The Speed of Euro Adoption

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Abstract

This paper estimates the speed and determinants of euro adoption across Italian provinces by exploiting the natural experiment in early 2002 when euro and lira dually circulated as legal tender. A unique data set with daily observations on the net flows of euro banknotes from the branches of the Bank of Italy, province by province, is used. The speed of euro adoption differs according to the availability of transaction technology and demographic characteristics. Lessons for countries adopting a new currency are obtained.

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1. Introduction

On January 1, 2002 the euro became legal tender and began circulating the European Monetary Union. A period when the old national legacies and the euro dually circulated ranged in length from zero to two months across member countries. In Italy the dual circulation of the lira and of the euro lasted two months until February 28; on March 1 the lira ceased to be legal tender and the euro became the only legal tender[1].

We exploit the natural experiment of the introduction of a new currency in an economic system to analyze the patterns of the speed of euro adoption in different areas and its relationship with the economic and demographic characteristics. To our knowledge this is the first empirical analysis using census data on this phenomenon[2]. We first derive a measure of the speed of adoption of the euro in each Italian province and then analyze cross-provinces determinants.

We argue that the spread of the new currency[3] was influenced by the economic and demographic characteristics of the areas examined. We investigate this hypothesis using a unique data set with daily data on the diffusion of the euro in Italian provinces through the branches of Bank of Italy.

We find that the diffusion of the euro differs across Italy, being faster in the Northern regions and slower in the Southern regions and in the Islands up to the beginning of February. Moreover, according to the results of the empirical analysis and in line with our a

[1] It is possible to convert Italian lire banknotes in euro banknotes at the branches of Bank of Italy until 28 February 2012. See Bank of Italy (2002a), (2002b) for a description of the transition to euro in Italy.

[2] The only two studies we are aware of on the introduction of the euro used survey data with a very limited coverage, Goodhart and Pappa (2003), and Cannon and Cipriani (2006). The latter, using data on church collections, find a certain degree of non neutrality of the monetary shock represented by the introduction of euro in Italy, due to a degree of money illusion in the behavior of consumers. Other studies, Angelini and Lippi (2006), Gaiotti and Lippi (2004), Del Giovane and Sabbatini (2006), used Italian data with a more extensive coverage to detect effects of the introduction of euro on prices without finding any. As for census currency data disaggregated at a sub-national level, the only data comparable to our data-set are those collected from the 37 Federal Reserve Cash Offices by Judson and Porter (2004) to estimate the dollars circulating outside the United States.

priori, the speed of euro adoption is influenced by the availability of transaction technology and by demographic characteristics.

We believe that policy implications for the countries planning to switch to the euro may be obtained from our study in order to implement an optimal transition strategy to the new currency fully acknowledging the peculiarities of each economic system.

The paper is organized as follows. After reviewing the related literature in Section 2, Section 3 describes the data and the methodology. The empirical evidence is reported in Section 4 while Section 5 discusses the robustness of the results. Section 6 presents lessons that may be derived for countries adopting a new currency, while conclusions are drawn in Section 7.

2. Related literature

We looked at those works on currency demand that studied the factors we expect to determine the speed of adjustment of the money balances in the new currency to the desired level. Our interest lies precisely in what determines the different velocity of diffusion of the euro throughout Italian areas towards its equilibrium level. We focus on the availability of transaction technology, demographic and social characteristics affecting the speed of adoption of the new fiat money.[4]

The use of cash is expected to fall as transaction technology improves, reducing the need for cash and the urgency to replenish the cash balances held. Such improvements can be empirically proxied by the number of ATM (automated teller machines), POS (point of

[3] Given the initial amounts of banknotes delivered to post offices and banks before January 1 2002 (frontloading) and their subsequent distribution by these to commercial chains and retailers (sub-frontloading).

[4] We do not consider the variables that traditionally determine the long-run money demand, the scale variable that accounts for transactions (such as the gross domestic product or consumption) and the opportunity cost reflecting the appropriate interest rate, but we focus only on the variables that affect the adjustment of

sale terminals), or the use of credit and debit cards. Snellman, Vesala and Humphrey (2001) studying ten European countries between 1987 and 1996 find the diffusion of POS to be one of the key determinant of the substitution of non-cash payments for cash, while that of ATM has an ambiguous effect on the substitution for cash.[5]

As for the relevance of the shadow economy Attanasio, Guiso and Jappelli (2002) find empirical results possibly in line with the interpretation that cash holding is considerably higher in Central and in Southern Italy, where the underground economy and criminal activities are deemed to be more widespread than in Northern Italy. Rogoff (1998) too believes that besides to interest rates, the main determinants of cash holdings are the ratio of taxes to GDP, and a proxy for violent crime. Zizza (2002) finds that crime positively affects the demand for currency using Italian data.

We also expect the age of the population to be positively related to the use of cash and hence to a faster adoption of the new currency, since more advanced transaction technologies (e.g. debit and credit cards) are less used with increase in age. Aside from behavioral motives, this correlation arises because the elderly have a higher probability of being poor, a condition that limits the scope of available cash alternatives.

Finally, as for the effects of the introduction of a new fiat currency, a work by Lotz and Rocheteau (2002) examines within a dual currency search-theoretic framework the different options a policy-maker faces. The model developed offers some policy prescriptions for a currency reform in which a fiat currency is replaced with a new one. To induce the move to the new currency, the government must help agents to co-ordinate in order to achieve a new equilibrium. In particular, it has to introduce measures to stop the use of the old currency, to

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actual money balances to the desired ones. See Duca and Van Hoose (2004) for a survey on the money demand literature.

[5] Raa and Shestalova (2004) find with Dutch data results consistent with the restrictions imposed on Whitesell's model (1989, 1992) according to which currency has a lower fixed cost and is preferred to debit

reduce the conversion cost and finally to define the length of time of dual currency circulation. The authors conclude that their model could be amended to allow for innovation in the payment system, in the form of a new currency (like the euro) that speeds up trades and reduces transaction costs.

3. Data and methodology

The data set we use is unique because it comprises data on the daily inflows and outflows of lira and euro banknotes through the branches of the Bank of Italy that act as cash offices and are the points through which the currency is first put in circulation and also finally withdrawn for destruction. We obtained the speed of euro adoption measure computing over the period observed the derivatives of each of the 95 curves of currency stocks resulting per every province. Each of these curves consists of 63 observations, one per each of the business days between January 2 and March 29 and the observation represents the cumulated euro banknotes put in circulation (subtracting the ones withdrawn from circulation) until the date considered in the province examined[6]. In the econometric analysis we employed the speed of euro adoption measured at the end of our sample, on March 29, 2002. The other variables used in the cross-section regressions are measured as of end 2001 (see Table 1 and Appendix).

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cards for small value transactions, while debit cards, having a lower variable cost, are chosen for large value transactions.

[6] Our assumption is that, in the period observed, the flows of euro banknotes between the different provinces were negligible so that the stocks built and, more importantly, the pattern of their growth, are reliable. This assumption is reasonable due to the feeble relevance of flows of banknotes for trading and tourism (the two main drivers of banknote migration across provinces) in the three months under investigation. The assumption hinges on the long extent of the dual circulation period which led part of the currency needs to be satisfied with the still circulating lire and on the proximity of our study period to the introduction of euro. Moreover in the period observed the flows should not have been altered significantly by tourism that in Italy begins on a large scale at Easter, that in 2002 was the 31st of March. We have of course also to take into account that cash service companies transporting the banknotes from the Bank of Italy to the private banking sector in principle could move across provinces part of the banknotes introduced by the Central Bank. Unfortunately data on these flows are not available but their magnitude shouldn't be large due first, to the short

[Insert Table 1 here]

The functional form that best fits the provincial euro stock curves is an exponential negative function, with an initial constant to account for the banknotes frontloaded and attributed to the 2nd of January as can be seen in Figure 1 that plots the observed euro stocks for the five Italian macro-areas, North-West, North-East, Centre, South and the Islands.

[Insert Figure 1 here]

Accordingly we estimated the following equation per each province:

$$E_{it} = c_i - a_i e^{-bit} \tag{1}$$

where E_{it} is the amount of euro; i indexes the provinces and ranges between 1 and 95; and t indexes the days and ranges between 1 and 63, that is from January 2 to March 31 (with the exclusion of the Saturdays and Sundays).

We defined the speed of adoption in each province i at every date t as the derivative of Eq. (1), whose expression is the following:

$$S_{it} = \frac{\partial E_{it}}{\partial t} = a_i b_i e^{-bit} \tag{2}$$

After estimating the parameters of Eq. (1), we substituted their values in Eq. (2) and evaluated the speed of adoption of euro S_{it} for all the 95 provinces and the 63 dates, obtaining for each date a vector S_t of 95 provincial speeds S_{it}.

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time period after the introduction of the new currency and second, to safety reasons that push to limit cash movements within Italy as much as possible.

After a specification search we ran a cross-section regression using the following specification:

$$\log (S_{i,\, t=63}) = b_0 + b_1 \log (ATM)_i + b_2 \log (POS)_i + b_3 \log (OLD)_i + \varepsilon_i \qquad (3)$$

where i, the province, ranges between 1 and 95, and t, the date, is fixed to 63, that is March 29, 2002. We regressed the dependent variable, the speed of adoption of the new currency, on the number per capita of *ATM* and *POS* terminals to capture for transaction technology and on a demographic variable, the percentage of elderly (over 65) people in the population, *old*, a proxy for individuals with a higher demand for cash.

4. Results

Measures of the speed of adoption of euro in the Italian provinces are obtained for all the dates observed and the provinces. In Figure 2 we plot the evolution of the speed of adoption of euro over the entire three months period examined, but only for the five major areas of Italy, North-West, North-East, Center, South and Islands (the vertical axis reports the measure in unit terms, along the axis the speed increases) in order to provide a comprehensive picture of how the euro spread in Italy. At the very beginning of the sample period, the speed in the Northern areas was higher than in the South and the Islands, but then around mid January, this pattern reversed with the latter areas displaying a higher speed to catch up with the Northern areas.

[Insert Figure 2 here]

Table 2 reports the results of the cross-section regressions where the dependent variable is the speed of euro adoption at the end of March 2002 (the first month with the euro being the only legal tender).

[Insert Table 2 here]

In our baseline model (model 1 in Table 2) we find that following a 1 per cent increase in the number of POS the speed of adoption decreases, as expected, by -2.2 per cent and that the effect of ATM on the speed of adoption is negative[7], as expected, being equal to -2.2 per cent at the end of March. The share of elderly people in a province's population has a positive effect on the speed of adoption equal to 5.5 per cent.

Our results are overall consistent with what we expected for the effect of transaction technology availability, which, *ceteris paribus,* should reduce the demand for cash and consequently also the urgency of switching to the new fiat currency. This hypothesis is also supported by the evidence that the use of payment cards rose at the beginning of 2002 and then abated, reflecting a desire to avoid cash transactions when the euro was first introduced to limit initial confusion with the use of the new currency.

We expected also to find that demographic variables linked to less use of sophisticated means of payment could proxy for factors associated with and presumably lead to a higher use of cash than the average of the population. The variable we used to proxy for a high proclivity to use cash is the percentage of elderly people in a region's population.

5. Robustness checks

We performed a number of robustness checks both on the data set and on the specification used.

With regard to the data set we calculated the stocks of euro excluding the frontloaded and sub-frontloaded euro banknotes, accounted for in the first inflow of banknotes in the economy dated January 2, to check for a possible outlier effect. This however did not change the shape or the pattern of the curves. As for the measure of the speed of adoption, we

[7] Slightly not statistically significant.

replaced the measure in Eq. (2) with simple differences between the cumulated stocks at the end and the beginning of the sample. Once again, the results did not significantly change.

For robustness we ran the regressions fixing the date at the end of January and at the end of February (coinciding with the end of the dual circulation period) and the results were again similar.

In the specification search we also checked if other variables that might be linked to individual preferences for cash could help to explain the heterogeneity in the spread of the euro through Italy. We checked if the amount of banknotes frontloaded and sub-frontloaded (that is the banknotes available in each province already on the first day of introduction of the euro) had an impact. In our search we looked also at the level of unemployment, the percentage of graduates in the population, the percentage of people with only the primary school degree. All the variables above were not statistically significant, and their inclusion did not alter the results we had for the variables of our preferred specification (see Table 2). We also tried to see if the speed of euro adoption was influenced positively by an index of criminality, and indeed it was, possibly in line with a positive relation between demand for cash and underground economy extent. Nevertheless we did not include criminality in our preferred specification given the uncertainty about its economic meaning with regard to the speed of euro adoption. Actually, evidence collected in euro-area countries indicated to the contrary that criminality refrained from converting or using cash in the immediate aftermath of the introduction of euro, to avoid to be detected by the authorities at a time when the vigilance on money laundering was very high.

6. Lessons for countries adopting a new currency

We believe that from the analysis of the previous sections some lessons and implications may be derived and considered by countries that plan to switch to a new fiat currency, namely the euro.

The first lesson is that the speed with which a new currency spreads in an economic system depends on the availability of transaction technology alternatives to cash. In particular a wide distribution of ATM and POS is beneficial to satisfy the need of cash in the new currency in an ordered manner, decreasing the requested speed of diffusion of cash into the economy and the probability of a failure of the system in providing the amount of cash desired by population in a given geographical area.

The second lesson is that the demographic structure of the population may be relevant in planning the injection of the new cash into the economy. Elderly people in their routine transactions usually employ more cash and less alternative means of payments, such as debit and credit cards, than the average of the population, due to their lower level of income and lower attitude to use newer transaction technologies. This may lead to consider providing cash more quickly and in larger amount in regions where the percentage of elderly in the population is higher, since inventories of old currency will be exhausted quickly and the new one will be requested faster.

Moreover we think other three implications are noteworthy. The first one is that a thorough assessment of the resilience of payment system to shocks in the choice of transaction technology alternatives is needed. In particular the overload capacities of the ATM, POS and credit cards networks, have to be fully tested to avoid potential disruption of the transaction processes due to peak of use in the aftermath of the introduction of a new currency. The second implication is that unnecessary welfare losses in terms of time wasted by citizens in queuing to withdraw cash or to convert old currency notes and coins into the

new ones may be avoided thanks to a proper planning of front-loading, sub-front-loading, and diffusion of the new currency into the economy. Finally, the opportunity of introducing a dual circulation period may be evaluated given that, besides helping to avoid unmotivated steps in the level of prices and monetary illusion via an easier comparison of the prices in the two currencies, it may additionally help to avoid unnecessary shocks in transaction behavior providing a gradualist approach to the transition.

To sum up, the main lesson that we believe comes out of our study, is that in order to obtain a smooth changeover to a new currency, a careful preparatory work has to be conducted well ahead, taking properly into consideration the peculiarities of each country involved with regard to the characteristics of the financial system, payment system and population.

7. Conclusions

The natural experiment of the euro introduction in the first months of 2002 was an extraordinary one. The changeover from twelve national legacies to a single new currency happened in an institutional framework which accommodated the existence of twelve national countries. This notwithstanding the changeover was a success and the operations were conducted smoothly thanks also to the positive reaction of the public to the introduction of the new fiat currency. In Italy a gradualist approach was adopted to minimize the inconvenience for consumers and business. Specifically, the period of dual circulation was extended until February 28, 2002, the latest date allowed by the Ecofin Council.

The length of the dual circulation period in Italy gives the opportunity to build an unprecedented daily measure of the speed of adoption of the euro at a disaggregate level for 95 provinces under reasonable assumptions. Two facts support the validity of this experiment. The first is the shortness of the period considered. The second is the

circumstance that until February 28 the euro was a legal tender with a competitor, the Italian lira, that prevented the euro from being the only mean of payment in cash transactions and that likely did not lead to relevant flows of euro banknotes migration contrary to lira banknotes. Moreover the period considered does not include Easter, March 31, 2002, that represented the first relevant episode of tourism following the introduction of the euro that could cause banknote migration. One caveat is the possible existence of flows of banknotes within Italy arising from the activity of the cash service companies and for which data are not available. Nevertheless, because we are interested to the comparison of the patterns of the speed of adoption of the euro across areas, the phenomenon of interest, the relative patterns across areas, should not be significantly biased. For these reasons, new insights on the pattern of diffusion of a new currency can be gleaned from analyzing these high frequency cross-section data.

After deriving a measure of the velocity of the spread of the new money in Italy, we test some hypotheses about the determinants of the speed of euro adoption. We find empirical evidence that the availability of transaction technology and the share of the elderly significantly account for cross-regional patterns of the speed of euro adoption. We do not find statistically significant effects of unemployment and education levels, neither of the amounts of banknotes frontloaded, while criminality could play a role even if not clearly interpretable.

These results suggest that financial technology and demographics need to be taken into account not only in modeling continuous time series data on money demand but also in analyzing unusual transitions involving the adoption of new currencies. On the verge of the entrance of a number of Eastern European countries in the euro area and in a period in which other common currency areas in the world are discussed, it is relevant to assess the relevance of the factors shaping the diffusion of a new fiat currency in an economic system. This assessment should help to design a smooth transition from the old currencies to the new

ones, minimizing the possibility of a chaotic transition, with shortages of cash or difficulties in conducting transactions with alternative means of payment. Moreover the evaluation of the factors driving the adoption of the new *numeraire* could assist in the definition of an adequate preparatory phase, and eventually also of a dual circulation period, to eliminate or at least abate dramatically the allegations of welfare losses, due to forms of temporary monetary illusion in pricing behavior of consumers and producers, made by part of the public opinion and also by some economists. Hopefully, more research on the interplay between financial technology and currency areas issues will be conducted.

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Appendix

The data set

The data set refers to 95 [8] Italian provinces.

Automated tellers machines: number of ATMs located in the provinces examined at the end of each year; the source is the banking statistics data set collected by Bank of Italy (Matrice dei Conti).

Criminality: number of total crimes; Ministry of Internal Affairs and Istat data reworked.

Old: percentage of people over 65; Istat (National Institute of Statistics) data reworked.

Euro stocks: cumulated net inflows of euro banknotes in the economy through the branches of Bank of Italy, daily frequency (business days); the source is a banknote statistics data set of Bank of Italy.

Points of sale: number of POS located in the provinces examined at the end of each year; the source is the banking statistics data set collected by the Bank of Italy (Matrice dei Conti).

[8] We consider the administrative distribution of Italy in the 95 provinces existing until 1996 since the distribution of the 99 branches and subsidiaries of Bank of Italy is coherent with it (in 1996 eight new provinces were created). Hence we aggregated the data of the eight new provinces created in 1996 with the data of the provinces of which they were part before 1996.

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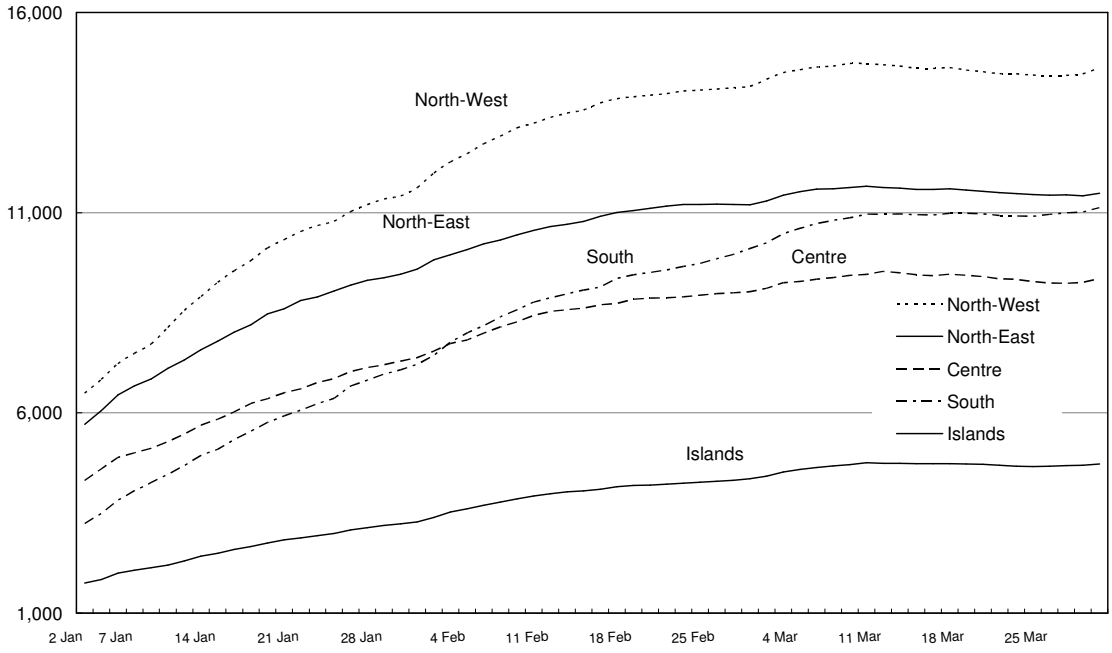
Figure 1

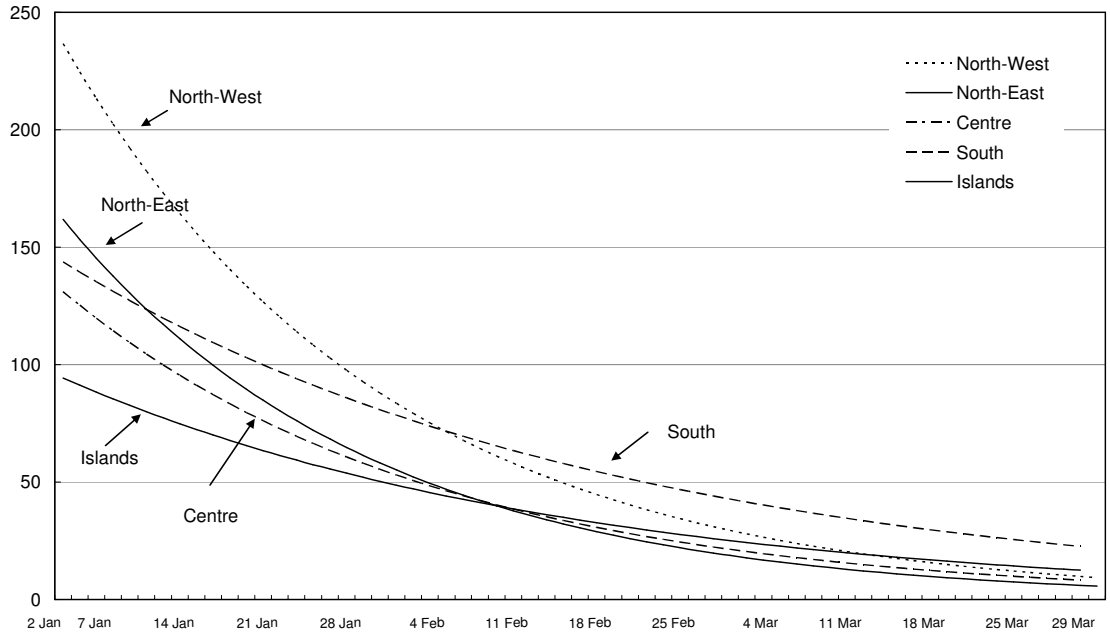
Euro stocks in Italian areas [1]



(1) Euro stocks are reported on the vertical axis and are in millions. On the horizontal axis there are the days in 2002 for which they are computed.

Figure 2

The speed of euro adoption in Italian areas [1]



(1) The speed of euro adoption is reported on the vertical axis and is an absolute number. On the horizontal axis there are the days in 2002 for which is computed.

Table 1

SUMMARY STATISTICS [1]

	December 2001
Speed of euro adoption [2]	
Mean	15.9
Standard deviation	37.2
Euro stocks [2]	
Mean	543
Standard deviation	748
ATM	
Mean	362
Standard deviation	419
POS	
Mean	7,873
Standard deviation	10,121
Old	
Mean	19.2
Standard deviation	3.2
Number of observations	95

Sources: Bank of Italy, ISTAT (Italian National Institute of Statistics).
1) Data refer to Italian provinces. Speed of euro adoption, ATM and POS are absolute numbers. Euro stocks are expressed in millions and old is the percentage of the population older than 65. 2) Speed of euro adoption and euro stocks are reported as of end of March 2002.

Table 2

BASELINE AND ALTERNATIVE MODELS OF THE SPEED OF EURO ADOPTION[1]

Explanatory variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ATM	-2.21	-2.38	-0.64	-0.34	-0.32	-0.47*
	1.61	*1.65*	*1.72*	*2.55*	*2.54*	*0.85*
POS	-2.20*	-2.26*	-3.75***	-3.75***	-4.00***	-4.07***
	1.28	*1.29*	*1.36*	*1.37*	*1.38*	*1.38*
Old	5.46**	5.77***	5.76***	5.74**	4.45	3.17
	2.54	*2.62*	*2.53*	*2.54*	*2.72*	*3.22*
Frontloading		0.27	0.09	0.09	-0.12	-0.18
		0.51	*0.49*	*0.49*	*0.52*	*0.53*
Criminality			3.39***	3.37***	2.85**	2.69**
			1.25	*1.26*	*1.32*	*1.34*
Unemployment				0.19	-0.06	0.03
				1.19	*1.20*	*1.21*
Graduate					2.30	3.07
					1.77	*2.05*
Primary						3.66
						4.88
R^2	0.17	0.17	0.24	0.24	0.25	0.25
No. of observations	95	95	95	95	95	95

1) Standard errors are the figures in italics below the respective coefficient.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.