A Simple Model of Hysteresis in Employment
under Exchange Rate Uncertainty
(Ein einfaches Modell zur Beschäftigungs-Hysteresis bei Wechselkursunsicherheit)

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Abstract: A model leading to employment hysteresis due to sunk hiring- and firing-costs is proposed. A potential mechanism based on a band of inaction that could account for a 'weaker' relationship between employment and its determinants is augmented by exchange rate uncertainty. As a result of option value effects the band of inaction is widened. Thus, the hysteresis effects are strongly amplified by exchange rate uncertainty (as numerical examples demonstrate). Non-linearities in the employment-relation are implied, i.e. 'spurts' in new employment or firing may occur after an initially weak response to a reversal of the exchange rate.

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1. Introduction

Reducing exchange rate volatility is often considered as one major advantage of EMU. The usual presumption has been that exchange rate volatility impedes foreign trade. Unfortunately empirical evidence on this aspect is as yet ambiguous.\(^1\) However, a recent study by Belke, Gros (1997) finds a significant negative relationship between intra-ERM exchange rate volatility and different labour market indicators for several EU-countries. We would argue that the absence of evidence of a strong impact of exchange rate variability on the volume of trade is due to neglecting a band of inaction of export activity based on sunk costs whose impacts are amplified by volatility-induced uncertainty. The prior of many economists would be that employment performance in an open economy should be finally linked to export activity; this implies a transmission of exchange rate volatility to labour markets. This transmission channel implicitly allows a transfer of the above mentioned inactivity band to labour markets, leading to stronger persistence in (un)employment. Thus we would conclude that one part of the empirical puzzle might be attributed to the mis-specification of tests which do not allow for bands of inaction and, additionally, for the impacts of volatility on these bands (see Côté (1994)).\(^2\)

The outline of the paper is as follows: section 2 gives an outline of the general features of our model. In section 3 this model is applied to derive employment hysteresis under certainty due to sunk hiring- and firing-costs. It develops a potential mechanism based on a band of inaction that could account for a 'weaker' relationship between employment and its determinants. This model is augmented by one-off uncertainty (i.e. a single stochastic change occurring in one period) in section 4. As a result of option value effects the band of inaction is widened and, thus, the hysteresis effects are amplified by uncertainty. As an extension a more permanent uncertainty, i.e. a stochastic change occurring in two periods, is considered too. In order to illustrate the magnitude of hysteresis effects under certainty and uncertainty numerical examples, are computed in section 5. Section 6 concludes.

\(^1\) However, for significant impacts see e.g. Deutsche Bundesbank (1998), pp. 49 ff., De Grauwe (1987), and Sapir, Sekkat (1990).

\(^2\) Another explanation of the puzzle might be that certainly for intra-European trade the market access costs, emphasised e.g. by Krugman (1998), pp. 44 ff., cannot be the main cause for exchange rate volatility affecting trade. The reason is that in Europe most firms already have a very elaborate distribution network in all other countries. From this point of view, the following model should be interpreted in terms of investment in employment instead of trade decisions. See Belke, Gros (1997) and Darby, Hughes Hallet, Ireland, Piscitelli (1997).
2. The baseline model

We consider a model of an exporting firm which has been active or passive in a foreign market in the past. Depending on its past state of activity this firm might either retain activity or exit (if it has been active in the past) resp. remain passive or enter the foreign market (if it has been passive). If a previously inactive firm enters the market, it has to bear entry costs, i.e. costs of hiring new labour. These expenditures cannot be regained and are therefore ex-post treated as sunk costs. Thus entering can be compared with an investment project. Analogously, leaving the market, leading to sunk firing costs, can be compared with a disinvestment process. Due to the intertemporal nature of the investment problem expected future revenues become relevant.

According to this set-up, we have to differentiate between three different spaces of time. The past, which determines the initial conditions, the present period $t$, when the firm has to decide based on expectations concerning the future. The present decision determines present sunk costs, present revenues and expected future returns on investment. The latter may be uncertain because they depend on a stochastic exchange rate. Taking a benchmark case abstracting from any kind of uncertainty as a reference point, we analyse the impacts of a one-off stochastic exchange rate shock on the "investment" respectively the hiring or firing decision. It will become obvious that uncertainty generates an option value of waiting, and therefore introduces a bias in favour of a "wait-and-see"-strategy. This stands for the deviation from the - purely net present value oriented - orthodox neoclassical theory ('Marshallian criterion') of investment (Darby et. al. (1997), p.1, Dixit (1992), pp. 110 ff., Dixit, Pindyck (1994), p. 4., and Krugman (1989), pp. 52 ff.).

Since the firm's employment decision can be understood as an irreversible investment, we follow a real option approach. The latter has much in common with financial option theory. The firm's employment opportunity corresponds to a call option on a common stock. This option gives the firm the right to employ (invest), hiring costs being the exercise price of the option, and to obtain a 'project'. The value of this project is affected by stochastic shocks. The option itself is valuable, and exercising the employment investment "kills" the option. The loss of the option value has to be considered as opportunity costs which have to be covered by future profits. Analogously, disinvestment (firing) can be interpreted as a put option (Krugman (1989), p. 53, Pindyck (1991), p. 1133). The same logic applies in this case. Taking into account hiring and firing under uncertainty, we focus on two options simultaneously.

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The firm $j$ is assumed to be a price taker in the foreign and in the currency market. It produces one unit\(^4\) of a final product using $a_j$ units of labour, with the wage $w$ being the price of labour input, i.e. variable costs are $w \cdot a_j$. Selling on the foreign market, the firm receives the price $p^\ast$. The gross profit (in domestic currency) on sales in the foreign market, without consideration of hiring and firing costs, is:\(^5\)

\[
R_{j,a,t} = p^\ast \cdot e_t - w_t \cdot a_j.
\]

with:
- $t$ : time index
- $j$ : index for potential domestic exporters
- $R_{j,a,t}$ : gross profit of firm $j$ in period $t$ (if active)
- $e_t$ : exchange rate (home currency price of foreign exchange)
- $w_t$ : wage rate
- $a_j$ : input coefficient of labour of firm $j$
- $p^\ast$ : price of the domestic export good (in foreign currency).

Since it is well-known that short-term volatility of exchange rates exceeds the variability of prices, wages and productivity by far,\(^6\) we feel justified to ascribe revenue volatility solely to exchange rate volatility. For this purpose and for simplicity reasons, we assume $w_t = w$ and $a_j$ to be constant and normalise $p^\ast$ to unity. As a consequence, the exporters are forced to bear unit revenue changes (in their own currency) proportionally to the exchange rate changes.\(^7\) A weaker form of the results of our model stays valid, if $p^\ast$ changes, but under-proportionally compared with the exchange rate. Moreover, the same logic can be applied to import-competing firms, whose revenues are influenced by the exchange rate as well.

Using this simplification, the gross profit of firm $j$ follows as:

\[
R_{j,a,t} = e_t - w \cdot a_j \quad \text{(if active)}, \quad \text{otherwise} \quad R_{j,p,t} = 0 \quad \text{(if passive)}.
\]

It is assumed here that the hiring costs $H_j$ (including training costs) must be spent at the moment the entry is executed.\(^8\) Analogously, the firm has to pay firing costs $F_j$ at the time it leaves the market (e.g. severance pay). If it later decides to re-enter the market, the entire

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\(^4\) By this, we follow a non-specific approach: If an institutional firm is imagined to be divided into single production units, every unit is represented here individually. Since the structure of the costs between the units of the institutional firm is not restricted, this approach has a very high generality. Moreover, by this form of (fictitious) disaggregation a totally new erection as well as an enlargement of employment by an institutional firm can be included.


\(^7\) This implies a 'pricing to market'-behaviour. See Krugman (1986), pp. 30 f., Krugman (1989), pp. 40 ff.

\(^8\) Investment in employment that takes 'time to build' (i.e. implementing a lead) magnifies effects of uncertainty. See Pindyck (1988), p. 973, Dixit, Pindyck (1994), pp. 46 ff.
hiring costs must be repaid.\textsuperscript{9} If the firm is inactive for only one period, the staff must be completely re-set up and the hiring costs must be paid anew. Since switching the state of activity leads to a complete depreciation of hiring resp. firing costs, $H_j$ and $F_j$ have to be regarded as sunk costs ex post (Dixit, Pindyck (1994), p. 8, Bentolila, Bertola (1990), Dornbusch (1987), pp. 7 ff.).\textsuperscript{10} Specific investments in new employees close to the production process may partly be irreversible because of market regulation and institutional arrangements.\textsuperscript{11}

The decision as to whether or not the firm should sell abroad is reached by a comparison of the expected present values of the returns with or without being active in the decision period $t$. In addition to the state of activity in the preceding period, the present revenues and expenditures as well as the influence of the current activity decision on the future returns must be taken into account. The comparison of the present value of both alternatives (activity or inactivity), under consideration of hiring- and firing costs and of the present value of the future revenues, is carried out by an examination of both cases (previously active or passive).

3. Decision under certainty

3.1 Employed (i.e. active) in the preceding period

A firm $j$ which has been active in the preceding period and will continue its activity will gain the period $t$ revenue $R_{j,a,t}$. Since it expects the same revenue for the whole infinite future the present value of annuity due of future revenues under activity from period $t+1$ on is $\delta \cdot V_{j,a,t+1} = \delta \cdot (e^{-w \cdot a_j})/(1 - \delta)$. The discount factor is defined here as $\delta = 1/(1 + i)$ with a risk free interest rate $i$; i.e. $(1 - \delta) = \delta \cdot i$ is the rate of interest costs. The entire present value of continuing activity is:

$$R_{j,a,t} + \delta \cdot V_{j,a,t+1} = e^{-w \cdot a_j} + \frac{\delta \cdot (e^{-w \cdot a_j})}{1 - \delta} = \frac{e^{-w \cdot a_j}}{1 - \delta}. \tag{3}$$

If an previously active firm $j$ exits in $t$, it has to bear firing or (expressed equivalently) disinvestment costs $F_j$ without any current and future gains ($R_{j,p,t}=0$ and $V_{j,p,t+1}=0$). The present value of an instantaneous exit can be written as:

$$R_{j,p,t} + \delta \cdot V_{j,p,t+1} - F_j = -F_j \tag{4}.$$

\textsuperscript{9} A firm often has the option to produce or not to produce with existing capital (operating option, Pindyck (1988), p. 970, p. 982). Our firm does not dispose of this option, since already one period of inaction leads to complete depreciation of the "employment project". Another interesting option we do not consider, is the option to conduct direct investments in overseas production capacity, which is modelled explicitly in Kulatilaka, Kogut (1996).

\textsuperscript{10} We abstract here from additional uncertainty over $H_j$ and $F_j$.

\textsuperscript{11} However, one has to distinguish between specific investment as analysed in this paper and general investment, which enables the firm to cope with different situations in the future. Thus the latter type is often claimed to be positively correlated with exchange rate variability. See e.g. Gros (1987).
The firm is indifferent between these two alternatives if the present value of continuing activity equals the present value of an instantaneous exit:\(^\text{(5)}\)

\[
\frac{e^{-w\cdot a_j}}{1-\delta} = -F_j .
\]

With this, the trigger exchange rate value for switching from one strategy to the other is:

\[
\text{e}_{j,\text{exit}}^c = w\cdot a_j - (1-\delta)\cdot F_j .
\]

The firm \(j\) exits if the exchange rate \(e\) falls below \(e_{j,\text{exit}}^c\). Therefore unit revenue \(e\) has to cover at least the wage costs \(w\cdot a_j\) less interest costs of exit. Interest costs of exit are an opportunity gain of non-exit. Hence due to the sunk firing costs the price floor is below variable costs.

### 3.2 Unemployed (i.e. passive) in the preceding period

A previously non-active firm earns neither current nor future profits if it remains passive:

\[
\text{R}_{j,p,t} + \delta \cdot V_{j,p,t+1} = 0 .
\]

If the firm enters the market and therefore hires new employees it has to pay extra hiring costs \(H_j\) to be able to earn current and future profits:

\[
-H_j + \text{R}_{j,a,t} + \delta \cdot V_{j,a,t+1} = -H_j + e^{-w\cdot a_j} + \frac{\delta \cdot (e^{-w\cdot a_j})}{1-\delta} = -H_j + \frac{e^{-w\cdot a_j}}{1-\delta} .
\]

The firm is indifferent between entering or remaining passive if the present value of continuing non-activity equals the present value of an instantaneous entry:

\[
0 = -H_j + \frac{e^{-w\cdot a_j}}{1-\delta} .
\]

With this, the trigger exchange rate value for entering can be expressed as:

\[
\text{e}_{j,\text{entry}}^c = w\cdot a_j + (1-\delta)\cdot H_j .
\]

The firm enters if the exchange rate \(e\) exceeds \(e_{j,\text{entry}}^c\). The entry decision becomes favourable if the unit revenue \(e\) covers at least the labour costs \(w\cdot a_j\) plus the interest costs of entry. Interest costs of entry become relevant as they have to be interpreted as an opportunity gain of staying passive. Due to the sunk hiring costs, the necessary unit revenue is larger than the variable costs. So the required surplus over unit wage costs will be the larger the higher the sunk costs are.

\[\text{12}\] In both cases the firm has to bear losses. We exclude the case of bankruptcy, where the firm is not able to pay for firing costs or to bear the operating losses. Either the owner has to pay for it or the 'firm' \(j\) is only a unit of an entire institutional firm, which is able to cover these losses.
3.3. Width of the hysteresis band

Combining both trigger values a 'band of inaction' (hysteresis band) results (Fig. 1).

Fig. 1: Band of inaction of a single-unit firm j under certainty

The width of the hysteresis band under certainty is determined by the interest costs of hiring and firing:

\[
e^c_{j,\text{entry}} - e^c_{j,\text{exit}} = (1 - \delta) \cdot (H_j + F_j) = \frac{i \cdot (H_j + F_j)}{1 + i}.
\]

The existence of a band of inaction implies that the current realisation of the exchange rate is not sufficient to determine the current state of the firm's activity. In order to select one of the multiple equilibria, the history of activity has to be regarded (i.e. hysteresis).

4. The model under one-off uncertainty and the possibility of waiting

4.1 The implication of uncertainty and the option value of waiting

The following variant of the model is designed to illustrate the impacts of uncertainty on the band of inaction according to the 'option value of waiting' à la Pindyck (1988, 1991), Dixit (1989, 1992), Dixit, Pindyck (1994), and Krugman (1989), 52 ff. Taking these contributions as a starting point, we ask whether even a temporary, short-run increase (short-run spike) in uncertainty can have a significant impact on the dynamics of employment. For this purpose we turn our focus on investment (hiring) and disinvestment (firing) simultaneously.

To be more specific, we analyse the effects of an expected future stochastic one-time shock on the band of inaction. However, assuming a risk-neutral firm we abstract from risk-aversion. Focusing on employment impacts of uncertainty, we take up an idea originally proposed by Dornbusch (1987), pp. 8 f., Dixit (1989), p. 624, fn. 3, and Pindyck (1991), p. 1111. Moreover, analysing short-run spikes in uncertainty (instead of permanent uncertainty) has the side effect of the applicability of simple algebraic methods instead of using dynamic programming techniques as described by Dixit, Pindyck (1994), pp. 95 ff. In the spirit of Cox,
Ross, Rubinstein (1979), p. 230, we prefer simple instead of advanced dynamic programming tools, in order not to obscure the underlying economics.

The exchange rate is regarded as stochastic. We suppose a non-recurring single stochastic change in the exchange rate, which can be either positive (+\(\varepsilon\)) or negative (–\(\varepsilon\)) (with \(\varepsilon \geq 0\), mean preserving spread). This kind of binomial stochastic process was introduced into the theory of option pricing by Cox, Ross, Rubinstein (1979). For simplicity reasons, in our context both realisations of the change \(\varepsilon\) are presumed to have a probability of \(\frac{1}{2}\):

\[
e_{t+1} = e_t \pm \varepsilon \quad \Rightarrow \quad E_t(e_{t+1}) = e_t.
\]

From period \(t+1\) on, the firm will decide under uncertainty again. Thus, the trigger exchange rate value under certainty ("c-trigger") as derived above will become valid again. The stochastic change between \(t\) and \(t+1\) leads to a widening of the band of inaction due to the possibility of a "wait-and-see"-strategy. Under certainty, the relevant alternative strategies are to enter or not for a previously inactive firm resp. to exit or not for a formerly active firm. Under uncertainty and the feasibility to delay an investment, a third possibility has to be taken into account: the option to wait and to meet the respective decision (i.e. entry or exit) in the future. The option to employ in the future is valuable because the future value of the ‘asset’ obtained by employment is uncertain. If its value will decrease the firm will not need to employ and will only lose what it will have spent to keep the employment opportunity. This limits the risk downwards and with this generates the inherent value of the option (Dixit, Pindyck (1994), p. 9 and pp. 15 ff., Krugman (1989), p. 53).

4.2 Employed (i.e. active) in the preceding period

4.2.1 No re-entry

Under uncertainty a previously active firm has to decide whether to leave the market now (instantaneous exit) or to stay active, including the option to leave later. It may appear advantageous for the firm to bear temporary period \(t\) losses, if there is a possibility of future gains. In this case the firm can avoid additional exit and re-entry costs. On the one hand the firm anticipates the possibility of future gains if the future exchange rate turns out to be favourable (+\(\varepsilon\)). On the other hand the firm foresees that it can avoid future losses if the exchange rate change will be negative (–\(\varepsilon\)) with a later exit in \(t+1\). With this, the exit trigger under uncertainty \(e_{j,\text{exit}}^u\) ("u-trigger") must be below the c-exit rate:

\[
e_{j,\text{exit}}^u < e_{j,\text{exit}}^c \quad \text{(condition)}.
\]

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13 We assume here that the exchange risk rate is fully diversifiable as in Dixit, Pindyck (1994), p. 27, which implies that uncertainty in the exchange rate is not related to what happens with the overall economy.
If the current exchange rate $e_t$ falls below $e^{c,exit}_t - \varepsilon$ even a $(+\varepsilon)$-realisation will not induce the firm to stay in the future since then $e_{t+1} < e^{c,exit}_t$. Thus, in this case the problem becomes trivial since the firm exits in $t$. It follows that condition $\Box$ must hold for the non-trivial case:

(14) \[ e^{u,exit}_t > e^{c,exit}_t - \varepsilon \quad (\text{condition } \Box) \]

Consequently, focusing on the range $]e^{c,exit}_t - \varepsilon, e^{c,exit}_t[$ is sufficient to compute the $u$-exit rate.

The expected present value of the wait-and-see strategy in period $t$ is defined as the probability-weighted average of the present values of both $\varepsilon$-realisations. Conditional on the $(-\varepsilon)$-realisation the firm will use its option to leave in $t+1$ causing firing costs $F_j$. In this case, the present value is:

(15) \[ R_{j,a,t} - \delta \cdot F_j + \delta \cdot V_{j,a,t+1} = e^{u} - w \cdot a_j - \delta \cdot F_j . \]

In case of the favourable $(+\varepsilon)$-realisation the firm will stay:

(16) \[ R_{j,a,t} + \delta \cdot V_{j,a,t+1} = e^{u} + w \cdot a_j + \frac{\delta \cdot (e^{u} - w \cdot a_j)}{1 - \delta} . \]

Combining (15) and (16), the expected present value of the wait-and-see strategy is:

(17) \[ E_t(V_{wait}^{t,j}) = e^{u} - w \cdot a_j - \frac{1}{2} \cdot \delta \cdot F_j + \frac{1}{2} \cdot \delta \cdot \frac{e^{u} - w \cdot a_j}{1 - \delta} . \]

The present value of an immediate exit is simply determined by firing costs $F_j$:

(18) \[ E_t(V_{exit}^{t,j}) = V_{exit}^{t,j} = -F_j . \]

Hence, the firm is indifferent between exit in $t$ and 'wait-and-see' if $E_t(V_{exit}^{t,j}) = E_t(V_{wait}^{t,j})$. As a consequence, the $u$-exit-trigger follows (with: exit for $e_t < e^{u,exit}_t$):

(19) \[ e^{u,exit}_t = w \cdot a_j - (1 - \delta) \cdot F_j - \frac{\delta \cdot e^{c,exit}_t}{2 - \delta} = e^{c,exit}_t - \frac{\delta \cdot e^{c,exit}_t}{2 - \delta} = e^{c,exit}_t - \frac{\varepsilon}{1 + 2_i} . \]

An illustration of the wait-and-see strategy is given in Fig. 2. Even though the exchange rate $e_0$ falls below the $c$-exit rate $e^{c,exit}_t$ the firm does not leave in period $t$, since in the $(+\varepsilon)$-case the firm will be located inside the hysteresis band under certainty in the future.
Fig. 2: Wait-and-see-strategy in period t for a previously active firm

The whole bunch of relations between the trigger values under certainty and uncertainty is depicted in Fig. 3.

Fig. 3: Band of inaction under uncertainty in period t

4.2.2 Re-entry

So far we have neglected a non-trivial problem which may arise, if $\varepsilon$ is very large. In this case it may turn out to be favourable to leave the market in t and to re-enter in t+1 if ($+\varepsilon$) is realised.\textsuperscript{14} For this case to occur the next period exchange rate must be larger than the c-entry trigger (conditions $\heartsuit$ and $\heartsuit$ are still valid):

\textsuperscript{14} This problem is mentioned in Krugman (1989), pp. 63 ff.
\[ e_{t+1} = e_t + \varepsilon > e^e_{j,\text{entry}} \quad \text{(condition } \circ) . \]

The expected present value of an immediate exit and a possible re-entry in \( t+1 \) is:

\[ E_t(V^\text{exit, re-entry}_{j,t}) = -F_j - \frac{1}{2} \cdot \delta \cdot H_j + \frac{1}{2} \cdot \delta \cdot \frac{e + \varepsilon - w \cdot a_j}{1 - \delta} . \]

The expected present value of the wait-and-see strategy has already been calculated above (see eq. (17)). If \( E_t(V^\text{exit, re-entry}_{j,t}) \) is larger than \( E_t(V^\text{wait}_{j,t}) \), immediate exit (and potential re-entry) takes place:

\[ \text{exit and re-entry for: } E_t(V^\text{exit, re-entry}_{j,t}) - E_t(V^\text{wait}_{j,t}) > 0 \]

\[ e_t < e^e_{j,t,\text{exit, re-entry}} = (\frac{1}{2} \cdot \delta - 1) \cdot F_j - \frac{1}{2} \cdot \delta \cdot H_j + w \cdot a_j . \]

Equation (22) determines the exit-trigger under uncertainty if condition \( \circ \) is fulfilled. If \( \varepsilon \) is so large that condition \( \circ \) is valid, the trigger value \( e^e_{j,t,\text{exit, re-entry}} \) does not depend on \( \varepsilon \) any more. Why does this expression not contain \( \varepsilon \)? The realisation of \( \varepsilon \) definitively plays a role in the qualitative decision whether condition \( \circ \) is fulfilled, but not in a quantitative respect any more. Combining equation (22) and condition \( \circ \) leads to:

\[ \text{condition } \circ': e_t > w \cdot a_j + (1 - \delta) \cdot H_j - \varepsilon \]

\[ (22'):\quad e_t < (\frac{1}{2} \cdot \delta - 1) \cdot F_j - \frac{1}{2} \cdot \delta \cdot H_j + w \cdot a_j \]

\[ \Rightarrow \quad w \cdot a_j + (1 - \delta) \cdot H_j - \varepsilon < (\frac{1}{2} \cdot \delta - 1) \cdot F_j - \frac{1}{2} \cdot \delta \cdot H_j + w \cdot a_j . \]

Solving equation (23) results in the limit value \( e^e_{j,t,\text{exit, re-entry}} \). For \( \varepsilon > e^e_{j,t,\text{exit, re-entry}} \) an exit in \( t \) and a re-entry in \( t+1 \) may occur, if \( e_t < e^e_{j,t,\text{exit, re-entry}} \).

\[ \varepsilon > e^e_{j,t,\text{exit, re-entry}} = (1 - \frac{\delta}{2}) \cdot (F_j + H_j) . \]

The situation which leads to an exit-re-entry strategy is shown in Fig. 4. Because \( e_t < e^e_{j,t,\text{exit, re-entry}} \), the firm exits in \( t \). Since \( \varepsilon \) is so large, that given the \((+\varepsilon)\)-realisation the c-entry trigger is exceeded, the firm will re-enter in \( t+1 \) in case of \((+\varepsilon)\). So the absolute value of \( \varepsilon \) that induces an exit-re-entry-strategy has even to be larger than \( e^e_{j,t,\text{exit, re-entry}} \), which was calculated based on \( e^e_{j,t,\text{exit, re-entry}} \).
4.3 Unemployed (i.e. passive) in the preceding period

4.3.1 No re-exit

A previously inactive firm has to decide whether to enter the market now (instantaneous entry) or to stay passive, including the option to enter later. It may appear advantageous for the firm to dispense with transient period t gains, if there is the possibility of future losses. In this case, the firm can avoid additional entry and re-exit-costs via a wait-and-see-strategy. The firm anticipates the possibility of internalising future gains by an entry in t+1 if the future exchange rate turns out to be favourable (+ε). Besides, the firm foresees that it can avoid future losses if the exchange rate change will be negative (–ε) by staying passive. Consequently, the entry trigger under uncertainty u-entry must exceed the c-entry rate:

\[ e_{j,\text{entry}}^u > e_{j,\text{entry}}^c \]  (condition \( \bullet \)).

If the current exchange rate \( e_t \) exceeds \( e_{j,\text{entry}}^c + \varepsilon \) even a (–ε)-realisation will not induce the firm to leave in the future since then \( e_{t+1} > e_{j,\text{entry}}^c \). So the firm definitely enters in t. In order to exclude this trivial case condition \( \bullet \) must hold:

\[ e_{j,\text{entry}}^u < e_{j,\text{entry}}^c + \varepsilon \]  (condition \( \bigcirc \)).

Conditions \( \bullet \) and \( \bigcirc \) are implicitly illustrated in Fig. 3. Consequently, focusing on the range \( [e_{j,\text{entry}}^c, e_{j,\text{entry}}^c + \varepsilon] \) is sufficient to compute the u-entry rate.

The expected present value of the wait-and-see strategy in period t is defined as the probability weighted average of the present values of both ε-realisations. Conditional on a (+ε)-realisation, the firm will use its option to enter in t+1 causing hiring costs \( H_j \), so the present value is:
\[(27) \quad R_{j,p,t} - \delta \cdot H_j + \delta \cdot V_{j,a,t+1} = 0 - \delta \cdot H_j + \delta \cdot \frac{e + \varepsilon - w \cdot a_j}{1 - \delta}. \]

For a \((-\varepsilon)-\)realisation the firm will remain passive: \(R_{j,p,t} + \delta \cdot V_{j,a,t+1} = 0 + \delta \cdot 0 = 0\). Consequently, the expected present value of the wait-and-see strategy for a previously inactive firm is given by:

\[(28) \quad E_t(V_{j,t}^{\text{wait}}) = -\frac{1}{2} \cdot \delta \cdot H_j + \frac{1}{2} \cdot \delta \cdot \frac{e + \varepsilon - w \cdot a_j}{1 - \delta}. \]

The expected present value of an immediate entry (without a re-exit) is (see eq. (8)):

\[(29) \quad E_t(V_{j,t}^{\text{entry}}) = e - w \cdot a_j - \delta \cdot \frac{e - w \cdot a_j}{1 - \delta} = - H_j + \frac{e - w \cdot a_j}{1 - \delta}. \]

The value of having the flexibility to make the employment decision in the next period rather than to employ either now or never, can easily be calculated as the difference between the two expected net present values:

\[(30) \quad OV(e, \varepsilon) = E_t(V_{j,t}^{\text{wait}}) - E_t(V_{j,t}^{\text{entry}}) \quad \text{with: } \frac{\partial OV}{\partial e} < 0, \quad \frac{\partial OV}{\partial \varepsilon} > 0. \]

In other words, the firm should accept to pay the (call) option value \(OV\) more for an employment opportunity that is flexible, than for one that restricts the firm only to employ now or never.\(^{15}\) An increase in uncertainty enlarges the value of the option to employ later. The reason is that it enlarges the potential payoff of the option, leaving the downside payoff unchanged, since it will not exercise the option if the exchange rate falls (Dixit, Pindyck (1994), pp. 39 f.).

The firm is indifferent between entry in \(t\) and wait-and-see if \(E_t(V_{j,t}^{\text{entry}}) = E_t(V_{j,t}^{\text{wait}})\), i.e. if \(OV = 0\). The \(u\)-entry-trigger follows (entry for \(e > e_{j,\text{entry}}^u\)):

\[(31) \quad e_{j,\text{entry}}^u = w \cdot a_j + (1 - \delta) \cdot H_j + \frac{\delta \cdot \varepsilon}{2 - \delta} = e_{j,\text{entry}}^c + \frac{\delta \cdot \varepsilon}{2 - \delta} = e_{j,\text{entry}}^c + \frac{\varepsilon}{1 + 2i}. \]

The required margin \((e_{j,\text{entry}}^u - e_{j,\text{entry}}^c)\) above the unit wage costs and hiring costs is the higher, the larger the uncertainty is.

An illustration of the wait-and-see strategy can be found in Fig. 5. Even though the exchange rate \(e_2\) exceeds the \(c\)-entry rate \(e_{j,\text{entry}}^c\) the firm does not enter in period \(t\), since in the \((-\varepsilon)\)-case the firm will be located inside the band of inaction under certainty in the future.

\(^{15}\) An analogous logic can be applied to the disinvestment/firing put option case.
Fig. 5: Wait-and-see strategy in period t for an previously inactive firm

The question may arise whether the ability to hedge the exchange rate changes the firms decisions. The answer is no. The only difference in the firm's calculus in the case of hedging will be that the expectation operator (e.g. in eqs. (28), (29), (30)) can be dropped. If the hedged values of the exchange rate equal the expected values, the firm ends up with a (certain) net present value which exactly corresponds to its expected net present value without hedging. Hence for a risk-neutral firm and without transaction costs of hedging there is no gain from hedging and the firm is still better off waiting (Pindyck (1991), p. 1114, Dixit, Pindyck (1994), pp. 29 f.).

4.3.2 Re-exit

So far we have again neglected the problem which arises if \( \varepsilon \) is very large, since in this case it may turn out to be favourable to enter the market in t and to re-exit in t+1 if \((-\varepsilon)\) is realised. For this case a necessary condition is that the next period exchange rate must be lower than the c-exit trigger (conditions 1 and 2 are still valid):

\[
(32) \quad e_{t+1} = e_t - \varepsilon < e_{j,exit}^c \quad \text{(condition 3)}.
\]

The expected present value of an immediate entry and a possible re-exit in t+1 is:

\[
(33) \quad E_t(V_{entry, re-exit}) = e - w \cdot a_j - H_j - \frac{1}{2} \cdot \delta \cdot F_j + \frac{1}{2} \cdot \delta \cdot \frac{e + \varepsilon - w \cdot a_j}{1 - \delta}.
\]

As in the 're-entry' case, the expected present value of the wait-and-see strategy has been calculated above (see equation (28). If \( E_t(V_{entry, re-exit}) \) is larger than \( E_t(V_{wait}) \), immediate exit (and potential re-entry) is favoured by the firm:
(34) entry and re-exit for: \( E_t(Y_{j,t}^{\text{entry}, \text{re-exit}}) - E_t(Y_{j,t}^{\text{wait}}) > 0 \)

\[ e_t > e_{j,t}^{\text{entry}, \text{re-exit}} = (1 - \frac{1}{2} \delta) \cdot H_j + \frac{1}{2} \delta \cdot F_j + w \cdot a_j . \]

Equation (34) represents the entry-trigger under uncertainty if condition 3 is fulfilled. If \( \varepsilon \) is so large that condition 3 is valid, (as above) the trigger value \( e_{j,t}^{\text{entry}, \text{re-exit}} \) does not depend on \( \varepsilon \) any more. Equation (34) combined with condition 3 leads to the same limit value as in the analogous problem above: \( e_j^{\text{entry}, \text{re-exit}} = e_j^{\text{exit}, \text{entry}} \). For \( \varepsilon > e_j^{\text{entry}, \text{re-exit}} \) an exit in t and a re-entry in t+1 can occur, if \( e_t > e_{j,t}^{\text{entry}, \text{re-exit}} \).

**Fig. 6: Entry in t and re-exit in t+1**

The entry-re-exit scenario is illustrated in Fig. 6. Since \( e_3 > e_{j,t}^{\text{entry}, \text{re-exit}} \), the firm enters in t. Since \( \varepsilon \) is so large, that given the \((-\varepsilon)\)-realisation the c-exit trigger is passed, the firm will re-exit in t+1 in case of \((-\varepsilon)\). \( e_3 \) is larger than \( e_j^{\text{entry}, \text{re-exit}} \), so the absolute value of \( \varepsilon \) that induces an entry-re-entry-strategy has even to be larger than \( e_j^{\text{entry}, \text{re-exit}} \), which was calculated based on \( e_{j,t}^{\text{entry}, \text{re-exit}} \).

### 4.4 Width of the hysteresis band under uncertainty

Combining both \( u \)-trigger values, the width of the band of inaction under uncertainty for 'small' \( \varepsilon \) results as:

\[
(35) \quad e_j^{u,\text{entry}} - e_j^{u,\text{exit}} = (1 - \delta) \cdot (H_j + F_j) + \frac{2 \cdot \delta \cdot \varepsilon}{2 - \delta} = \frac{i \cdot (H_j + F_j)}{1 + i} + \frac{2 \cdot \varepsilon}{1 + 2i} \\
= (e_j^{c,\text{entry}} - e_j^{c,\text{exit}}) + \frac{2 \cdot \delta \cdot \varepsilon}{2 - \delta} = (e_j^{c,\text{entry}} - e_j^{c,\text{exit}}) + \frac{2 \cdot \varepsilon}{1 + 2i} .
\]

For a small standard deviation \( \varepsilon \) the width of the hysteresis band under uncertainty is determined by the band under certainty, i.e. by interest costs of hiring and firing, and
additionally, by the uncertainty $\varepsilon$ in a linear way. However, in the case of re-entry resp. re-exit, i.e. for 'large' $\varepsilon$, the width of the inaction-band under uncertainty is limited to:

$$
e^{\text{entry, re-exit}}_{j,t} - e^{\text{exit, re-entry}}_{j,t} = H_j + F_j.
$$

The relation between this maximum width under severe uncertainty (i.e. for 'large' $\varepsilon$) and the width in the case of certainty is only determined by the interest rate and not by the hiring- and firing costs:

$$
e^{\text{entry, re-exit}}_{j,t} - e^{\text{exit, re-entry}}_{j,t} = e^{\text{c, entry}}_{j} - e^{\text{c, exit}}_{j} = 1 + i.
$$

Compared to certainty the band of inaction, spanned by the interval between the two thresholds, is widened by uncertainty, independent of a 'small' or 'large' $\varepsilon$. That is, uncertainty increases the probability that a firm stays active (passive) if the current level of revenue $e$ has descended (ascended) from a formerly high (low) level that has induced entry (exit).

Abstracting from potential aggregation problems, one empirical implication with respect to labour markets might be, that in cases of devaluation or other causes improving profits (e.g. recovery from a recession) the firms should be very cautious and wait for a greater assurance of a permanent prospect of high level profits before enhancing regular full-time labour force. In the meantime, they will tend to exploit the current profit opportunities by applying less irreversible but perhaps currently more costly types of production, i.e. overtime and temporary work. Analogously, in cases of revaluation the firms will stick to their regular full-time labour force, extensively making use of short-time work. Finally, non-linearities in the relation between employment and its determinants are emphasised. From a macroeconomic perspective, after a reversal of the exchange rate (or other determinants) the initially weak response of employment will evolve into a very strong response, once the thresholds of many firms are passed; i.e. a 'spurt' in investment resp. employment or disinvestment resp. firing, will occur.

4.5 A Model with two successive stochastic exchange rate changes

We now presume that the binomial stochastic change $\pm \varepsilon$ will occur two times: between period $t$ and $t+1$ and again (with equal absolute magnitude $\varepsilon$ and the same 0.5-probabilities) between $t+1$ and $t+2$. By considering one additional period of uncertainty, the firms ('dis')employment

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16 For an adequate aggregation method in the case of micro-hysteresis (i.e. relay-hysteresis with trigger values), see Göcke (1994) or Belke, Göcke (1994).

17 For 'spurts' in investment see Pindyck (1988), pp. 980 f. Dixit, Pindyck (1994), pp. 15 f., vividly illustrate the non-linear reaction of US-employment after recovery in the mid 1993. Moreover, some European labour markets are characterised by high unemployment. Since this corresponds to our 'previously inactive'-case, any increase in uncertainty in revenues will imply higher unemployment persistence for these economies.
decision becomes more complicated, since the number of possible strategies has increased. For simplicity reasons, we now assume 'small' $\varepsilon$, abstracting from re-entry- and re-exit strategies.\textsuperscript{18}

4.5.1 Active in the preceding period

With 'two-off' uncertainty the band of inaction will be widened even compared to the above case with 'one-off' uncertainty. Therefore we focus on the range $(e_{j,\text{exit}}^u - \varepsilon) < e_t < e_{j,\text{exit}}^u$ when we calculate exit trigger values. In period $t$ the firm has to decide on the alternatives "exit now" and "wait and see" until $t+1$. The firm anticipates that following period $t+1$ a second change will occur. Hence, in $t+1$ the decision problem of the firm will be the same as in the case with 'one-off' uncertainty in $t$. Using the results calculated above, the firm's dynamic decision problem can be tackled via a backward induction procedure.

The expected present value of the wait-and-see strategy in period $t$ is defined as the probability-weighted average of the present values of both $\varepsilon$-realisations between $t$ and $t+1$. Conditional on the $(\varepsilon)$-realisation the firm will leave in $t+1$ with a present value:

$$\text{(38)} \quad R_{j,a,t} - \delta \cdot F_j + \delta \cdot V_{j,p,t+1} = e^{-w \cdot a_j} - \delta \cdot F_j.$$  

In case of the favourable ($+\varepsilon$)-realisation the firm will remain active. Since the firm will be confronted with another stochastic change between $t+1$ and $t+2$, in the $(+\varepsilon(t))$-case, the firm – via backward induction – has to calculate again with a 'wait (once) and see' value analogous to eq. (16) (substituting $e$ by $(e + \varepsilon(t+1))$, since an additional change occurs):

$$\text{(39)} \quad R_{j,a,t} + \delta \cdot \mathbb{E}(V_{j,t+1}^{\text{wait}}(e_t+\varepsilon)) = e^{-w \cdot a_j} + \delta \cdot [e + \varepsilon - w \cdot a_j - \frac{1}{2} \cdot \delta \cdot F_j + \frac{1}{2} \cdot \delta \cdot \frac{e + 2 \cdot e - w \cdot a_j}{1 - \delta}].$$

Using (38) and (39), the expected value of the period $t$ waiting strategy is:

$$\text{(40)} \quad \mathbb{E}(V_{j,t}^{\text{wait}}) = e^{-w \cdot a_j} - \frac{\delta}{2} \cdot F_j + \frac{\delta}{2} \cdot [e + \varepsilon - w \cdot a_j - \frac{1}{2} \cdot \delta \cdot F_j + \frac{1}{2} \cdot \delta \cdot \frac{e + 2 \cdot e - w \cdot a_j}{1 - \delta}].$$

Indifference between waiting until $t+1$ and an immediate exit in $t$ (with present value ($-F_j$)) is given by $\mathbb{E}(V_{j,t}^{\text{wait}}) = -F_j$. The exit-trigger for twice repeated uncertainty follows as:

$$\text{(41)} \quad e_{j,\text{exit}}^{u2} = e_{j,\text{exit}}^c - \frac{2 \cdot \delta \cdot \varepsilon}{-4 + \delta^2 + 2 \cdot \delta} = e_{j,\text{exit}}^c - \frac{2 \cdot (1+i) \cdot \varepsilon}{1 + 6 \cdot i + 4 \cdot i^2} = e_{j,\text{exit}}^u - \frac{\delta^3 \cdot \varepsilon}{(\delta-2) \cdot (-4 + \delta^2 + 2 \cdot \delta)}.$$

\textsuperscript{18} For option pricing models with two stochastic changes see Cox, Ross, Rubinstein (1979), pp. 236 ff., and Dixit, Pindyck (1994), pp. 41 ff.
4.5.2 Inactive in the preceding period

Here we focus on the range \( e_{\text{entry}}^u < e_t < (e_{\text{entry}}^u + \varepsilon) \) when we calculate entry trigger values. In period t the firm has to decide whether to "enter now" or "wait and see" until t+1 is favourable. In the case of the (+\( \varepsilon \))-realisation a waiting firm will enter in t+1 and has a conditional expected value of:

\[
(42) \quad \delta \cdot (-H_j + \frac{e + \varepsilon - w \cdot a_j}{1 - \delta}).
\]

For the (-\( \varepsilon(t) \))-realisation it remains waiting. Using results of eq. (28), by backward induction and substituting \( e \) by \( (e - \varepsilon) \), the value conditional on (-\( \varepsilon \)) is:

\[
(43) \quad \frac{\delta^2}{2} \cdot (-H_j + \frac{e - w \cdot a_j}{1 - \delta}).
\]

The expected present value of the entire "wait-and-see" strategy \( E_t(V_{j,t}^{2,\text{wait}}) \) can be calculated, using (42) and (43). It has to be compared to the expected present value of an immediate entry which is:

\[
(44) \quad E_t(V_{j,t}^{\text{entry}}) = -H_j + \frac{e - w \cdot a_j}{1 - \delta}.
\]

Indifference \( [ E_t(V_{j,t}^{\text{entry}}) = E_t(V_{j,t}^{2,\text{wait}}) ] \) leads to the entry trigger:

\[
(45) \quad e_{\text{entry}}^u = e_{\text{entry}}^c + \frac{2 \cdot \delta \cdot \varepsilon}{-4 + \delta^2 + 2 \cdot \delta} + \frac{2 \cdot (1 + i) \cdot \varepsilon}{1 + 6 \cdot i + 4 \cdot i^2} + \frac{\delta^3 \cdot \varepsilon}{(\delta - 2) \cdot (-4 + \delta^2 + 2 \cdot \delta)}.
\]

Fig. 7: Sequence of the bands of inaction under two successive stochastic changes

- \( e_5 \) wait in t
- \( e_4 \) wait in t
- \( e_5 \) entry in t+1
- \( e_{\text{entry}}^u \) entry in t+2
- \( e_{\text{entry}}^c \) stay passive
- \( e_{\text{exit}}^c \) stay active
- \( e_{\text{exit}}^u \) exit in t+2
- \( e_{\text{entry}}^u \) exit in t+1
An illustration of the firm's strategies can be found in Fig. 7. If a previously active firm faces the exchange rate $e_t = e_4$ it will wait (stay active) though $e_4$ is below $e_{j,exit}^u$. Since a double ($+\varepsilon$)-realisation will lead to a situation above the c-trigger $e_{j,exit}^c$ it is favourable for the firm to remain in the market. The analogous situation of a previously inactive firm is given with $e_5$. It will wait (stay passive) though the exchange rate exceeds $e_{j,entry}^u$. As a consequence, the band of inaction increases again in the case of two successive (instead of one) stochastic changes. 'Large' $\varepsilon$, implying a traverse of the band of inaction in $t+1$, and with this a re-entry resp. a re-exit in $t+1$, will become less probable. The reason is that now in $t+1$ the u-triggers (i.e. one-off uncertainty) will become valid instead of the c-triggers.

Our analysis could be extended by adding more periods of uncertainty which induces a further widening of the hysteresis-band. This implies a repeated backward induction along the lines taken above, but this would be a hard way to walk. Another possibility is the transition to continuous time models with permanent uncertainty. However, we dispense with the use of the latter, since it implies the application of advanced mathematical tools (e.g. Ito's lemma) without leading to significant additional insights concerning our research purposes.\(^{19}\)

5. Numerical examples

In order to convey an idea of the impacts of the underlying model and to illustrate our results, we calculate two simple numerical examples. In the first example we let the hiring and firing costs be only a small percentage of the variable costs (10%), the interest rate given as 10% p.a. We compare the results with the case of 100% hiring and firing costs (2. example).\(^{20}\) Variable costs are normalised to unity ($w \cdot a_j = 1$)

First example: $w \cdot a_j = 1 ; F_j = 0.1 ; H_j = 0.1 ; i = 0.1 \Rightarrow \delta = \frac{10}{11}$

\[
\begin{align*}
e_{j,exit}^c &= 0.99091 ; e_{j,entry}^c = 1.009091 \\
e_{j,exit}^u &= 0.99091 - 0.83333 \cdot \varepsilon ; e_{j,entry}^u = 1.009091 + 0.83333 \cdot \varepsilon \\
e_{j,exit}^{u2} &= 0.99091 - 1.34146 \cdot \varepsilon ; e_{j,entry}^{u2} = 1.009091 + 1.34146 \cdot \varepsilon \\
e_{j,t,exit, re-entry} &= e_{j,entry, re-exit} = 0.109091 ; e_{j,t,exit, re-entry}^{exit} = 0.9 ; e_{j,t,entry, re-exit}^{entry} = 1.1
\end{align*}
\]

Second example: $w \cdot a_j = 1 ; F_j = 1 ; H_j = 1 ; i = 0.1 \Rightarrow \delta = \frac{10}{11}$

\[
\begin{align*}
e_{j,exit}^c &= 0.9091 ; e_{j,entry}^c = 1.09091 \\
e_{j,exit}^u &= 0.9091 - 0.83333 \cdot \varepsilon ; e_{j,entry}^u = 1.09091 + 0.83333 \cdot \varepsilon \\
e_{j,exit}^{u2} &= 0.9091 - 1.34146 \cdot \varepsilon ; e_{j,entry}^{u2} = 1.09091 + 1.34146 \cdot \varepsilon \\
e_{j,t,exit, re-entry} &= e_{j,entry, re-exit} = 1.09091 ; e_{j,t,exit, re-entry}^{exit} = 0 ; e_{j,t,entry, re-exit}^{entry} = 2
\end{align*}
\]


\(^{20}\) Krugman (1989), p. 57, regards sunk costs ranging from zero to half of variable costs as reasonable for the US-case. In the EU, institutional rigidities may lead to an even higher proportion.
The illustration of both examples (Fig. 8.1 and Fig. 8.2) look alike at first glance. However, they differ with respect to the absolute values on the abscissa and the ordinate. Due to the increase in the amount of hiring and firing cost by factor 10, the width of the inaction-band as well as the value of $e_{j,exit} = e_{j,entry}$ are growing by the same factor. For both examples, the relation between the maximum width under uncertainty and the width in the case of certainty is according to equation (37) only determined by the interest rate, independently of the amount of hiring and firing costs:

$$\frac{e_{j,entry, re-exit}^{u} - e_{j,entry, re-exit}^{c}}{e_{j,entry}^{c} - e_{j,exit}^{c}} = \frac{1+i}{i} = \frac{1+0.1}{0.1} = 11 .$$

Taking into account the option values induced by exchange rate uncertainty implies an amplification of hysteresis effects by a maximum factor of 11 in our examples. Since future gains are less heavily discounted by lower interest rates, the option value is the higher the
lower the interest rate is. Consequently, the amplifying impact of uncertainty on the band of inaction is decreasing in the interest rate.

The impact of two-time uncertainty on the band of inaction is depicted in Fig. 9 for the first numerical example. The limitation of the band of uncertainty by 'large' \( \varepsilon \) is less binding than in the on-off uncertainty case. But since we have not computed the exact realisation of the limit value of \( \varepsilon \), we merely focused on the range \([0, \varepsilon_{\text{exit}, \text{re-entry}}]\).

Fig. 9: Band of inaction under two-time uncertainty dependent on \( \varepsilon \) (first example)

Our theoretical results are compatible with recent empirical studies, which show that option values can be large and that investment rules that do not take them into account are very misleading.\(^{21}\)

6. Conclusions

In this paper a model leading to employment hysteresis due to sunk hiring- and firing-costs is proposed. A potential mechanism based on a band of inaction that could account for a 'weaker' relationship between employment and its determinants is augmented by exchange rate uncertainty. As a result of option value effects the band of inaction is widened and, thus, the hysteresis effects are strongly amplified by uncertainty (as numerical examples demonstrate).

We feel justified to ascribe revenue volatility solely to exchange rate volatility. For this purpose and for simplicity reasons, we assumed foreign prices \( p^* \), wages \( w \) and productivity \( 1/a_j \) to be constant. However, since uncertainty \( \varepsilon \) is included additively in the revenue function it is straightforward to interpret \( \varepsilon \) as an all comprising expression of uncertain exchange rates, foreign prices, wages and productivity. Moreover, the relation (including the band-of-inaction-

\(^{21}\) See e.g. the studies cited by Dixit, Pindyck (1994), p. 7.
characteristic) between employment and all its determinants (e.g. the wages) is affected by uncertainty. Thus, the impacts implied by sunk costs and uncertainty are manifold. We only calculated exchange rate triggers, holding other determinants of employment constant. Of course, one could proceed similarly and calculate trigger values for e.g. wages. As a result, a hysteresis-band concerning wages will occur (Belke, Göcke (1994)), which will be widened by uncertainty. The latter will lead to a weakening of the relation between employment and wages. Since employed insiders are sheltered to an increasing extent from unemployed outsiders, the problem of dual labour markets is aggravated by uncertainty.

Summarising, compared to the prediction of the majority of labour market models, real world employment may appear less sensitive to changes in the exchange rate, foreign prices, wages and productivity, due to uncertainty.

References


