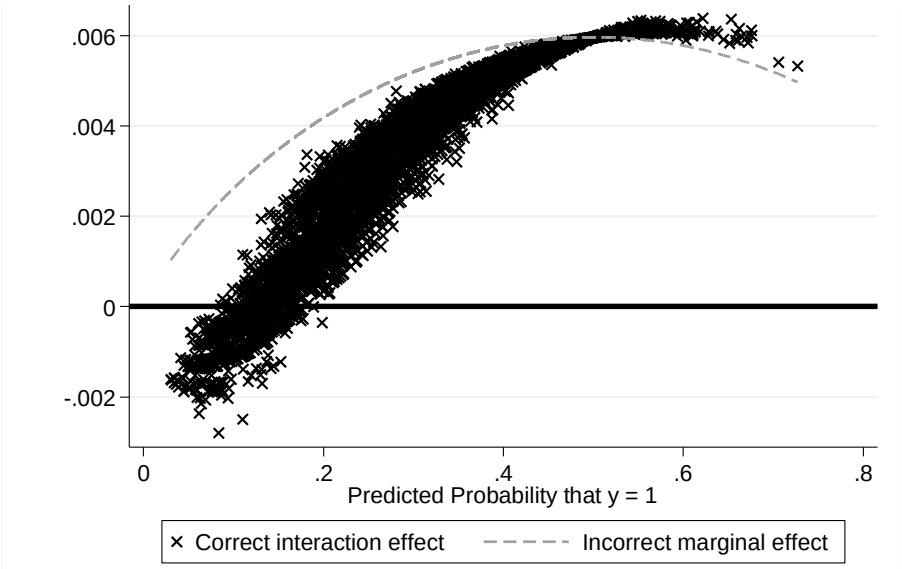
Table 2 – Marginal effects after probit model estimation

	PRO_IMM		*PRO_TRADE*	
	1.1	1.2	2.1	2.2
Predicted probability of dependent variable = 1	28.32%	28.51%	20.92%	20.93%
FEMALE	-0.017	-0.016	-0.073***	-0.072***
	(0.013)	(0.013)	(0.014)	(0.014)
AGE	0.002***	0.002***	0.000	0.000
	0.000	0.000	(0.001)	(0.001)
EDUYRS	-0.118***	0.011***	0.012***	0.016***
	(0.045)	(0.002)	(0.001)	(0.002)
MARRIED	0.081***	0.083***	0.011	0.012
	(0.018)	(0.018)	(0.012)	(0.012)
SINGLE	0.075***	0.074***	0.022*	0.021
	(0.023)	(0.023)	(0.019)	(0.019)
S_INCOME	0.027***	0.028***	0.019***	0.019***
	(0.004)	(0.004)	(0.003)	(0.003)
RELIGIOSITY	0.046**	0.046**	-0.048***	-0.049***
	(0.019)	(0.019)	(0.015)	(0.015)
CATHOLIC	-0.018	-0.015	0.002	0.005
	(0.015)	(0.015)	(0.020)	(0.021)
UNEMPLOYED	-0.001	-0.001	-0.007	-0.009
	(0.027)	(0.027)	(0.014)	(0.014)
PRIVATE_SECTOR	0.034**	0.036***	0.043***	0.044***
	(0.013)	(0.013)	(0.011)	(0.011)
SELF_EMPLOYED	0.080***	0.080***	0.051***	0.051***
	(0.022)	(0.022)	(0.017)	(0.017)
PATRIOTISM	-0.004	-0.003	-0.007	-0.008
	(0.019)	(0.019)	(0.011)	(0.011)
NATIONALISM	-0.027*	-0.028*	-0.111***	-0.111***
	(0.014)	(0.014)	(0.012)	(0.011)
EDUGPD	0.005***		0.007**	
	(0.002)		(0.003)	
GDP PER CAPITA	-0.126***	-0.067***	-0.071**	0.006
	(0.021)	(0.006)	(0.028)	(0.036)
Observations	9,388	9,388	9,388	9,388
Pseudo R-squared	0.06	0.06	0.08	0.08

* significant at 10%; ** significant at 5%; *** significant at 1%
Robust standard errors in parenthesis
The Kolmogorov-Smirnov test was employed on the residuals in order to check the normal distribution assumption.

Figure 1 – Interaction effects after probit models estimation

a) Interaction effects in model 1 (*PRO_IMM)*



b) Interaction effects in model 2 (*PRO_TRADE*)

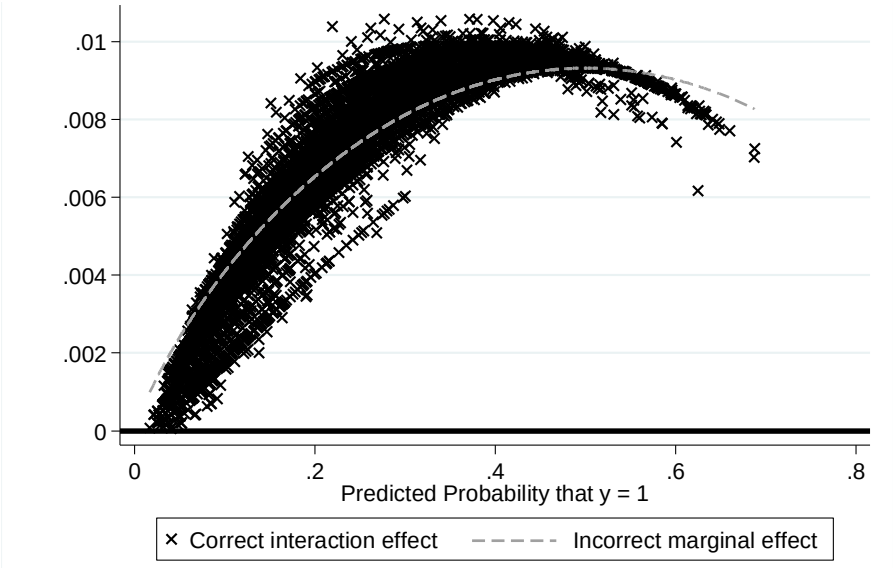
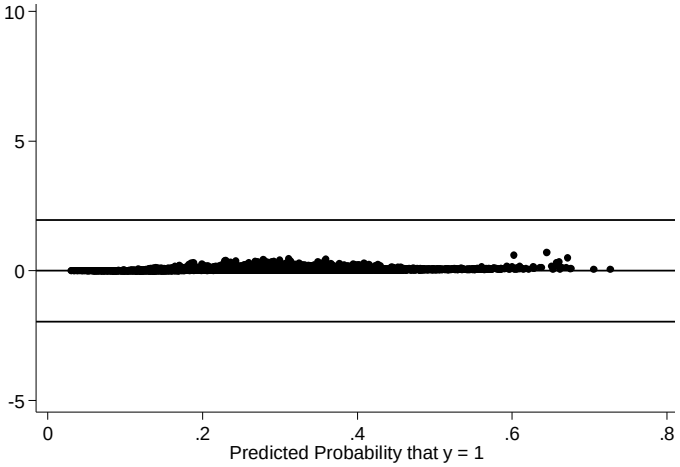


Figure 2 – Significance of the interaction effects

a) z-statistics of interaction effects in model 1 (*PRO_IMM)*



b) z-statistics of interaction effects in model 2 (*PRO_TRADE*)