

2.1 THE EURO CASH CHANGEOVER: A NOTE ON THE EFFECTS OF BOUNDED RATIONALITY AND RULES OF THUMB¹⁴

2.1.1 Introduction

Cette note examine les points de repère que les individus pourraient utiliser en convertissant les nouveaux prix en euro vers des anciens prix nationaux. Les résultats, qui se basent sur une petite enquête faite au sein de la Banque centrale du Luxembourg en mai 2001, suggèrent que des erreurs systématiques de conversion peuvent être faites. Ces erreurs pourraient avoir des effets économiques réels, au moins en ce qui concerne le court terme.

A single currency has been created for twelve EU countries. On 1 January 2002, people in these countries will finally have to learn living with a set of new prices converted into a new currency. Neo-classical economic theory suggests that simply switching from one denomination to another at a fixed rate, such a change would not have any real effects if people are «unbounded rational».

The euro cash changeover will have price effects. In particular, increased cross-country price transparency and arbitrage possibilities will increase competitive pressures in the long-term. This should reduce the price dispersion between countries. In the short-term, however, psychological price setting behaviour of firms, as well as inappropriate conversion and/or rounding of prices may have some impact on prices. This impact will be relatively small and of temporary nature, so it is unlikely to have any lasting effects on the rate of inflation.

De Nederlandsche Bank (2001) and Folkertsma (2001) analysed the impact of psychological price setting for the Netherlands. Both reports support the conclusion that the inflation risk seems very limited. Folkertsma (2001) simulates the likely impacts of the euro cash changeover in a worst case scenario. His results indicate that the harmonised consumer price index would increase temporarily by 0.88% at most. Not only may firms seek to exploit the public's inexperience with new prices in trying to permanently increase product prices, but real, implicit price changes may also occur due to changes in product size and volume. These supply-side effects have received a lot of attention, in particular in the German media (e.g. FAZ, 2001/03/22; Focus 2001/19; Tagesschau 2001/07/11). If these short-term effects arise in a systematic manner, they will produce real economic effects.

In contrast to the aforementioned studies, this note aims to illustrate that real economic effects may also arise from the demand side, as it may take several years before people truly and fully adopt the new currency and the new denomination of prices. It is not clear to which extent and for how long businesses will publish prices in both euro and the previous national currency, although in none of the Eurosystem countries payments may be made in former national currencies after 28 February 2002. The sooner firms start displaying the euro price only, the smaller is the possibility that consumers continue to think in their previous currencies. In the transition period it will be likely that individuals adopt rules of thumb to approximate the respective conversion rate in each member state.

By using rules of thumb rather than converting accurately, individuals make systematic errors. As a result, prices in euro will be systematically over- or underestimated. Consumers will act upon perceived price changes, just as if prices had really changed. They will consume less or more of all products depending on whether they consider the price – converted back into their previous currencies – high or low compared to what has so far been their benchmark price. Even if consumers are aware that price conversion is inaccurate, this will not alleviate the error, as otherwise they would have chosen different heuristics or would have converted price accurately in the first place.

It should be noted that consumers have to take into account «normal» price increases or inflation, which would have occurred anyway under their previous currencies and under the euro. Even at low inflation rates, this would make it hard if not to say impossible to compare the prices converted from euro to national benchmark prices before the euro cash changeover took place.

This note presents empirical results based on a small survey conducted at the Banque centrale du Luxembourg (BCL) on approximations and rules of thumb in the conversion of euro prices. We would like to emphasise very explicitly from the very beginning that it is in no way claimed that this survey presents representative or unbiased results. The aim is rather to provide an indication of a possible problem and to stimulate discussion on this topic.

¹⁴ by Thomas Mathä. Opinions expressed in this note are strictly personal opinions of the author and do not necessarily reflect those of the Central Bank of Luxembourg.

2.1.2 Bounded rationality and rules of thumb

Consumers will convert new prices in euro into their former national currencies for some time after the introduction of euro notes and coins, as they are necessarily unfamiliar with the new set of prices. How long will it take before consumers have successfully adjusted their reference system? This is likely to depend on the country in question, as well as on age, education, gender and other idiosyncrasies of individuals.

The official euro conversion rates are not easily applied in day-to-day purchasing decisions (see second column in table 1). This is partly related to the non-integerness and partly to the level of the conversion rate. It is certainly easier to convert currencies up to a conversion rate of 1:2 or 1:3 than higher ones such as 1:14, 1:166 or 1:340.

Hence, individuals will adopt rules of thumb rather than accurately converting prices during the transition period. This is due to a simple, but striking reason – human brainpower is limited. If the problems people face become too complex, human logical capacity ceases to cope. In other words, human rationality is bounded (e.g. Simon, 1959; Arthur, 1994). In order to avoid making random choices, we have developed methods to derive approximations of the proper solution to our headache. We derive best guesses or

‘guesstimates’. Such best guesses are based on simplifications of the original problem, or on adaptive learning behaviour. Rules of thumbs are such simplifications, which help us to successfully tackle our every day’s decision-making problems¹⁵.

For example, Asplund & Friberg (2001) showed, in using duty-free prices, that the simple fact that identical products are priced in different currencies is reason enough for the law of one price to fail. People seem to have only limited capabilities in comparing prices denominated in different currencies, as prices are allowed to deviate, often quite persistently so, from the law of one price. Moreover, this effect occurs despite near frictionless arbitrage possibilities, as consumers can choose in which currency to pay. Furthermore, all imaginable market imperfections that may otherwise plague price comparisons, such as transport costs and product characteristics, are basically removed due to the unique setting of the price comparison.

The third column in table 1 shows possible rules of thumb in different countries that people might be using during the transition process in order to compare prices in euro with prices in former national currencies. The fourth column gives an example of a possible reasoning process required in order to derive prices in former national currencies.

Table 1 Conversion from euro to former national currency

<i>Currency</i>	<i>Exchange rate./euro</i>	<i>Possible rule of thumb?</i>	<i>Example of possible reasoning processes</i>
ATS	13.7603	14	"Multiply by ten, memorise, multiply by four, memorise add both memorised values."
BEF	40.3399	40	"Multiply by two, memorise, multiply memorised value by two, memorise, and add a zero."
FIM	5.94573	6	"Multiply by two, memorise, multiply memorised value by three."
FRF	6.55957	6.5	"Multiply by six, memorise, multiply by a half, memorise, and add both memorised values."
DEM	1.95583	2	"Multiply by two."
GRD	340.75	350	"Multiply by three, memorise, multiply by a half, memorise, add both memorised values, memorise, and add two zeros."
IEP	0.787564	0.8	"Multiply by four, memorise, divide by five."
ITL	1936.27	2000	"Multiply by two, memorise, and add three zeros."
LUF	40.3399	40	"Multiply by two, memorise, multiply memorised value by two, memorise, and add a zero."
NLG	2.20371	2.2	"Multiply by two, memorise, and add ten percent of memorised value."
PTE	200.482	200	«Multiply by two, memorise, and add two zeros.»
ESP	166.386	166.67	"Multiply by two, memorise, divide by three, memorise add to original value, memorise, and add two zeros."

Source: STATEC

¹⁵ See also Gigezenes et al. (1999).

Divergence from the official conversion rate is more likely in very frequent, repetitive or impulsive purchasing decisions. These decisions, many of which may be habit based, represent the majority of consumers' daily purchasing decisions. In these cases, it is very likely that consumers will adopt rules of thumb to facilitate the comparison of new prices in euro with prices in former national currencies. Concerning less frequent, more expensive decision problems, such as cars, television sets and other durable goods, it is more likely that exact prices will be calculated.

2.1.3 Survey data

A survey was conducted at the BCL in May 2001, asking all BCL employees (approx. 170) how they would convert euro prices into each of the twelve former currencies. Respondents were also asked whether they find it easy or difficult to convert euro into particular currencies and were invited to write down the procedures they were following.

As with any survey, there are several sources of potential criticism. Firstly, the selection of respondents is not random and therefore subject to a non-representativeness bias. However, it must be said that central bank employees represent an important control group. If central bank employees make systematic mistakes in converting prices, i.e. by adopting rules of thumb, then it can be legitimately expected that the public in general will also make systematic mistakes. In addition, it is not clear to what extent central bank employees in their capacity as consumers and currency converters are different from the public at large in terms of bounded rationality.

Secondly, there may be a systematic bias in the questions on the conversion rates of other member states, since respondents were primarily resident in

Luxembourg. This is particularly the case with regard to non-bordering member states, as Luxembourg residents are not as familiar with these currencies and prices.¹⁶ In response to this criticism it has to be said that, up to date, the euro is still mostly a theoretical currency. Products are still predominantly paid for in national currencies. In some countries, products are priced in both national currency and euro, while in others not even this was the case until very recently. In the first quarter of 2001, about 1.43% of all payments were made in euro (European Commission, 2001). Hence, individuals have very limited experience with the euro and the conversion – in most people's minds, simply has not happened yet. This is further compounded by the fact that in May 2001, only 51% of all interviewed people in different euro zone countries knew the exact conversion rate for their respective national currency (EOS Gallup, 2001).

This survey aims to analyse the adoption of different rules of thumb in different member states. A priori, it is conjectured that individuals' rationality is independent of nationality. Hence, it may be argued that asking Luxembourg residents about conversion rates of the euro versus different national currencies may provide some valuable first insights as to whether the adoption of rules of thumb by the public leads to a systematic and measurable economic impact.

2.1.4 Response

The sample includes 50 more or less completed surveys. This represents a response rate of almost 30% of all BCL employees. As always, some observations had to be removed, because the survey was not completed properly. Between 80% and 84% of all respondents provided some sort of comments on the reasoning process of how to convert prices.

Table 2 *Total Responses, and Comments on "Reasoning Process"*

	<i>ATS</i>	<i>BEF</i>	<i>FIM</i>	<i>FRF</i>	<i>DEM</i>	<i>GRD</i>	<i>IEP</i>	<i>ITL</i>	<i>LUF</i>	<i>NLG</i>	<i>PTE</i>	<i>ESP</i>
Indication of reasoning process	40	40	41	42	42	42	40	41	42	42	40	42
No indication of reasoning process	10	10	9	8	8	8	10	9	8	8	10	8
Total Responses	50	50	50	50	50	50	50	50	50	50	50	50

¹⁶ Note that currencies other than the Luxembourg and Belgian franc are in circulation in the Luxembourg economy; most notably the French franc and the German mark.

The Reasoning Process?

It is striking that some respondents' answers were not consistent across columns. When respondents were asked to provide their rule of thumb (column 3 in table 1), they wrote down *a*, but when asked how they came up with this rule, they indicated that they were calculating *b* (column 4 in table 1). This can only mean that respondents only fully realised what kind of rules of thumb they were to adopt, when asked to write them down. Table 3 illustrates the deviations in the answers. The Spanish peseta is an outlier as 35.4% of respondents' answers deviated from the stated approximate conversion rate when asked to provide details about their actual reasoning process, when converting prices. The Austrian shilling, Greek drachma and French franc follow at some distance.

Rounding mistakes were also found in the conversion procedure. To give an example, a respondent may indicate that his approximate conversion rate for the French franc is 6.6. This may be calculated either as rule A "multiply by six then add ten per cent of the calculated number" or by rule B "multiply by six then add two thirds of the initial number". In the latter case the respondent may introduce a rounding error. The "true" or "valid" approximate conversion rate can therefore only be detected by analysing the provided reasoning process. To take account of these deviations, a second series was constructed using respondents' descriptions of their rules of thumbs provided in the reasoning process. Hence, in this case the above example translates into an approximate conversion rate of 6.67. Results presented below refer to the newly constructed series.

Table 3 Consistency of Answers "Probable Rule of Thumb" and "Process in Mind"

	ATS	BEF	FIM	FRF	DEM	GRD	IEP	ITL	LUF	NGL	PTE	ESP
Obs. identical	38	48	48	41	47	40	46	48	48	44	48	31
Obs. not identical	11	0	1	8	2	8	3	1	0	5	1	17
Total obs.	49	48	49	49	49	48	49	49	48	49	49	48
Prop. identical, in %	77.6	100.0	98.0	83.7	95.9	83.3	93.9	98.0	100.0	89.8	98.0	64.6

It is likely that these deviations indicate that the conversion rate for these countries is more difficult. Also, the conversion process in these countries often requires the use of 1/3, 2/3, etc.¹⁷ These are not easily calculated. This is also suggested by the correlation coefficient of 0.87 found between the proportion of respondents indicating an «easy» conversion rate (see table 5) and the proportion of consistent answers across columns (see table 3).

It is also important to realise that different reasoning processes or rules of thumb can lead to the same approximate conversion rate. One respondent may approximate the Italian conversion rate by "multiplying by two and multiplying by a thousand" while another one may "multiply by two and add three zeros". Mathematically there is no difference. The observed approximate conversion rate is identical, but the underlying reasoning, i.e. the rule of thumb, surely is not.

A Finite Number of Rules?

Due to their incapability to accurately convert prices, individuals look for patterns, labels and other attributes that convey some kind of prominence, conspicuousness or uniqueness in trying to solve the problem (e.g. Mehta et al., 1994 on focal points in coordination games). One of the attributes used may simply relate to the simplicity of conversion. Since individuals are bounded rational, it is likely that only a limited number of reasoning processes may be used in the whole population. The number of approximate conversion rates is likely to be even more limited, as different reasoning processes may lead to identical approximate conversion rates.

The following figures give a detailed picture of responses. All provided responses are presented in the figures, and the number below each bar corresponds

¹⁷ In many cases, deviations may be attributed to rounding differences. One individual may stop rounding before the decimal while another stops after the first decimal place. Not knowing that both respondents used identical rules of thumb (provided by answers given in the reasoning process), one would have to regard these two answers as two different rules of thumb.

strictly to one approximate conversion rate, equivalent to one or more rules of thumb or reasoning processes. To be more precise, each bar represents the outcome of a reasoning process. If the reasoning process delivers different results, then this will be presented in separate bars. No distinction is made between reasoning processes leading to the same approximate conversion rate. Consider for example the reasoning process “*multiply by thirteen, memorise, multiply by fourteen, memorise, add the two memorised values and divide the sum by two*” and the reasoning process “*multiply by thirteen, memorise, take one half of the original value, memorise and add both memorised values together*”. Clearly, they are two different reasoning processes – but the outcome of both is identical, namely 13.5. As the numerical values attached to them are identical, they are represented in the same bar in figure 1.

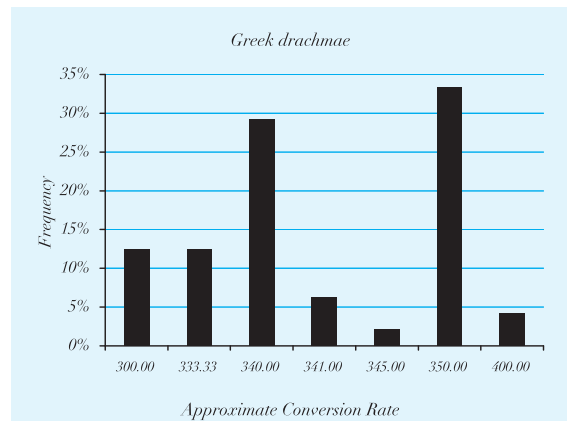
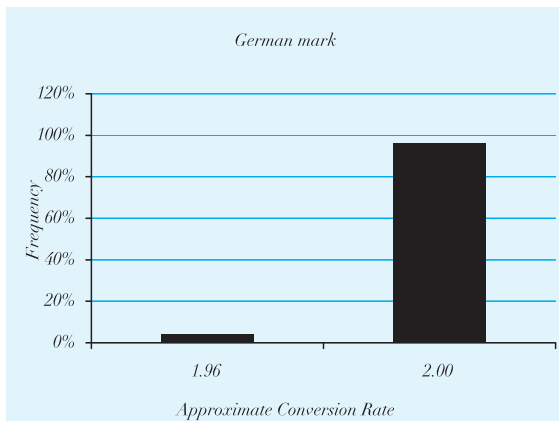
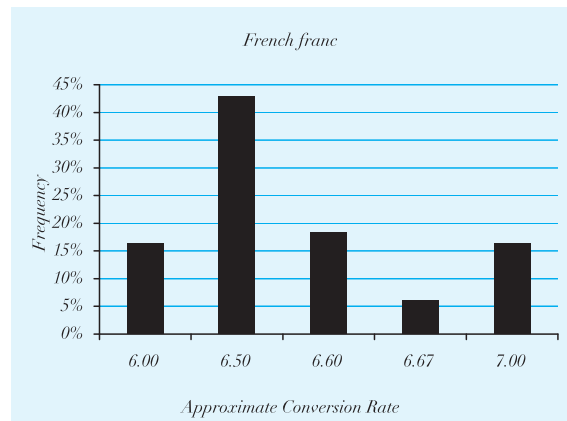
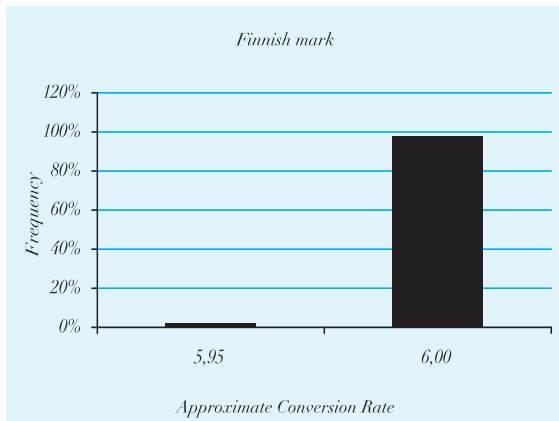
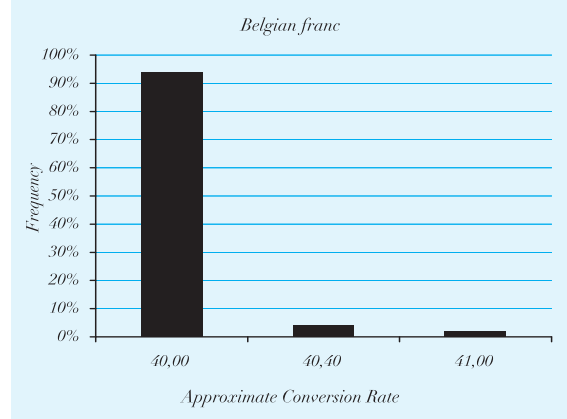
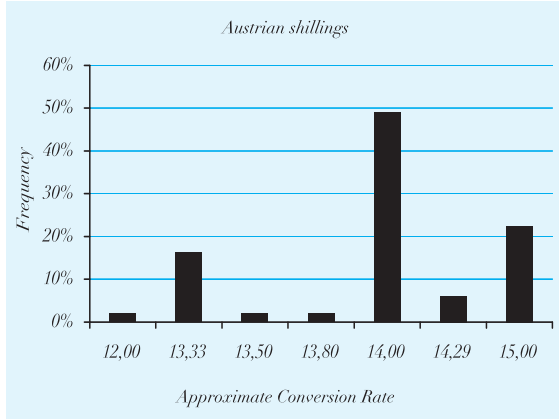
Two facts emerge very clearly from the figures. Firstly, for each currency only a limited and small number of approximate conversion rates are chosen. Secondly, for the Belgian and Luxembourg franc the Finnish and German mark, the Italian lira and the Portuguese escu-

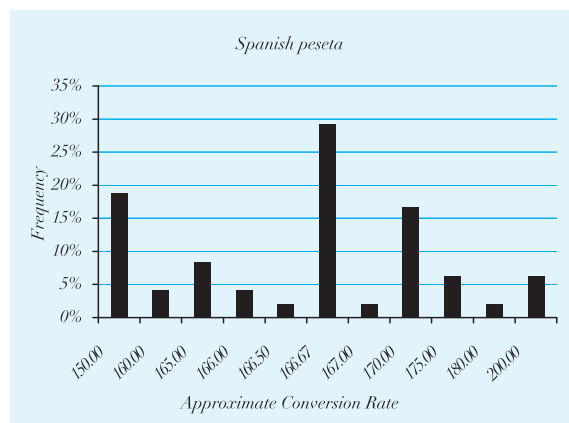
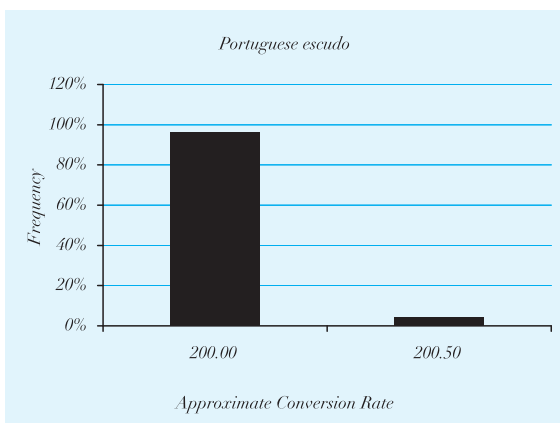
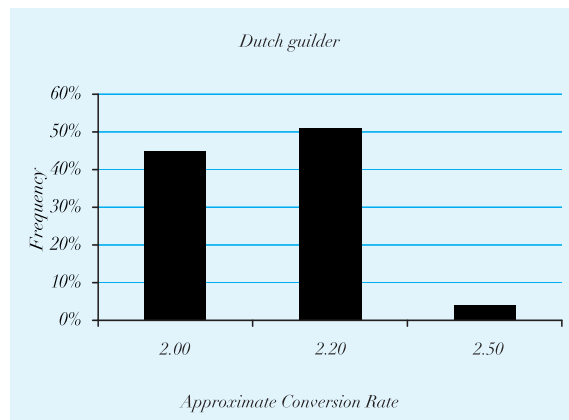
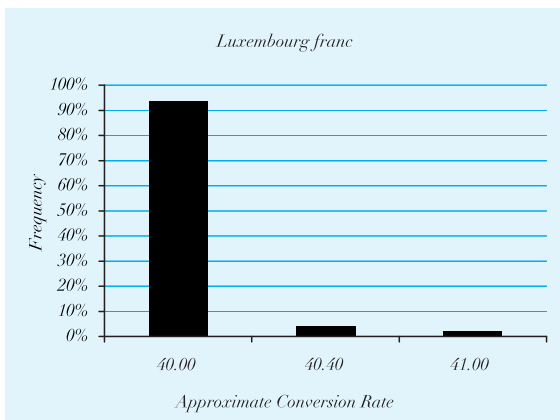
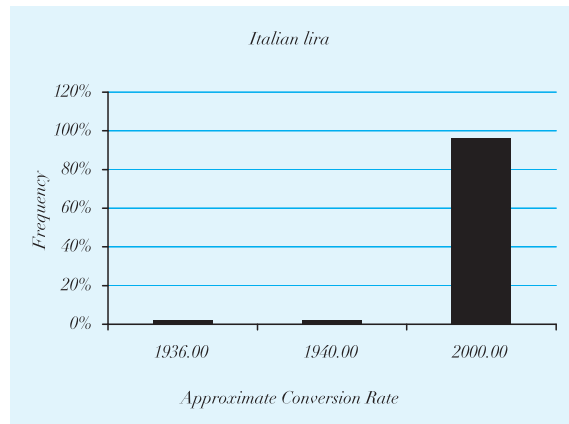
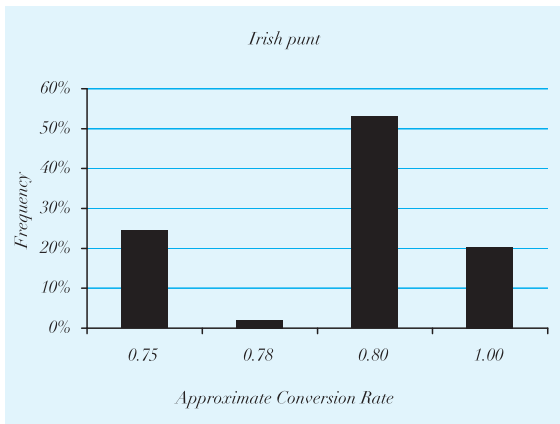
do, it is highly likely that respondents come up with the same approximate conversion rate.

The results for the Irish punt and the Dutch guilder seem to be odd. In the Irish case, it seems clear that prices in the shops will change. This fact alone should suffice to trigger a rule of thumb which is different from “*unity*”. A priori, it is difficult to foresee that about 20% of respondents adopt rules of thumb overestimating euro prices by a staggering 27%! In the case of the Dutch guilder, about 40% of all respondents indicate that they would convert price by “*multiplying by 2*”. Such a rule of thumb represents a deviation of about -10%. In both cases, however, the deviations do not turn out to be statistically significant.

On the one hand, one has to admit that these two cases highlight that a more systematic survey may be called for. In particular, it may be the case that the outcome for different currencies significantly depends on the nationality of the respondents. On the other hand, it was argued previously that there is no reason, at least on theoretical grounds, why this should be the case, i.e. why the bounded rationality should depend on nationality.

Figure 1 Frequency Distribution of Approximate Conversion Rates, per Currency





How Large is the Deviation and is it Systematic?

Table 4 gives some summary statistics of the responses. Positive deviations from the official conversion rule indicate that respondents will tend to over-estimate euro prices, i.e. their own conversion errors make them believe that prices have increased relative to their level prior to the euro cash changeover.

Table 4 Summary Statistics

	<i>ATS</i>	<i>BEF</i>	<i>FIM</i>	<i>FRF</i>	<i>DEM</i>	<i>GRD</i>
Official	13.7603	40.3399	5.94573	6.55957	1.95583	340.75
Average	14.078	40.038	5.999	6.529	1.998	340.166
Median	14.000	40.00	6.00	6.50	2.00	340.00
Min.	12.000	40.00	5.95	6.00	1.96	300.00
Max.	15.000	41.00	6.00	7.00	2.00	400.00
Std.	0.626	0.16	0.01	0.29	0.01	19.94
Coeff. Var.	0.04	0.00	0.00	0.04	0.00	0.06
Avg. Deviation in euros	0.023	-0.007 *	0.009 ***	-0.005	0.022 ***	-0.002
T-Stat.	0.507	1.85	7.45	0.10	5.32	0.03
No. Obs.	49	48	49	49	49	48

	<i>IEP</i>	<i>ITL</i>	<i>LUF</i>	<i>NLG</i>	<i>PTE</i>	<i>ESP</i>
Official	0.78756	1936.27	40.3399	2.20371	200.482	166.386
Average	0.828	1997.469	40.038	2.122	200.020	166.539
Median	0.80	2000.00	40.00	2.20	200.00	166.67
Min.	0.75	1936.00	40.00	2.00	200.00	150.00
Max.	1.00	2000.00	41.00	2.50	200.50	200.00
Std.	0.09	12.40	0.16	0.13	0.10	11.68
Coeff. Var.	0.11	0.01	0.00	0.06	0.00	0.07
Avg. Deviation in euros	0.052	0.032 ***	-0.007 *	-0.037	-0.002 ***	0.001
T-Stat.	0.45	4.93	1.85	0.64	4.62	0.01
No. Obs.	49	49	48	49	49	48

Note: ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

How Easy is it to Convert Individual Currencies?

Table 5 shows clearly that there are some significant differences between countries. Respondents seem to have serious difficulties in converting euro to Spanish pesetas, Greek drachmae and Austrian shillings. This is not surprising, as in these cases conversion requires numerous calculation processes. Unsurprisingly, the German mark seems to be the case with the easiest conversion.

overestimate euro prices, while in Belgium, Luxembourg and Portugal the opposite will be the case. For the remaining countries no significant effects could be found. However, this may largely be related to the very small sample size and the sample selection problem.

The systematic adoption of rules of thumb, represented by approximate conversion rates, could lead to real economic effects. In the case of Finland, Germany and Italy, it may not be unreasonable to argue that, *ceteris paribus*, consumer demand could be negatively affected,

Table 5 Question Concerning "Ease of Conversion"

	<i>ATS</i>	<i>BEF</i>	<i>FIM</i>	<i>FRF</i>	<i>DEM</i>	<i>GRD</i>	<i>IEP</i>	<i>ITL</i>	<i>LUF</i>	<i>NLG</i>	<i>PTE</i>	<i>ESP</i>
Obs. Yes	17	48	43	28	50	10	25	44	48	39	46	11
Obs. No	33	2	7	22	0	40	25	6	2	11	4	39
Total obs.	50	50	50	50	50	50	50	50	50	50	50	50
Prob. Yes in %	34.0	96.0	86.0	56.0	100.0	20.0	50.0	88.0	96.0	78.0	92.0	22.0

2.1.5 So what? – an outlook

This note aimed to raise an issue, which has not attracted attention in the debate on the euro cash change-over – the adoption of rules of thumb by the public in converting currencies. I believe that the presented evidence, based on a small survey conducted at the Banque centrale du Luxembourg, shows quite pervasively that individuals are likely to adopt certain rules of thumb in converting euro prices to former national currencies in order to compare the new price with the old price. A priori, it is unclear how long businesses will continue display prices in both euro and the previous currency, and how quickly individuals will be able to adopt the new reference system. The younger generation may respond very swiftly, while the older generation may have significant difficulties for quite some time. This may also depend on the country in question. In cases such as Germany, where rough approximations are very easy, it may take longer to adopt the new currency and price system than in countries such as Spain, where the rules of thumb are more complicated.

It has also been shown that, in six out of twelve cases, deviations from official conversion rates arise in a systematic fashion, implying that the public will systematically tend to over- or underestimate euro prices. In Finland, Germany and Italy the tendency will be to

ted, as the prices converted by rules of thumb appear much higher. However, assuming that such short-term effects on the volumes of consumption might occur, the consumption behaviour would return to equilibrium after some time as individuals review their saving-consumption decision over longer periods. A fall in consumption would show up in an unanticipated increase in the saving ratio, and vice versa. If individuals correct these deviations, consumption and savings respectively would catch up in subsequent periods. Therefore, real effects should remain limited over time. However, under such a scenario there could be important effects on the composition of the consumption basket. If catching up with the original consumption / savings plan occurs over a relatively short period, it is likely that this might affect the purchases of durable goods versus those of non-durable goods.

Under this caveat, the magnitude of the economic effects may in general depend on:

1. how widespread the usage of certain rules of thumb are,
2. the threshold at which individuals start using more accurate rules of thumb,
3. the size of the price elasticity of demand.

In reality, it will be extremely difficult to separate this effect from other price effects simultaneously arising, such as rounding effects, effects due to psychological price setting, etc.

An interesting question is whether the individual effects tend to offset or compound each other. This depends, again, on the specific country and currency in question. Taking Germany as an example, individuals may convert a price of 69 cents into former German Mark, by rounding the price to 70 cents, and then applying the rule of thumb 'multiply by two'. In this case, psychological price setting by firms together with the subsequent rounding up of prices, incidentally due to the same phenomenon, i.e. bounded rationality, leads to an aggravation of the overestimated prices.¹⁸ For other countries, especially where the rule of thumb under-estimates the real euro price, e.g. Belgium and Luxembourg, the rounding up and rule of thumb effects in converting will tend to offset each other.

Clearly, these two effects depend on the level of the individual prices as well as their distribution. The rounding up effect may decline in relative terms as the prices increase, while the rule of thumb effect is proportional to prices – until we decide to use more refined heuristics. Hence the aggregate effects are very difficult to determine a priori, since the exact level and distribution of consumer and retail prices would have to be known in order to draw some justified inferences.

Finally, it cannot be stressed enough that this note does not claim to provide answers. Rather, it aims to raise some questions and increase awareness of possible effects arising due to the adoption of rules of thumb during and after the cash changeover.

2.1.6 References

Arthur, B. (1994): Inductive Reasoning and Bounded Rationality, in *American Economic Review*, Vol. 84, No. 2, Papers and Proceedings, pp. 406-411.

Asplund, Marcus and Friberg, Richard (2001): The Law of One Price in Scandinavian Duty Free Stores, in *American Economic Review*, Vol. 91, No. 4, pp. 1072-1083.

De Nederlandsche Bank (2001): Quarterly Bulletin, June 2001, Amsterdam, De Nederlandsche Bank.

EOS Gallup Europe (2001): Flash Eurobarometer 98/2: Euro Attitudes (wave 2) - Euro Zone, Analytical report, June 2001, <http://www.europa.eu.int/euro>.

European Commission (2001): Quarterly Review of the Use of the Euro, First Quarter 2001, No. 6, Brussels, European Commission, <http://www.europa.eu.int/euro>.

Folkertsma, C. K. (2001): The Euro and Psychological Prices: Simulations of the Worst-Case Scenario, Research Memorandum WO&E No. 659, Amsterdam, De Nederlandsche Bank

Gigerenzer, G. Todd, P. M, and the ABC Research Group (1999): *Simple Heuristics that Make us Smart*, (Oxford: Oxford University Press).

Focus (2001): Vorsicht T€uro by Kowalski, M.; Meck, G.; Schuster, J.; Schweighöfer, K. and Stadler, R. (2001), in *Focus*, Nr. 19. pp. 228-238.

Mehta, J., Starmer, C. and Sugden, R. (1994a): The Nature of Salience: An Experimental Investigation of Pure Coordination Games, in *American Economic Review*, Volume 84, No. 3, pp. 658-73

Simon, H. (1959): Theories of Decision-Making in Economics and Behavioural Science, in *American Economic Review*, Vol. 49, No. 3, pp. 253-283.

Tagesschau (2001/07/12): ARD-Aktuell, <http://www.tagesschau.de/archiv/themen2001/euro/studie>

¹⁸ *Many prices, in particular in retailing, are psychological prices. It is clear that retailers and producers are trying to price their products in a similar fashion after the euro conversion. Hence, in converting euro back to the respective national currencies, individuals will round up prices much more frequently than in doing the reverse.*