

# **Heterogeneity of Investment Decisions and Monetary Policy : A Comparative Study between Europe and the United-States**

Frank Paolucci<sup>1</sup>

University of Reunion,  
CERESUR.

---

<sup>1</sup> University of Réunion, CERESUR.  
e-mail : frank.paolucci@univ-reunion.fr

# **Heterogeneity of Investment Decisions and Monetary Policy : A Comparative Study between Europe and the United-States**

## **Abstract:**

Many economists agree that the optimal monetary rule is the one which, in face of technological shocks, succeed in maintain low (even zero) inflation rate. Nevertheless, the complexity of production process and irreversibility of investment decisions are not really considered. For all that, in a model designed to flesh out macroeconomics dynamics, it is important not to understate the investment behaviours. We investigate a non linear investment model for the main european countries to take into account the changes in monetary regime experienced since 1970 on capital accumulation process. This econometric analysis is an original framework by using Smooth Transition Regression models, in which monetary orientations appear to play a major role in out of equilibrium dynamics of total capital stock. We also provide a comparative study of capital stock accumulation processes in France and in the United-States for the sole equipment and computer goods. It reveals that a pure inflation target leave open the possibility of an economic instability.

**Key Words:** Monetary Policy, Investment dynamics, Non linear models.

**JEL Classifications :** C22, C52, E52, E58, O57.

## **Introduction**

Many economists agree that the optimal monetary rule is the one which, in face of technological shocks, succeed in maintain low (even zero) inflation rate. The Central Banks have to remove interest rates to stabilize inflation pressures, this ultimate target is supposed to provide therefore stabilization of output gaps. This “theoretical consensus” about the aim of Central Bank is nevertheless criticable : it supposes that the apparition of a new technology is sufficient to explain the rise of productivity. They do not consider time to build, or in other words, that returns on investment can not be immediate, because dependant of capacities of firms to integrate efficiently new capital processes. By fact, it raises the question of the role of monetary policy and mainly the way by which the Central Bank can take place. This paper tries to understand this debate, usually called “rules versus discretion”. We explore the role of monetary policy process in France, Italy, Germany and The Netherlands, over the last decades. We also compare the capital stock accumulation process between France and the United-States for the sole equipment and computer goods. In the United-States case only, we consider two sub-periods (1967-1981 et 1982-1997) that correspond to the major monetary policy changes occuring in the early eighties (Romer C.D., Romer D.H. 1989 ; Clarida R., Gali J. and Gertler M. 1998 ; Romer C.D. 1999).

The plan of the paper is as follows : **Section II** presents the econometric procedure used to estimate the relation between capital accumulation and monetary interventions. **Section III** discuss about an important issue for monetary policy in face of technological shocks. **Section IV** offers concluding remarks.

### **§1 : Non linear models for investment dynamics**

Following S. Tevlin and K. Whelan (2000), we begin by implementing a linear model that considers the adjustment costs of the capital stock between two periods, and also the deviations separating the effective stock from the optimal one. Nevertheless, the Squares Cusum Tests reveal an instability of the

parameters. We thus develop a *Smooth Transition Regression* model (STR) so as to introduce the changes of regimes of the capital accumulation process. To select a relevant STR model, we apply the methodology introduced by Teräsvirta T. (1994), that is a serie of embedded (overlapping) tests.

The generic model we implement is thus the following:

$$\Delta k_t = c(1)* \Delta k_{t-1} + c(2)* \Delta Y_t + c(3)* \Delta R_t + c(4)* \Delta CF_t : \{Linear Component\}$$

$$+$$

$$(c(5)* \Delta Y_t + c(6)* \Delta R_t + c(7)* \Delta CF_t)*(1 + \exp\{-c(8)*(k_{t-1} - c(9))\})^{-1} : \{Non linear Component\} \quad (1)$$

with,  $k_t$  the capital stock ;  $Y_t$  the national product ;  $R_t$  the cost of capital ;  $CF_t$  the Cash Flow ;  $c(1)$  to  $c(4)$  the coefficients of the linear model ;  $c(5)$  to  $c(7)$  the potential parameters of the function ;  $c(8) = \gamma$ , the speed of the change of the constitutive values of the transition function ;  $c(9) = c$ , the regimes' change threshold.

One should notice that the transition functions essentially reflect the *changes of the speed* of the capital accumulation process. Comparing the transition functions does not offer any insight about changes of growth regimes, but only about dynamic reactions of the accumulation processes. We thus have the following relations:

- The speed of adjustment increases when the transition function tends to 1.
- Conversely, the speed of adjustment decreases when the transition function tends to 0.

## **§2 : Results and properties of non linear STR models**

We distinguish between the linear component and the non linear component of the models. Graphs 1-6 describe the results for the non linear component (i.e. transition functions). Tables 1-6 present the values of the coefficients of both linear and non linear components. Within STR models, the speed of adjustment of the capital stock is captured by the shape of the transition functions. By definition, those functions are defined over  $[0 ; 1]$ .

## 2.1. European countries transition functions results

Table 1

GERMANY (1981:3 – 2003:4)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.89 (**)	0.036 (*)	-0.002	0.011	-0.02	-0.2 (**)	-0.12 (**)	210 (*)	0.01 (*)
Adjusted $R^2$	0.94		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.32	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)

GERMANY TRANSITION FUNCTION (Graph 1)

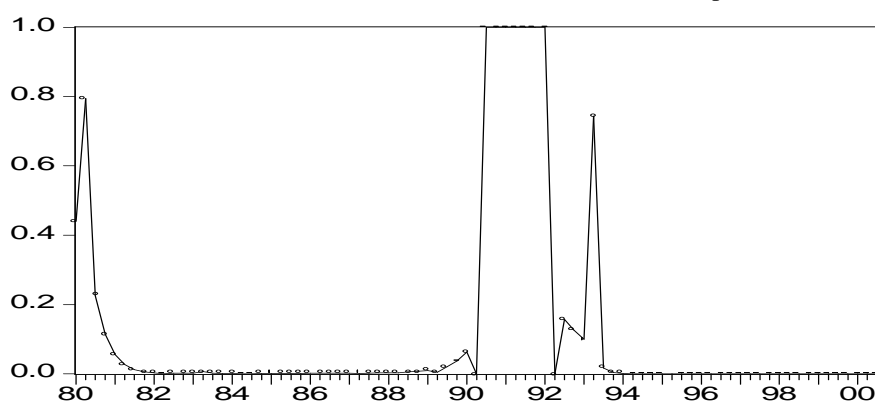


Table 2

FRANCE (1980:2 – 2003:4)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.88 (**)	0.08 (**)	-0.004 (*)	0.003	0.12	-0.1	0.12 (**)	320 (*)	0.002 (**)
Adjusted $R^2$	0.77		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.24	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)

FRANCE TRANSITION FUNCTION (Graph 2)

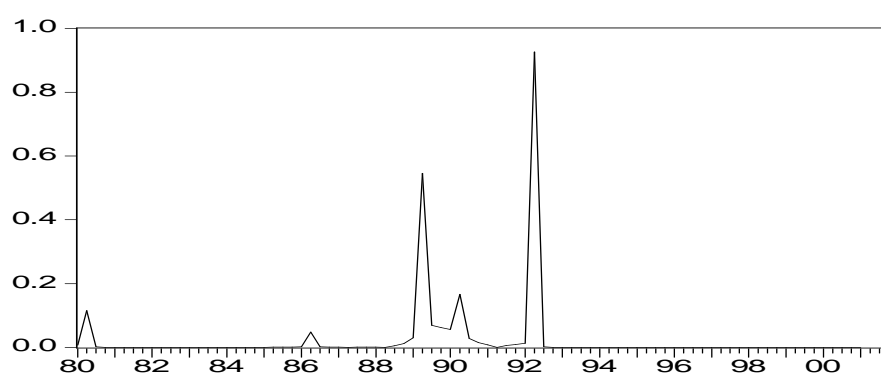


Table 3

ITALY (1980:1 – 2002:4)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.88 (**)	0.20 (**)	-0.015 (**)	0.013	0.08	-0.03	0.012 (*)	256 (*)	0.005 (**)
Adjusted R <sup>2</sup>	0.85		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.42	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)

ITALY TRANSITION FUNCTION (Graph 3)

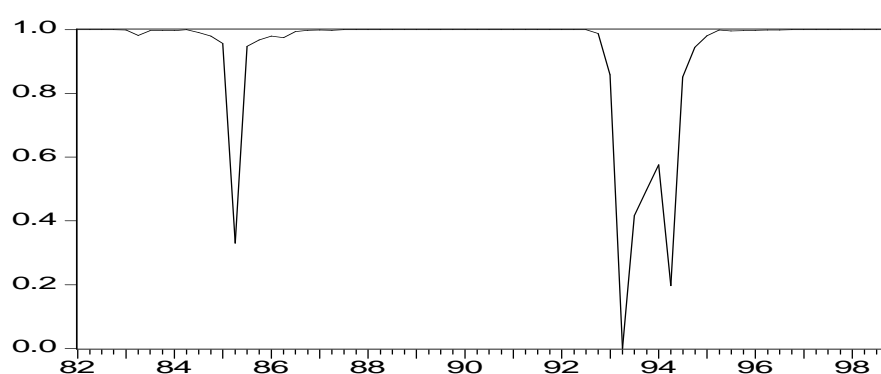
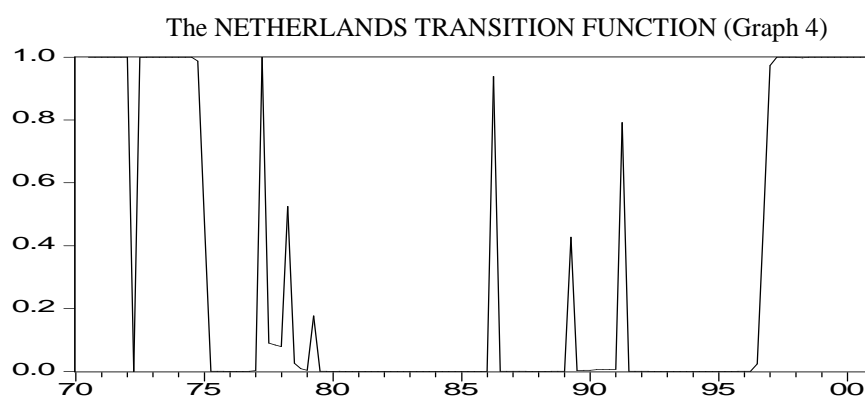


Table 4

The NETHERLANDS (1970:1 – 2003:3)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.66 (**)	0.12 (**)	-0.002	0.19 (**)	-	-0.01 (*)	-	231 (*)	0.002 (**)
Adjusted R <sup>2</sup>	0.90		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.12	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)



From Graphs above, we observe that the speed of adjustment of the capital stock and its (time-lagged) reactions to exogenous shocks are thus different from one country to another (see for example the reactions of the various transition functions occurring during the years 1989 ; 1991 and 1992-93). We also see that Italy is the only country that exhibits an acceleration of its capital stock accumulation process during the 1980-1998 period. Other countries (France, The Netherlands and Germany) are all in a decelerating phase, except for Germany during the first years of its political re-unification. One should note also that, since 1995, The Netherlands experiment a phase of sustained acceleration of the capital stock accumulation process. Since 1995, we can isolate two groups of countries : Italy and The Netherlands are in a period of acceleration, while France and Germany stay in a phase of deceleration (See §2, Graphs 1-4). Moreover, the exogenous variables are different.

They also have a different impact on investment dynamics depending on the country and the periods. Those results are extensively commented in Section 3 (§3). Next sub-section describes the comparative study between France and the United-States.

## 2.2. Comparative Study between France and the United-States (Equipment and computer goods).

Table 5

USA (1982:1 – 2004:2)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.87 (**)	0.23 (**)	-0.01	0.033	-0.1	-	-	347 (*)	0.009 (**)
Adjusted $R^2$	0.89		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.58	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)

USA TRANSITION FUNCTION (Graph 5)

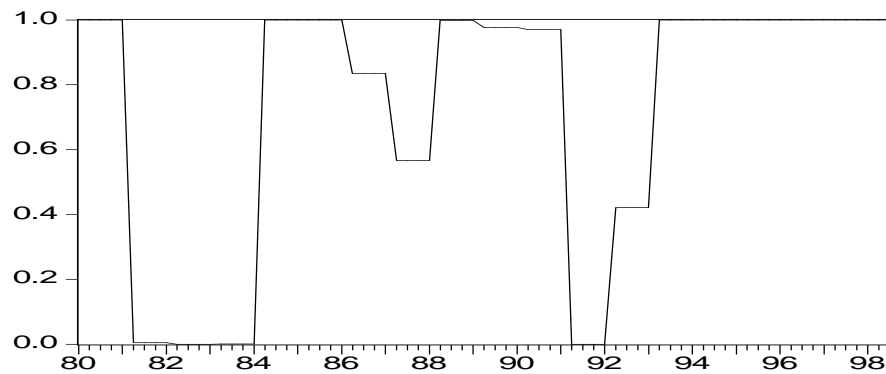
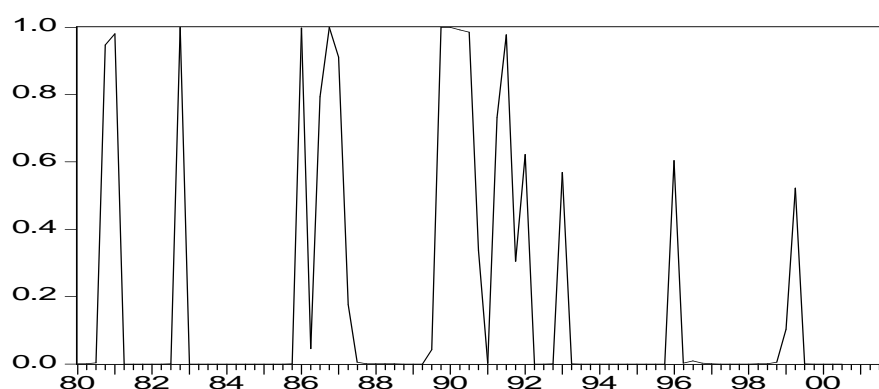


Table 6

FRANCE (1981:1 – 2004:4)								
C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)
0.89 (**)	0.17 (*)	-0.04 (*)	0.07	-	-	0.13 (*)	262 (*)	0.018 (**)
Adjusted R <sup>2</sup>	0.55		Prob (F- Statistic)	0.000		Breush- Godfrey Stat	0.24	

(Between brackets : coefficients values; \*\* : significant at a 1% threshold ; \* : significant at a 5% threshold)

FRANCE TRANSITION FUNCTION (Graph 6)



From Graphs 5-6, we notice that the reduction of the capital stock basis greatly modifies the shape of the adjustment process. Comparing Graph 2 and 6, we observe a greater volatility of the french transition function when the capital stock is bounded to equipment and computer goods only.

Next section presents our main results. We focus on the interaction between monetary variables and investment decisions. For this purpose, we distinguish between the linear (i.e. capital accumulation *per se*) and the non linear component of the models (i.e. speed of adjustment of the capital stock/transition dynamics).

### **§3 : Capital accumulation and adjustment processes**

#### **- On capital accumulation (linear component)**

We observe that France and Italy are (weakly) sensible to variations of the short term interest rate, and not sensible to liquidity constraints (Cash Flow).

Conversely in Germany and in the Netherlands, the short term interest rate has a non significant impact on capital accumulation dynamics, while liquidity constraints have a strong influence, particularly in the Netherlands. We also notice that in the four countries, investment expenditures positively react to variations of the amount of sales, but that these reactions are contrasted from one country to another. Indeed, the impact of the real variables (variations of Sales) is stronger in the Netherlands and in Italy, if we compare to France and Germany. For the same reasons, the monetary interventions have a different impact according to the nature and size of the capital stock. Indeed, the short term real interest rate in France and the United-States has a significant impact when the capital stock is equipment and computer goods. This result is linked to the fact that the variations of the short term interest rate affect essentially “flexible investment decisions”, i.e. decisions that could be reported at a longer term. Such decisions concern the necessary improvements of existing production capacities, and should be distinguished from replacement investment decisions. Indeed, replacement investment decisions are relatively independent of the variations of the short term interest rate. Consequently, the long term evolution of the capital stock is less sensible to the evolution of the short term interest rate as it incorporates a larger scale of capital goods -including replacement investment goods.

For the United-States, the STR model confirm the impact of the major monetary policy change that occurs in the early eighties, on the capital accumulation dynamics.

### **- On the speed of adjustment of the capital stock (non linear component)**

Our econometric results suggest the following observations:

1. The reactions of the capital accumulation process to major exogenous shocks (Oil crisis, 1991 Iraqi war, German re-unification ... etc.) are specific to each country. For example, France and The Netherlands react quite immediately to the first 1991 Iraqi crisis while Italy and Germany are weakly affected.
2. Since 1992-1993, we observe a decrease of the speed of accumulation which is linked to the global economic depression and is common to all countries. Only the Netherlands and Italy experiment, since 1994-1995, an increase of the speed of capital accumulation. France and Germany are still trapped in a phase of deceleration.
3. The volatility of the speed of adjustment is different depending on the countries, the size of the capital stock and the periods we consider. More precisely, and as an illustration, if we observe the evolution of the speed of the transition in France, for the 1981-1999 period and in the United-States for the 1982-1997 period, we conclude to higher volatility in France.
4. The variables that are involved in the transition functions are not substitutes and are calibrated differently from one country to another.
5. For the United-States, it seems that the variations of the interest rate are “neutral” over the observed changes of the speed of capital accumulation. This means implicitly that monetary interventions are no more a primary cause for the distortions of the transition function. Moreover the period of stability corresponds to an acceleration of the speed of capital accumulation dynamics. The observed changes of the speed of capital accumulation are linked to the evolution of non

monetary variables (variations of the amounts of sales) and also to exogenous shocks.

6. For european countries, the interpretation of the impact of monetary policies on investment decisions is less clear than in the US case. If the monetary variable has a significant impact on the transition function in the Netherlands and -above all- in Germany, its impact is non significant in France and Italy. In spite of this diversity, we observe for example a strong similarity of the shape of the transition functions between France and Germany. This means that even in structurally similar countries, exogenous variables have a different impact on accumulation processes, particularly monetary variables.

Now, if we compare the linear and non linear components of the models, we notice major differences between the linear and non linear components. The last remark raises a serie of questions:

- Why Sales become non significant in all countries?
- Why short term interest rate becomes significant for Germany and The Netherlands?
- Why investment adjustments become sensible to liquidity constraints in France and in Italy? And conversely,
- Why investment adjustments become non sensible to liquidity constraints in The Netherlands?

To answer those questions is not a trivial task. The answer is essentially linked to the diversity of the national contexts of production within the euro zone. If the speed of adjustment of the capital stock (non linear component) is influenced by liquidity constraints in France and Italy, it is certainly because self-financing is a current investment strategy in those countries.

Then, if we suppose that the Bundesbank is (historically) a monetary reference for the Banque de France or the Banca di Italia, we could relevantly assume that the short term interest rate is higher in France and Italy. Consequently in Germany, the monetary variable influences investment adjustments, while French and Italian investors are more sensible to liquidity constraints.

Another question is related to the observation that the variations of sales become non significant in all countries. Since real variables are known to have a stronger impact on long term accumulation processes (linear component), this is not a surprising observation. The speed of adjustment of the capital stock is thus less sensible to the variations of sales, compare for example to the evolution of Cash-Flow in France and Italy.

#### **§4 : Conclusion**

Estimations of STR models confirm the idea that (inter)national heterogeneity is a major feature of investment decisions, particularly in Europe. We find more precisely that the reactions of the adjustment process of the capital stock are specific to each economic situation, and are strongly influenced by the objectives of the monetary policy within each country.

We also observe that, even in countries which are similar from an aggregate economic point of view, the reactions to exogenous shocks are fundamentally dissimilar. Stabilizing the reactions of economic decision-makers, for example to monetary changes or fiscal changes, is then a serious task since it could greatly simplify the coordinating and regulatory role of european institutions by improving convergence and reducing structural disparities. In this respect, and because of its crucial position, the European Central Bank (ECB) is confronted to serious challenges, and the stabilization of investment decision-makers' expectations is part of these challenges. Improving agents' confidence for the ECB's monetary orientations, is then a decisive aspect of the political debate about the objectives, the means and the efficiency of monetary policies within the European Union. The expected effects could be a reduction of the range of investment decisions' volatility, and a validation of the major ECB's objectives.

## References

Clarida R., Gali J. and Gertler M. (1998), Monetary Policy Rules and Macroeconomic Stability : Evidence and some theory, N.B.E.R. Working Paper n°6442, March, 1998.

Hicks J. (1973), Capital and Time, Oxford Clarendon Press.

Teräsvirta T. (1994), Specification, estimation and evaluation of smooth transition autoregressive models, Journal of the American Statistical Association, 89, pp.208-18.

Romer C.D., Romer D.H. (1989), Does Monetary Policy Matter? A new test in the spirit of Friedman and Schwartz, N.B.E.R. Macroeconomics Annual 1989.

Romer C.D. (1999), “Changes in Business Cycles : Evidence and Explanations”, in *Journal of Economic Perspectives*, 13, Spring, pp. 23-44.

Tevlin S., Whelan K. (2000), Explaining the Investment Boom of the 1990s, Working Paper Series N.B.E.R. March, 2000.

Tsonas E.G., Christopoulos D.K. (2003), Maastricht and real convergence : european evidence from threshold and smooth transition regression models”, in *Journal of Policy Modeling*, 25, pp.43-52.

Van Dijk D., Teräsvirta T. and Franses P.H. (2000), Smooth Transition AutoRegressive Models – A Survey of Recent Developments, Econometric Institute Research Report EI2000-23/A.