The Role of the Business Cycle in Exchange Rate Pass-Through: The Case of Finland

By: Nidhaleddine Ben Cheikh and Christophe Rault

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Nidhaleddine Ben Cheikh[a] and Christophe Rault[b,*]

[a]*ESSCA School of Management, PRES UNAM, 1 Rue Lakanal, 49000 Angers (France).*

[b]*LEO (UMR CNRS 7322), University of Orléans, Rue de Blois-B.P.6739, 45067 Orléans Cedex 2, (France); IZA,and CESifo (Germany) ; and William Davidson Institute at the University of Michigan, Ann Arbor, Michigan (United States)*

Abstract

In this paper we investigate whether exchange rate pass-through (ERPT) responds nonlinearly to economic activity along the business cycle. Using quarterly data spanning the period 1975:1 to 2011:1, we explore the existence of nonlinearities in ERPT to CPI inflation for the Finnish economy. Within a logistic smooth transition framework, our investigations reveal a strong regime-dependence of pass-through, depending positively on economic activity. Besides, point estimates indicate that the long-run pass-through coefficient is equal to 0.15% (weakly significant) when GDP growth is below a threshold of 3%. However, when the Finnish economy's growth rate speeds up - above the threshold of 3% - ERPT elasticity increases to 0.47%. These results provide some useful guidance on how policymakers should act over different phases of the business cycle. More specifically, monetary policy should factor in the nonlinear mechanism of ERPT over the business cycle in order to prevent exchange rate movements from fueling a continuous inflationary process.

Keywords: Exchange rate pass-through, Inflation, Business cycle, Smooth Transition Regression models

J.E.L classification: C22, E31, F31

[*]Corresponding author: E-mail address: chrault@hotmail.com. Web-site: http://chrault3.free.fr.

1. Introduction

Understanding how a significant number of exchange rate movements are passed through to changes in consumer prices has important implications for several macroeconomic issues, including monetary policy effectiveness, adjustment in trade balances and optimal choice of exchange rate regime. However, the bulk of the empirical literature on exchange rate pass-through (ERPT) relies on time series or cross country analysis that assumes the constancy of estimated coefficients. In spite of the usefulness of such analysis, it offers little guidance on how policymakers should act over different macroeconomic regimes, such as along different phases of the business cycle. As argued by Goldfajn and Werlang (2000), in periods when the economy is booming, foreign and domestic firms may have more incentives to pass currency changes through prices, rather than in periods of recession when their sales are already falling. This means that ERPT may be greater in periods of prosperity than in periods of economic slump. Goldfajn and Werlang (2000) provide empirical evidence of asymmetric behaviour of ERPT over the business cycle in a linear panel data framework. They find that depreciations have a higher pass-through to prices during expansion periods.

In the more recent literature, the business cycle is also pointed out as an important source of nonlinearity for the pass-through. For instance, Correa and Minella (2006) suggest using a nonlinear regime-switching model, namely a threshold regression model, where the transition across regimes is abrupt, and provide support of a nonlinear dynamic behavior of ERPT with respect to economic activity in Brazil. In a similar vein, NOGUEIRA JR. and LEON-LEDESMA (2008) employ a nonlinear smooth transition regression (STR) framework to investigate the presence of nonlinearities between ERPT and output growth. They find that economic activity is an important driving factor for the nonlinearity in ERPT in 3 out of 6 Inflation Target countries in their sample.

Following the mentioned studies, our paper raises the question of whether the degree of pass-through is affected or not in a nonlinear way by the business cycle. As in Nogueira Jr. and Leon-Ledesma(2008), we use a logistic STR model where the transition between states is rather smooth. However in contrast to that paper, our study deals with the case of Finland, due to the highly volatile character of boom-bust episodes experienced by the country. Indeed, during the pre-EMU era, Finland went through an intense boom in the late 1980s, followed by a sharp contraction in the early1990s and an exceptionally long recovery, which lasted roughly until the turn of the twentieth century. Regarding the causes of the boom-bust cycle, several studies have put forth the role of exchange rate policy among other factors (See Jonung, Kiander, and Vartia, 2008; Jonung and Hagberg, 2005). Finland has experienced several different exchange rate regimes, evolving from a hard peg policy to a floating regime in 1992, and, finally, joining the Euro area in 1999. Thus, we expect that the boom-bust cycle episodes, combined with the evolution of the exchange rate regime, would generate a nonlinear mechanism in ERPT for the Finnish economy.

The aim of our paper is to contribute to the existing empirical literature and to the policy debate regarding the sensitivity of CPI inflation to currency fluctuations. The novelties of this paper are twofold: First, we seek to shed further light on the relationship between the extent of pass-through and economic activity, using a nonlinear framework. We think that linear models, as employed by Goldfajn and Werlang (2000), are possibly not an adequate representation for this kind of exercise. We need a relevant econometric methodology to capture a possible asymmetric behavior of the ERPT mechanism, before drawing any policy conclusions. To the best of our knowledge, only the study of Nogueira Jr. and Leon-Ledesma (2008) has used STR models to capture nonlinearity in pass-through with regard to the business cycle. Second, we focus on the intriguing case of the Finnish economy due to the intense boom-bust cycle that it experienced during the 1980s and the 1990s. At the same time,

Finland went through different exchange rate arrangements justifying the need for a thorough exploration of the "ERPT-Business cycle" correlation. No other study has applied a nonlinear STR estimation approach in this context.

The remainder of the paper is structured as follows: Section 2 offers more details about the Finnish economy. Turning to the empirical part of our study, Section 3 presents the applied econometric specifications and the data, while Section 4 reports the main empirical results. Finally, Section 5 concludes.

2. A brief overview of the Finnish economy

Finland constitutes an interesting case for studying the relationship between ERPT and the business cycle. Indeed, the economy has gone through different macroeconomic developments in the last four decades, experiencing higher variability of some macroeconomic variables - namely real GDP, inflation and exchange rate – during the pre-EMU era (see Figure 1).

In the 1970s, inflation increased sharply and the economy slowed down as Finland was hit by the two severe oil price shocks known as the OPEC crises. In contrast to most other European countries, Finland did not experience a major rise in unemployment in the aftermath of the oil crises of the 1970s. The recovery of the Finnish economy was facilitated by the devaluations of the markka in 1977 and 1978. Real wages also declined during 1977-78 and 1980-81, due to high inflation rates, and real income growth increased strongly in 1979 and remained high during the second oil price shock.

In the aftermath of the oil crisis, Finland pursued nominal exchange-rate targeting policies, where the exchange rate of the markka (the Finnish currency) was used as a nominal anchor in an attempt to eliminate the inflation-devaluation cycle. This policy was relatively

successful for several years. The exchange rate remained fixed within a band of 4.5% from October 1982 to November 1988 and within a band of 6% from November 1988 to March 1989. The Finnish economy grew throughout the 1980s, fuelled by the deregulation of financial markets, with a large credit boom and a rapid increase in asset prices, investment and consumption. Signs of an overheated economy began to show in the latter part of the 1980s when inflation rates started to increase quickly from 2.3% in 1986 to about 7% in 1989-90.

In the early 1990s, Finland underwent a deep depression as a part of the collapse of trade with the former Soviet Union in 1991. Between 1990 and 1994 the cumulative loss was 26.4 percentage points for real income and 24.0 percentage points for employment. The markka came under severe pressure as the depression grew deeper. In November 1991, the government enforced a devaluation of the currency of approximately 12%. In the autumn of 1992, the "hard-currency" policy became unsustainable and the Bank of Finland had to let the markka float.[1]

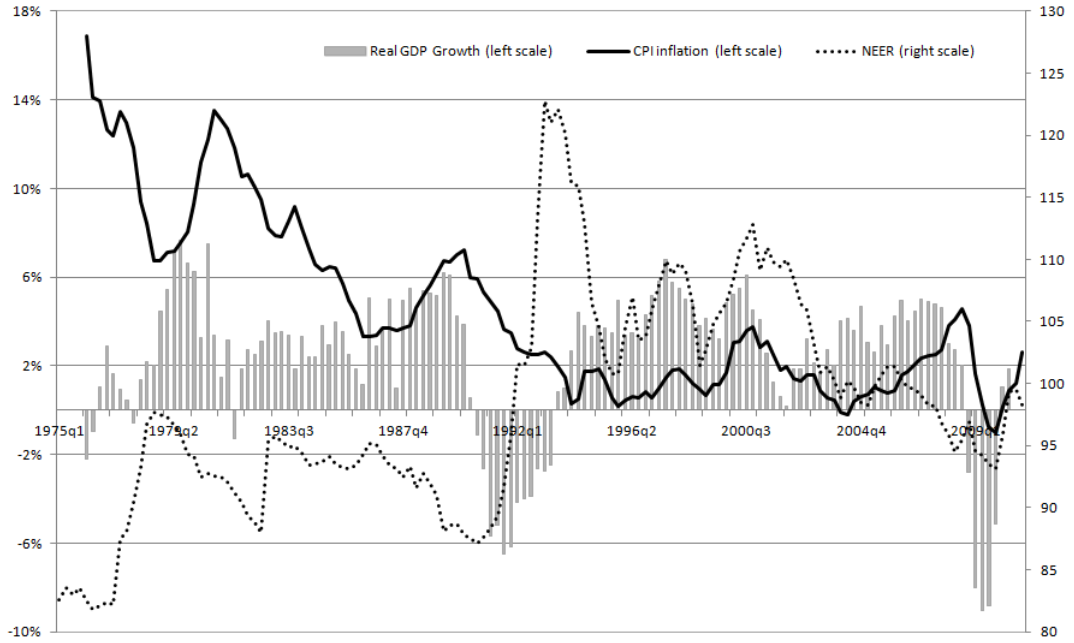
The decline in GDP stopped and a turnaround took place in the autumn of 1993.The recovery was driven by a strong upturn in exports and during the remainder of the 1990s the economy grew rapidly and new industries emerged.[2] In the aftermath of the early 1990s crisis, the Bank of Finland introduced a domestic inflation target. This target gradually gained credibility, as witnessed by the narrowing interest rate differential between Finland and Germany. The rate of inflation was kept at a low level, around two percent per annum throughout the period 1995-2000. The period of floating ended in October 1996 when Finland joined the Exchange Rate Mechanism (ERM). In 1999 the markka was pegged to the Euro,

[1]According to Ketelsen and Kortelainen (1996), the evolution from fixed to floating entailed a structural change in the Finnish pass-through elasticities.

[2]The structure of the economy changed fundamentally. The old forestry and engineering industries became less important while high-tech sectors such as the mobile phone industry dominated the recovery process (see Jonung and Hagberg, 2005).

after Finland became a member of the EMU in 1995.Euro. During the post-EMU era, inflation in Finland has remained for the most time within the range of the European Central Bank's definition for price stability and has been among the lowest ones in the Euro area.

Figure 1: Cycle, inflation and exchange rate in Finland



3. Econometric specifications and data

In this section, we estimate a logistic STR (LSTR) pass-through equation in the spirit of Ben Cheikh (2012); Nogueira Jr. and Leon-Ledesma (2011); Shintani, Terada-Hagiwara, and Tomoyoshi (2013). This equation allows us to test whether ERPT responds nonlinearly to the business cycle. This can be described as a nonlinear backward-looking Phillips curve as follows:

$$\pi_t = \alpha + \sum_{j=1}^{N} \lambda_j \pi_{t-j} + \sum_{j=0}^{N} \psi_j \Delta y_{t-j} + \sum_{j=0}^{N} \delta_j \Delta w^*_{t-j} + \sum_{j=0}^{N} \beta_j \Delta e_{t-j} + \left(\sum_{j=0}^{N} \phi_j \Delta e_{t-j} \right) G(s_t; \gamma, c) + \varepsilon_t, \quad (1)$$

, where π_t is the CPI inflation rate, Δe_t is the rate of depreciation of the nominal effective exchange rate, Δy_t is the output growth, used to capture changes in domestic demand conditions, and Δw_t^* is the changes in foreign producer cost. $G(s_t;\gamma,c)$ is the logistic transition function driving the nonlinear dynamic. $G(s_t;\gamma,c)$ is bounded between 0 and 1, and depends upon the transition variable s_t, the slope parameter γ and the threshold parameter c. γ is also called the speed of transition which determines the smoothness of the switching from one regime to the other. A measure of the economic activity is considered as a transition variable $s_t = \Delta y_{t-j}$ in equation (1).[3]

In our analysis, we focus on the long-run exchange rate pass-through (*LR ERPT*) which is given by the following long-run time-varying coefficients:

$$LR\ ERPT = \left[\sum_{j=0}^{N}\beta_j + \sum_{j=0}^{N}\phi_j\, G(s_t;\gamma,c)\right] \Big/ \left[1 - \sum_{j=1}^{N}\lambda_j\right] \qquad (2)$$

The ERPT coefficient can adopt different values depending on whether the transition variable s_t is below or above the threshold value. If $(s_t - c) \to -\infty$, i.e. the economic activity is below the threshold, pass-through coefficient is equal to: $LR\ ERPT = \sum_{j=0}^{N}\beta_j \big/ \big(1 - \sum_{j=1}^{N}\lambda_j\big)$. This corresponds to the pass-through elasticity during *low activity regime* (when $G(s_t;\gamma,c) = 0$). However, if $(s_t - c) \to +\infty$,i.e. the economic activity is above the threshold, then long-run pass-through coefficient becomes:$LR\ ERPT = \big(\sum_{j=0}^{N}\beta_j + \sum_{j=0}^{N}\phi_j\big) \big/ \big(1 - \sum_{j=1}^{N}\lambda_j\big)$. The latter corresponds to the degree of pass-through during *high activity regime* when $G(s_t;\gamma,c) = 1$).

The nonlinear pass-through equation (1) is estimated for the Finnish economy using quarterly data spanning the period 1975:1 to 2011:1. All the data we use are taken from the OECD's Economic Outlook database, except for exchange rate series which are obtained

[3]More details about the transition variable are given in section 4.

from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). Inflation rates series represent the quarterly change in the consumer prices index (CPI). Output growth is constructed using the rate of growth of the real GDP. The nominal exchange rate is defined as domestic currency units per unit of foreign currencies, which implies that an increase represents a depreciation for the home country. Finally, to capture changes in foreign costs we follow Bailliu and Fujii (2004) by constructing an exporter partners' cost proxy. In logarithms, this is measured as follow: $w_t^* \equiv q_t + ulc_t - e_t$, where q_t is the unit labor cost (ULC) based real effective exchange rate, ulc_t is the ULC in the domestic country and e_t the nominal effective exchange rate.[4] To determine the lag length of the variables entering equation (1), we follow Van Dijk, Teräsvirta, and Franses (2002) by adopting a general-to-specific approach to select the final specification. We start with a model with a maximum lag length of $N = 4$, and then sequentially drop the lagged variables for which the t-statistic of the corresponding parameter is less than 1.0 in absolute value.

4 Empirical results

In this section, we raise the question of whether the degree of ERPT is affected by the business cycle in a nonlinear way. The sparse empirical evidence on the issue of nonlinearity has suggested a positive relationship between economic activity and the transmission of exchange rate. Intuitively, markups and profit margins are procyclical, hence prices would move in the same direction as the business cycle, increasing during expansion and decreasing during an economic slowdown.[5] Therefore, in periods when the economy is booming, foreign

[4]Individual series in level are non-stationary according to the efficient unit-root test suggested by Elliott and al. (1996), and the Kwiatkovski-Phillips-Schmidt-Shin (KPSS, 1992) test, extended by Carrion-i-Silvestre and Sanso (2006). We also tested for the presence of a cointegrating relationship between variables (in levels) entering the pass-through equation using the well-known cointegration tests of Johansen (1988, 1991), and we report that variables are not cointegrated. Results are available upon request. Consequently, log differences of the variables are used in the estimation of the logistic STR pass-through equation given in equation (1).

[5]The power of employees in wage negotiations is also more important during recovery periods resulting in a higher propensity of producers to price increases.

producers are more willing to pass through cost increases such as those coming from the exchange rate. As a result, ERPT would be greater in periods of prosperity than in periods of slump. In accordance with this argument, García and Restrepo (2001) explain that the lower ERPT in Chile in the 1990s is due, in part, to the positive dependence of pass-through to economic activity. According to the authors, the negative output gap during this period offset the inflationary impact of exchange rate depreciation. To the best of our knowledge, only the study of Nogueira Jr. and Leon-Ledesma (2008) uses the STR model to capture nonlinearity in ERPT with respect to the business cycle. The authors investigated the presence of nonlinearities in a sample of 6 developed and developing Inflation Target countries. Our paper, unlike Nogueira Jr. and Leon-Ledesma (2008), deals with the Finnish case. We expect that the boom-bust cycle episodes, combined with the evolution of the exchange rate regime, would generate a nonlinear mechanism in ERPT for the Finnish economy.

In our empirical specifications, economic activity is considered to be the driving factor in the nonlinear dynamic. As a proxy for economic activity along the business cycle, we consider the rate of growth of the real GDP.[6] Thus, lagged real GDP growth is considered the transition variable($s_t = \Delta y_{t-j}$) in the STR model. When its values exceed an estimated threshold, these can be interpreted as periods of expansion, i.e. a *high activity regime*. While, when values are below the threshold, these are periods of economic slowdown or recession, i.e. a *low activity regime.* The choice of the adequate lagged real GDP growth as a transition variable by means of linearity tests is reported in Table 1. The linearity tests are conducted for each lagged output growth $\Delta y_{t-j}$with$j = 1,2,3,4$.[7]

[6]In their studies Goldfajn and Werlang (2000) and Correa and Minella (2006) used the output gap as a proxy for economic activity. However, as explained by Nogueira Jr. and Leon-Ledesma (2008), the use of an ad hoc detrending process like the output gap might eliminate valuable information from the data.
[7]More details on linearity tests are provided in Teräsvirta (1994, 1998).

Table 1: Tests for linearity against STR models Finland over 1975:1 to 2011:1

	Δy_{t-1}	Δy_{t-2}	Δy_{t-3}	Δy_{t-4}
H_0	0,319	0,039	0,039	0,037
H_{04}	0,701	0,030	0,035	0,139
H_{03}	0,221	0,412	0,696	0,809
H_{02}	0,201	0,169	0,053	0,005
Specification	Linear	LSTR	LSTR	LSTR

Note: The numbers are p-values of F versions of the LM linearity tests. The first row shows the results of the test of linearity against the alternative of STR nonlinearity. The second, third and fourth rows are the p-values of the sequential test for choosing the adequate transition function. The decision rule is the following: if the test of H_{03}yields the strongest rejection of the null hypothesis, we choose the exponential STR (ESTR) model. Otherwise, we select the logistic STR (LSTR) model. The last row reports the selected model.

As reported in the first row of Table 1, there is strong evidence of presence of nonlinearities. Once linearity has been rejected, the sequence of nested null hypotheses is conducted in order to choose the adequate transition function, *i.e.* logistic or exponential. In fact, economic intuition must be also considered in making the choice of the relevant STR specification. According to van Dijk, Teräsvirta, and Franses (2002), logistic STR models are more appropriate in describing processes whose dynamic properties are different in expansions from what they are in recessions, i.e. when economic activity is above or below a given threshold. Effectively, as shown from the second to the last row in Table 1, logistic specification is more appropriate in describing the nonlinear behaviour of pass-through.

Concerning the estimation of equation (1), a nonlinear least squares (NLS) estimation technique is employed, providing estimators that are consistent and asymptotically normal (see Teräsvirta, 1994, 1998). Estimation results from the logistic STR pass-through equation (1) are summarized in Table 2. In addition to the estimated threshold level and the speed of transition, we report long-run ERPT coefficients for the two extreme regimes, *i.e.* the low activity regime and the high activity regime. We also compute the sum of squared residuals ratio ($\mathrm{SSR}_{\mathrm{ratio}}$) between the logistic STR model and the linear specification which suggests a better fit for the nonlinear model. We also check the quality of the estimated LSTR models by

conducting several misspecification tests. We select the LSTR model with the transition variable $(s_t = \Delta y_{t-2})$. This specification passes the main diagnostic tests, i.e. no error autocorrelation, no conditional heteroscedasticity, parameter constancy and non remaining nonlinearity.

Table 2: Estimation results of LSTR pass-through equation over 1975:1 to 2011:1

$$\Delta\pi_t = \underset{(0,193)}{0,001} + \underset{(0,000)}{0,673}\Delta\pi_{t-4} + \underset{(0,308)}{0,010}\Delta e_t + \underset{(0,034)}{0,031}\Delta e_{t-1} + \underset{(0,091)}{0,008}\Delta e_{t-4} + \underset{(0,319)}{0,018}\Delta w_t^* + \underset{(0,013)}{0,102}\Delta w_{t-1}^* + \underset{(0,050)}{0,078}\Delta y_t + \left[\underset{(0,056)}{0,070}\Delta e_t + \underset{(0,082)}{0,023}\Delta e_{t-1} + \underset{0,105}{0,012}\Delta e_{t-4}\right] G(s_t;\hat{\gamma},\hat{c}) + \varepsilon_t$$

$$G(s_t;\hat{\gamma},\hat{c}) = \left(1 + \exp\left\{-\underset{(0,193)}{3,740}\left(\Delta y_{t-2} - \underset{(0,000)}{0,029}\right)\Big/ 0,033\right\}\right)^{-1}$$

$R^2 = 0,790;\ SSR_{ratio} = 0,755;\ pJB = 0,364;\ pLM_{AR(4)} = 0,507;$
$pLM_{ARCH(4)} = 0,228;\ pLM_c = 0,642;\ pLM_{RNL} = 0,787$

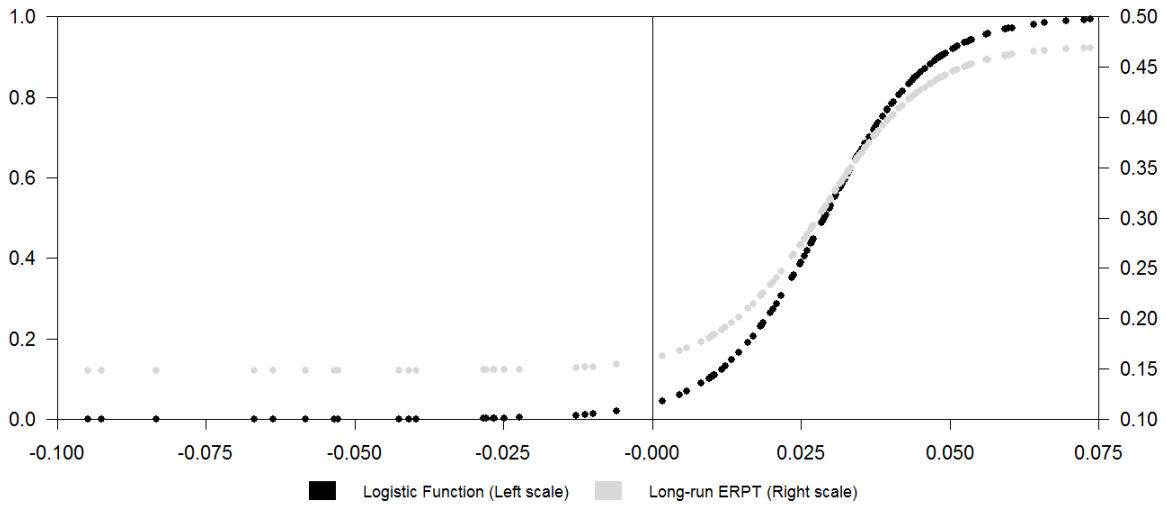
ERPT Elasticities	
Low Activity Regime: $G = 0$	**High Activity Regime:** $G = 1$
$LR\ ERPT = \underset{(0,121)}{0,148}$	$LR\ ERPT = \underset{(0,009)}{0,471}$

Note: The table reports estimation of water consumption equation from LSTR models. LR ERPT are pass-through elasticities for low and high activity regimes. The transition parameter γ is standardized by dividing it by the sample standard deviation of the transition variable s_t, which is equal to $\hat{\sigma}_s = 0.017$. Numbers in parentheses are the estimated standard errors. R^2denotes the coefficient of determination and $SSR_{ratio}$is the ratio of sum of squared residuals between LSTR model and the linear specification. The following rows corresponds to the misspecification tests: $pJB$is the p-values of Jarque-Bera normality test,$pLM_{AR(4)}$ is the p-values of the LM test of no error autocorrelation up to forth order, $pLM_{ARCH(4)}$ is the p-values of the LM test of no ARCH effects up to fourth order, $pLM_c$is the p-values of the LM test of parameter constancy and $pLM_{RNL}$is the p-values of the LM test of no remaining nonlinearity.

According to Table 2, the threshold value of real GDP growth is significant and is about 3%, signalling the presence of two economic activity regimes. Regarding speed of transitionγ, our results indicate relatively moderate values, proof of a smooth transition

between low and high activity regimes.[8] Concerning pass-through estimates, there is significant nonlinear ERPT with regard to the business cycle. In other words, we find that pass-through elasticities are significantly different between low and high activity regimes for the Finnish economy. Also, we denote that the extent of pass-through depends positively on economic activity (see Figure 2). In other words, the exchange rate transmission to CPI inflation is significantly greater when output growth is above a certain threshold. The long-run pass-through coefficient is equal to 0.15% (weakly significant) when GDP growth is below 3%, i.e. during economic slowdown. However, in periods when the Finnish economy grows at a faster pace - above the threshold of 3% - ERPT elasticity increases to 0.47%.

Figure 2: Estimated logistic functions and long-run ERPT as a function of past output growth



We have also plotted both the estimated transition functions and the long-run ERPT as a function of the transition variable lagged real GDP (see Figure 2). The plot reveals the regime-dependence of ERPT on the business cycle. The positive connection between long-run pass-through and real GDP growth is quite clear. These results are consistent with the existing empirical literature dealing with the relationship between pass-through and the business cycle. Indeed, in their logistic STR model, Nogueira Jr. and Leon-Ledesma (2008) found the same

[8]According to VAN DIJK, TERÄSVIRTA, and FRANSES (2002) estimates of γmay appear to be insignificant. This should not be interpreted as evidence of weak nonlinearity.

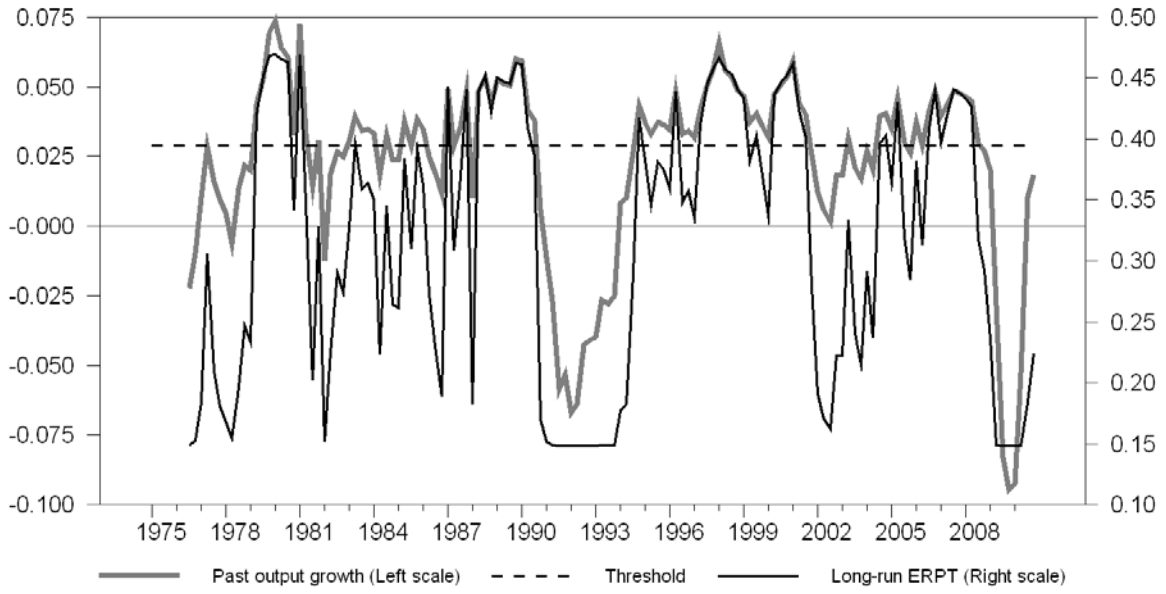
positive link between pass-through and economic activity. This is true for 3 out of the 6 Inflation Target countries in their sample.

Similarly, in a threshold autoregressive (TAR) framework, Correa and Minella (2006) suggest that when the output gap is above a certain threshold, ERPT becomes higher in Brazil. As is well-known, within TAR models, the transition across regimes is rather abrupt. However, we think that this assumption is unrealistic at the macroeconomic level, since there is a great diversity across foreign firms when forming opinions about the economic environment in the importing country. That's why in our study we assume that the transition from one regime to the other is rather gradual in using nonlinear smooth transition model. Besides, our results confirm the claim of Ketelsen and Kortelainen (1996). Although they did not test for the presence of nonlinearities, these authors suggested the possibility of a structural change in ERPT due to the different exchange rate regimes that have existed in the Finnish economy.

To give further insight into this plausible positive relationship, we plot time-varying ERPT coefficients over the 1975-2011 period (see Figure 3). On the same graphs, we also report lagged real GDP growth and the estimated threshold level. A visual inspection of this plot shows that the extent of pass-through into consumer prices was higher, for example, during the intense boom in the late 1980s or in the recovery phase of 1994-2000. However, over the turbulent years of the early 1990s, the sensibility of consumer prices to markka changes was very low, not exceeding 0.15%. Our findings of regime-dependence of pass-through to the business cycle have important implications for policy. When the economy enters a phase of overheating with rising inflation, this is exacerbated by the transmission of exchange rate changes to consumer prices. Thus, these results provide some useful guidance on how policymakers should act over different phases of the business cycle. To prevent the changes stemming from exchange rate movements from fuelling a continuous inflationary

process, monetary policy should factor in the nonlinear mechanism of ERPT over the business cycle.

Figure 3: Time-varying long-run ERPT and past output growth



5. Summary and concluding remarks

In this paper we have investigated a nonlinear mechanism in the exchange rate pass-through with respect to economic activity along the business cycle. Using quarterly data spanning the period 1975:1 to 2011:1, we explore the existence of nonlinearities in ERPT to CPI inflation in the Finnish economy. Finland constitutes an interesting case for studying the relationship between ERPT and the business cycle due to the higher variability of real output and the changes in the exchange rate policy that have taken place in the last four decades. Within a logistic smooth transition framework, our results reveal a strong regime-dependence of pass-through, which depends positively on economic activity. Moreover, point estimates show that the long-run pass-through coefficient is equal to 0.15% and weakly different from zero when GDP growth is below a threshold of 3%. However, in times when the Finnish

economy grows at a faster pace - above the threshold value of 3% - ERPT elasticity increases to 0.47%. Our findings of regime-dependence of pass-through to the business cycle have important implications for policy. When the economy enters a phase of overheating with rising inflation, this is exacerbated by the transmission of exchange rate changes to consumer prices. This could provide serious guidance for policymakers and how they should act over different phases of the business cycle, in order to prevent currency movements from fuelling an inflationary process. As the Finnish currency has been irreversibly linked to the Euro since 1999, this would be a more challenging task for the European monetary authorities to preserve price stability across the Euro area member states. Indeed, during the post-EMU era, inflation rates in Finland have been among the lowest ones in the monetary union. This adds credibility to the adoption of the single currency, as the primary goal of the ECB is to achieve price stability, reduce the degree of pass-through and maintain low inflation.

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