Changes in the price level and the nominal exchange rate have quite different impacts on the trade balance
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Abstract

Most of the literature on the real exchange rate and the trade balance assumes that the trade balance reacts in the same way irrespective of whether the nominal exchange rate or the price level changes. Both are seen as equivalent and the sign of the reaction of the trade balance dependent only on the fulfillment of the Marshall-Lerner (ML) condition of lack thereof. However, as will be shown analytically in the paper, the trade balance can react quite differently to changes of the nominal exchange rate on the one hand and of the price level on the other hand. More specifically, with a sufficiently large trade surplus, an appreciation due to an increase of the price level can lead to a further – and perverse – *increase* in the surplus while an appreciation of the nominal exchange rate leads to a – normal – decrease of the surplus. On the other hand, with a sufficiently high deficit, an appreciation due to changes in the price level can lead to a further increase in the deficit (the normal reaction) but an appreciation of the nominal exchange rate can lead to a – perverse – decrease of the deficit. Formal conditions are derived under which the reaction of the trade balance is normal or perverse. However, those conditions are quite different from the traditional ML condition which is shown to hold only under very restrictive assumptions. It is further shown that the trade balance only behaves in the same way to changes in the price level and in the nominal exchange rate when the ML condition is met. The focus on the ML condition might thus be seriously misleading.

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1 Introduction

It is widely assumed in empirical and applied policy work that changes in the real exchange rate lead to changes of the trade balance in the same way independently of whether the change is due to changes in the nominal exchange rate or the domestic price level. Both changes are seen as equivalent in their effect for the trade balance (Lee and Chinn, 2006; Arghyrou and Chortareas, 2008; Coudert et al., 2013).

The following paper shows however that this is not necessarily the case and that changes in nominal exchange rates and changes in the domestic price level affect the trade balance in quite different ways. The reaction between the two kinds of changes depends strongly on the initial position of their trade balance: As will be shown, countries that initially have sufficiently high trade deficits will see their trade balances *increase* when their nominal exchange rate appreciates; while with the same deficit an increase in the domestic price level will lead to an (expected) deterioration of the trade balance.

The case is reversed with a sufficiently high initial surplus: an appreciation of the nominal exchange rate leads to the expected deterioration of the trade balance while an increase in the domestic price level to an improvement. This has important policy implications for both the optimal policy to reduce deficits or surpluses and for the interaction of nominal exchange rate and price level changes between countries.

The paper adds to the literature in the following way: while changes in the nominal exchange rate have been widely analysed and conditions for a "normal" reaction of the trade balance have been established – the so called Marshall-Lerner (ML) conditions – the dependence of the ML conditions on the initial trade balance has often been mentioned but rarely have its consequences been seriously analyzed (see for instance the classic contributions by Robinson (1950) and Harberger (1950)).[1]. Also, to my knowledge the difference of the importance of the initial position for changes in the nominal exchange rate and the price level have not been analysed at all.

Additionally, most work has looked at very small changes in the exchange rate, i.e. at differentials. Here, we will generalize the analysis to discrete changes which has some additional implications to the purely differential analysis (Gandolfo (2002) initially uses differences but only for pedagogical reasons. His further derivations use differentials.). More importantly and new however is the derivation of the effects of the domestic price level on the trade balance and the systematic comparison of trade balance reactions to changes in the nominal exchange rate and the domestic price level.

The paper is structured in the following way: The first part sets out the behavioral equations necessary for the following analysis. In the second part, the effects of

[1] The J curve effect according to which the trade balance behaves perversely in the short run but normally in the long run relies on the difference between short- and long-run trade elasticities. Otherwise it assumes all other assumptions for the ML condition to hold. See for instance Bahmani-Oskooee and Ratha (2004)

changes in the nominal exchange rate on the trade balance will be derived as well as all the partial effects that influence this reaction. Further, the conditions under which the ML conditions can be derived will be clarified.

The third part derives the effects of changes in the domestic price level on the trade balance and to what degree and under which circumstances this reaction is different from the reaction to changes in the nominal exchange rate. The fourth part will show under which conditions the trade balance reacts in the same way to changes in nominal exchange rates and changes in the domestic price level. In the fifth part a simple simulation will be used to illustrate the different reactions of the nominal trade balance. A final part concludes.

2 The nominal trade balance

In this part we will first establish the central behavioral assumptions. Before presenting those assumptions let us first state the more general assumptions. We first assume the elasticities of supply of both exports and imports to be infinite. This means that the supply curves are horizontal in the price-quantity space. While a model with finite supply elasticities would be more general, we make the assumption of infinite elasticities for two reasons: first, in many economies resources are not fully utilized so that costs do not necessarily increase when the produced quantity is increased. This however implies also that we look only at relatively short time intervals in which costs do not significantly rise. The second reason is more technical: it is easier to derive the following results.

Second we assume imperfect substitution between domestically produced and traded goods. This assumption makes sense empirically if only for the reason that many domestic services – for instance – cannot be traded and thus not be substituted for imported goods.

Lastly, the following analysis is done in terms of domestic currency and not foreign currency. One could also conduct the analysis in terms of foreign currency. This is especially needed if a country gets into balance of payments difficulties because of a lack of foreign currency reserves. The implications for foreign currency reserve needs would then have to be drawn in terms of foreign currency trade balances. However, we are here mainly interested in developed countries which mostly have debts in their own currency so that the implications for foreign currency reserves are not essential here.

Having made the most important general assumptions, we can now look at the more specific behavioral assumptions. The nominal trade balance, TB, is the difference between nominal exports and nominal imports:

(1) $$TB = P_x Q_x - e P_m Q_m$$

Here, all subscripts x denote exports and all subscripts m denote imports. P are prices and Q quantities and e is the nominal exchange rate with:

$$e = \frac{\text{units of domestic currency}}{\text{1 unit of foreign currency}} \tag{2}$$

When e's value increases, there is a *depreciation* and when it decreases, there is an *appreciation*. The import value $P_m Q_m$ is denominated in foreign currency and transformed into domestic currency by the multiplication with e.[2]

The trade balance depends on five variables: foreign real income Y_f, domestic real income, Y_d, the exchange rate, e, the foreign price level, P_f and the domestic price level, P_d.

The export price is a positive function of the overall domestic price level P_d. It depends on P_d because the export sector needs intermediate goods and services from the domestic economy. This means:

$$P_x = P_x\left(\overset{+}{P_d}\right) \tag{3}$$

We can define a real exchange rate for exports, μ_x, in the following way:

$$\mu_x = \mu_x(P_x, e, P_f) = \frac{P_x}{eP_f} \tag{4}$$

The quantity of exports depends negatively on this real exchange rate and positively on foreign income:

$$Q_x = Q_x\left(\overset{-}{\mu_x}, \overset{+}{Y_f}\right) \tag{5}$$

Import prices depend positively on the foreign price level, P_f:

$$P_m = P_m\left(\overset{+}{P_f}\right) \tag{6}$$

We can further define a real exchange rate for imports, μ_m in the following way:

$$\mu_m = \mu_m(e, P_m, P_d) = \frac{eP_m}{P_d} \tag{7}$$

[2]We assume here that all imports are denominated in foreign currency. This does of course not need to be the case. For instance, in the Euro area trade between members is denominated in the common currency – euro – so that the share of imports from other Euro area members does not have to be transformed into domestic currency by using the nominal exchange rate. This implications of this should be analyzed further but here is not the place to do so.

Then, import quantities depend negatively on μ_m, and positively on domestic income:

(8) $$Q_m = Q_m\left(\overset{-}{\mu_m}, \overset{+}{Y_d}\right)$$

Plugging the behavioral equations (3) to (8) into (1) yields:

(9) $$\begin{aligned}&TB\left(P_f, P_d, Y_f, Y_d, e\right) = \\ &P_x\left(\overset{+}{P_d}\right) Q_x\left(\overset{-}{\mu_x}, \overset{+}{Y_f}\right) - eP_m\left(\overset{+}{P_f}\right) Q_m\left(\overset{-}{\mu_m}, \overset{+}{Y_d}\right)\end{aligned}$$

In the next sections we fill first analyse how the trade balance reacts when the nominal exchange rate e is changed and then how the trade balance reacts to changes in the domestic price level P_d.

2.1 Changes in the nominal exchange rate

In order to have the most general results possible, we look at differences and not at differentials. According to (9), a change in e affects the trade balance both directly – because e is part of the trade balance – and indirectly through the dependency of Q_x and Q_m on e. The resulting change in the trade balance can be written:[3]

(10) $$\frac{\Delta TB}{\Delta e} = P_x\frac{\Delta Q_x}{\Delta e} - P_m\left(Q_m + \frac{\Delta Q_m}{\Delta e}(e + \Delta e)\right)$$

We can now define the following elasticities (with all elasticities being greater than zero):

(11) $$-\eta_{q_x,\mu_x} = \frac{\Delta Q_x}{\Delta \mu_x}\frac{\mu_x}{Q_x};$$

(12) $$-\eta_{q_m,\mu_m} = \frac{\Delta Q_m}{\Delta \mu_m}\frac{\mu_m}{Q_m};$$

(13) $$-\eta_{\mu_x,e} = \frac{\Delta \mu_x}{\Delta e}\frac{e}{\mu_x};$$

(14) $$\eta_{\mu_m,e} = \frac{\Delta \mu_m}{\Delta e}\frac{e}{\mu_m}$$

Because we know the functional form ob both μ_x and μ_m we can write more explicitly:[4]

(15) $$\eta_{\mu_x,e} = \frac{1}{1+\frac{\Delta e}{e}};$$

(16) $$\eta_{\mu_m,e} = 1$$

[3]The change in the trade balance is $\Delta TB = (P_x + \Delta P_x)(Q_x + \Delta Q_x) - (e + \Delta e)(P_m + \Delta P_m)(Q_m + \Delta Q_m) - (P_x Q_x - eP_m Q_m)$. When there is a variable that does not change, the respective change is zero.

[4]Using the fact that $e + \Delta e = e(1 + \frac{\Delta e}{e})$

In order to insert the elasticity of exports and imports with respect to μ_x and μ_m into (10) we can use the fact that:

$$\begin{aligned}\frac{\Delta Q_x}{\Delta e}\frac{e}{Q_x} &= \left(\frac{\Delta Q_x}{\Delta \mu_x}\frac{\mu_x}{Q_x}\right)\left(\frac{\Delta \mu_x}{\Delta e}\frac{e}{\mu_x}\right) \\ &= \eta_{q_x,e} = (-\eta_{q_x,\mu_x}) \times (-\eta_{\mu_x,e})\end{aligned} \tag{17}$$

and

$$\begin{aligned}\frac{\Delta Q_m}{\Delta e}\frac{e}{Q_m} &= \left(\frac{\Delta Q_m}{\Delta \mu_m}\frac{\mu_m}{Q_m}\right)\left(\frac{\Delta \mu_m}{\Delta e}\frac{e}{\mu_m}\right) \\ &= -\eta_{q_m,e} = -\eta_{q_m,\mu_m} \times \eta_{\mu_m,e}\end{aligned} \tag{18}$$

Substituting (15) and (16) into (17) and (18), solving those equations for $\frac{\Delta Q_x}{\Delta e}$ and for $\frac{\Delta Q_m}{\Delta e}$, then substituting the resulting expressions into (10) and re-arranging yields:

$$\Delta TB = \frac{\Delta e}{e}\left(P_x Q_x \frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}} - eP_m Q_m\left(1-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)\right)\right) \tag{19}$$

For very small changes in e, Δe approaches zero and the term $\frac{\Delta e}{e}$ also approaches zero. However, the higher the changes, the more the different Δe are important.

The trade balance will behave "normally" when a depreciation / an appreciation of the exchange rate (i.e. an increase / decrease of e) leads to an improvement / a deterioration of the trade balance, i.e. if $\frac{\Delta TB}{\Delta e} > 0$. This normal behavior takes place if the following condition is met:

$$P_x Q_x \frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}} \overset{!}{>} eP_m Q_m\left(1-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)\right) \tag{20}$$

If, however, the right hand side is higher than the left hand side, the trade balance will behave "perversely".

There are now four partial effects that are a play and which determine the overall sign and strength of the effect of changes in the exchange rate with respect to the trade balance:

- **Quantity effect of exports**, $\frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}}$: c.p. leads to a normal behavior of the trade balance since the exchange rate and the export volume are positively related (a deprecation (appreciation) leads to an increase (decrease) of exports). The effect is asymmetric depending on whether changes in e are positive or negative. With higher Δe, an increase in e (depreciation) leads to a smaller quantity effect of exports; with higher (absolute) Δe, a decrease in e (appreciation) leads to a bigger change in exports.

- **Quantity effect of imports**, $-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)$: c.p. leads to a normal behavior of the trade balance since the exchange rate and the import volume are negatively related (a deprecation (appreciation) leads to a decrease (increase) of imports). The effect is also asymmetric depending on whether changes in e are positive or negative. With higher Δe, an increase in e (depreciation) leads to a *higher* quantity effect of imports; with higher (absolute) Δe, a decrease in e (appreciation) leads to a *lower* change in imports.

- **Price effect of imports** (the first 1 on the right hand side of (20)): c.p. contributes to a *perverse* reaction of the trade balance. Through the price effect, the total import value changes one-to-one with the nominal exchange rate e.

- **Stock effect**, $P_xQ_x - eP_mQ_m$: This effect works c.p. asymmetrically as long as the right hand side of (20) is higher than zero. Given the elasticities, a sufficiently high surplus ($P_xQ_x > eP_mQ_m$) c.p. leads to a normal reaction of the trade balance. However, a sufficiently high deficit ($P_xQ_x < eP_mQ_m$) c.p. leads to a *perverse* reaction.

Some more explanation of the strange behavior due to the stock effect is in order. In general, the absolute change in the trade balance is due to the sum of absolute changes both in nominal exports and in nominal imports.

For instance, if the exchange rate depreciates, the absolute amount of initial nominal exports unambiguously increases by the factor $\frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}}$. The total reaction of the trade balance then depends on the absolute change of nominal imports. Nominal imports change by the factor $1-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)$. If this factor is positive (when that is the case, see below) imports also increase due to a depreciation. When the absolute increase in nominal imports is higher than the increase in nominal exports due to a nominal depreciation, the trade balance will behave perversely. But this perverse effect will be more likely, the higher the initial level of nominal imports relative to nominal exports. That means that with given factors the absolute change of exports and imports is higher, the higher the initial export and import values are.

Of course, the problem only occurs as long as $1-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right) > 0$, i.e. as long as:

$$\eta_{q_m,\mu_m} < \frac{1}{1+\frac{\Delta e}{e}} \tag{21}$$

If imports always decrease due to a depreciation (i.e. if the quantity effect is higher than the price effect), there will always be a normal reaction of the trade balance. If condition (21) holds however, a perverse reaction is possible (although not necessary).

In this condition we again find an asymmetry with depreciations and appreciations: with a given η_{q_m,μ_m} the higher ceteris paribus the depreciation of the nominal exchange rate – the higher e's *increase* – the higher is the likelihood of this condition *not* to be met and the right hand side of (20) to be negative so that the trade balance reaction would always be normal, independently of the price and stock effect. Put another way: the higher a percentage increase in e is, the more likely the trade balance is to behave normally. On the other hand, a higher appreciation and thus a higher *decrease* of e decreases the likelihood of the right hand side of (20) becoming zero. This in turn increases ceteris paribus the likelihood of a perverse reaction of the trade balance.

Overall, since the reaction of the trade balance depends on those four effects its normal reaction – the fulfillment of condition (20) – cannot be assured ex ante. One needs detailed empirical information about the initial export and import values, the import and export quantity elasticities and the amount of change in the nominal exchange rate before being able to make a statement about the trade balance's reaction.

Note that the fulfillment of the famous ML condition is *not* sufficient to postulate normalcy. The traditional ML condition, i.e. $\eta_{q_x,\mu_x} + \eta_{q_m,\mu_m} > 1$, can only be derived under the condition of an initially balanced trade balance ($P_xQ_x = eP_mQ_m$) and sufficiently small changes in Δe so that $\frac{\Delta e}{e}$ approaches zero.

The ML condition is thus much too restrictive for an application to the real world in which differing initial balances are present. It neither takes the asymmetric stock effect nor differences in Δe into account. Condition (20) is the more general and empirically relevant condition for changes in the nominal exchange rate.

So far we have looked at the consequences of changes in e for the trade balance. In the next section we will look how changes in the domestic price level, P_d, affect the trade balance and when they differ from changes in the nominal exchange rate.

2.2 Changes in the domestic price level

Next, we will look at the effects of changes in the domestic price level P_d on the trade balance. Using behavioral equation (9), changes in the trade balance due to changes in P_d are:

$$\frac{\Delta TB}{\Delta P_d} = P_x\frac{\Delta Q_x}{\Delta P_d} + \frac{\Delta P_x}{\Delta P_d}Q_x + \frac{\Delta P_x \Delta Q_x}{\Delta P_d} - eP_m\frac{\Delta Q_m}{\Delta P_d} \tag{22}$$

We can define the following additional elasticities:

$$\eta_{p_x,p_d} = \frac{\Delta P_x}{\Delta P_d}\frac{P_d}{P_x}; \tag{23}$$

$$\eta_{\mu_x,p_d} = \frac{\Delta \mu_x}{\Delta P_d}\frac{P_d}{\mu_x}; \tag{24}$$

$$-\eta_{\mu_m,p_d} = \frac{\Delta \mu_m}{\Delta P_d}\frac{P_d}{\mu_m} \tag{25}$$

Where (using again the fact that we know the functional form of both μ_x and μ_m):

$$\eta_{\mu_x,p_d} = \eta_{p_x,p_d} \tag{26}$$

$$\eta_{\mu_m,p_d} = \frac{1}{1+\frac{\Delta P_d}{P_d}} \tag{27}$$

We can now use the following identities:

$$\begin{aligned}\frac{\Delta Q_x}{\Delta P_d}\frac{P_d}{Q_x} &= \left(\frac{\Delta Q_x}{\Delta \mu_x}\frac{\mu_x}{Q_x}\right)\left(\frac{\Delta \mu_x}{\Delta P_d}\frac{P_d}{\mu_x}\right)\\ &= -\eta_{q_x,p_d} = -\eta_{q_x,\mu_x}\times\eta_{\mu_x,p_d}\end{aligned} \tag{28}$$

and

$$\begin{aligned}\frac{\Delta Q_m}{\Delta P_d}\frac{P_d}{Q_m} &= \left(\frac{\Delta Q_m}{\Delta \mu_m}\frac{\mu_m}{Q_m}\right)\left(\frac{\Delta \mu_m}{\Delta P_d}\frac{P_d}{\mu_m}\right)\\ &= \eta_{q_m,p_d} = -\eta_{q_m,\mu_m}\times -\eta_{\mu_m,p_d}\end{aligned} \tag{29}$$

Substituting (26) and (27) into (28) and (29), solving (28), (29) for $\frac{\Delta Q_x}{\Delta P_d}$ and $\frac{\Delta Q_m}{\Delta P_d}$ and substituting those and the elasticity of export prices with respect to the domestic price level into (22) yields (after re-arrangement):

$$\Delta TB = \frac{\Delta P_d}{P_d}\left(P_xQ_x\eta_{p_x,p_d}\left(1-\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}\frac{\Delta P_d}{P_d}\right)\right)-\frac{eP_mQ_m\eta_{q_m,\mu_m}}{1+\frac{\Delta P_d}{P_d}}\right) \tag{30}$$

The reaction of the trade balance would be normal if $\frac{\Delta TB}{\Delta P_d} < 0$, i.e. if the trade balance improved (deteriorated) if the price level decreased (increased). The condition for normalcy thus is:

$$eP_mQ_m\frac{\eta_{q_m,\mu_m}}{1+\frac{\Delta P_d}{P_d}} \overset{!}{>} P_xQ_x\eta_{p_x,p_d}\left(1-\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}\frac{\Delta P_d}{P_d}\right)\right) \tag{31}$$

As with changes in the trade balance due to changes in the nominal exchange rate, there are again four effects that determine the overall sign of the relation between the trade balance and the domestic price level. However, those effects work differently:

- **Quantity effect of exports**, $-\eta_{p_x,p_d}\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}\frac{\Delta P_d}{P_d}\right)$: c.p. leads to normal behavior of the trade balance because the price level and the export volume are negatively related (a depreciation (appreciation) leads to an increase (decrease) of exports). As with the export quantity effect of a change in e, an appreciation increases the effect and a depreciation decreases it. In constrast to changes in e, the reaction of exports is mediated by the effect on the general domestic price level on the export price level, i.e. by η_{p_x,p_d}.

- **Quantity effect of imports**, $\frac{\eta_{q_m,\mu_m}}{1+\frac{\Delta P_d}{P_d}}$: c.p. also leads to a normal behavior of the trade balance (a depreciation (appreciation) leads to a decrease (increase) of imports). The effect is again asymmetric depending on the whether the price level increases or decreases. An increase (an appreciation) lowers the the quantity effect; a decrease increases the effect.

- **Price effect of exports**, η_{p_x,p_d}: c.p. does lead to a perverse reaction of the trade balance. Through the price effect, the total export value changes by the factor η_{p_x,p_d} to changes in the price level. Note that there is no price effect of imports as there was in the case of a change in the exchange rate. This is a more fundamental difference between changes in the exchange rate and changes in the price level than the differences in the two aforementioned quantity effects.

- **Stock effect**, $P_xQ_x - P_mQ_m$: This effect c.p. works asymmetrically but in the exact opposite way as with changes in the nominal exchange rate: Given the elasticities and the change in P_d, a sufficiently high *deficit* ($P_mQ_m > P_xQ_x$) leads to a normal reaction of the trade balance. In the case of changes in e it was a sufficiently high surplus that allowed a normal reaction. On the other hand, a sufficiently high surplus ($P_xQ_x > P_mQ_m$) c.p. leads to a perverse reaction (a deficit did that in the case of changes in e).

Thus, the four effects for changes in P_d differ from the case in which e changes. Those differences are especially pronounced in the price effect and in the stock effect.

Again, as with changes in e, there is again a condition that has to be met which makes the perversity possible. In the case of changes in P_d the perversity can only occur (but does not necessarily have to occur) if the right hand side of (31) is higher than zero:

$$\eta_{q_x,\mu_x} < \frac{1}{1+\eta_{p_x,p_d}\frac{\Delta P_d}{P_d}} \tag{32}$$

There is again an asymmetry depending of whether there is an appreciation ($\Delta P_d > 0$) or a depreciation ($\Delta P_d < 0$). However, the case is the reverse from changes in e since an increase (decrease) in e is a depreciation (appreciation) of e but an appreciation (depreciation) of P_d. This means that an appreciation due to P_d makes the overall non-normal reaction of the trade balance less likely and a depreciation makes it more likely.

Again, the ML condition is not sufficient to guarantee normalcy. The ML condition would only be valid for certain assumptions: we would need the initial trade balance to be zero, changes in ΔP_d to be sufficiently small so that $\frac{\Delta P_d}{P_d}$ is close to zero and the additional assumption that η_{p_x,p_d} be unity. Only under those very restrictive assumptions one can deduce the ML conditions also for changes in P_d.

It is also under these conditions that the reaction of the trade balance is the same both for changes in e and in P_d. However, if these conditions are not met, the reaction of the trade balance is likely to differ. This will be shown in the remainder.

2.3 Summary of qualitative results so far

Table 1 summarizes the qualitative results so far obtained:

- As such, the quantity effects on both imports and exports contribute to a normal reaction of the trade balance;
- ceteris paribus price effects on imports and exports contribute to a perverse reaction;
- the stock effect differs between changes in e and P_d: when e changes, an initial surplus tends to contribute to a normal reaction and a deficit tends to contribute to a perverse reaction; the reverse is the case with changes in P_d.
- With a sufficiently strong *depreciation* of the nominal exchange rate, the normalcy condition is more likely to hold; on the other hand, with a sufficiently strong *appreciation* of the domestic price level P_d is the normalcy condition more likely to hold.

Table 1: Partial effects (*n* – normal reaction; *p* - perverse reaction)

	Quantity effect of exports	Quantity effect of imports	Price effect of imports	Price effect of exports	Stock effect *surplus*	Stock effect *deficit*
Δe	*n*	*n*	*p*	–	*n*	*p*
ΔP_d	*n*	*n*	–	*p*	*p*	*n*

2.4 When does the trade balance react equally to changes in e and P_d?

In this section we show the condition under which the trade balance reacts in the same way to both changes in e and P_d. To do that we compare an appreciation of the same magnitude for both variables. The exchange rate e then decreases and the domestic price level increases by the same amount a, so that $a = |-\Delta e/e| = |\Delta P_d/P_d|$ (an appreciation would mean that the minus sign would be reversed). For changes in the nominal exchange rate this gives:

$$\begin{aligned} \Delta TB &= -a\left(\frac{P_x Q_x \eta_{q_x,\mu_x}}{1-a} - eP_m Q_m \left(1 - \eta_{q_m,\mu_m}\left(1-a\right)\right)\right) \\ &= a\left(eP_m Q_m \left(1 - \eta_{q_m,\mu_m}\left(1-a\right)\right) - \frac{P_x Q_x \eta_{q_x,\mu_x}}{1-a}\right) \end{aligned} \tag{33}$$

For changes in the price level, this gives:

$$\Delta TB = a\left(P_x Q_x \eta_{p_x,p_d}\left(1-\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}a\right)\right)-\frac{eP_m Q_m \eta_{q_m,\mu_m}}{1+a}\right) \tag{34}$$

Setting both equations equal gives this condition for an equal reaction of the trade balance to the same percentage changes in nominal exchange rates and in the price level:

$$\frac{eP_m Q_m}{P_x Q_x} = \frac{\eta_{p_x,p_d}\left(1-\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}a\right)\right)+\frac{\eta_{q_x,\mu_x}}{1-a}}{1-\eta_{q_m,\mu_m}(1-a)+\frac{\eta_{q_m,\mu_m}}{1+a}} \tag{35}$$

There might be a lot of solutions to this equality, but one important solution would be the aforementioned conditions for the ML condition to hold. If the trade balance was be zero (so that $\frac{eP_m Q_m}{P_x Q_x} = 1$), changes in e and P_d close to zero ($a \to 0$) and the elasticity of export prices with respect to the price level unity, i.e. $\eta_{p_x,p_d} = 1$, the reaction of the trade balance would be the same for both changes in e and P_d.

Again, one can see that those conditions are quite restrictive so that we cannot claim that the trade balance generally reacts the same way to both changes in nominal exchange rates and the price level. In most empirical cases, the reaction will be quite different. A simple simulation will show that.

2.5 Simulation

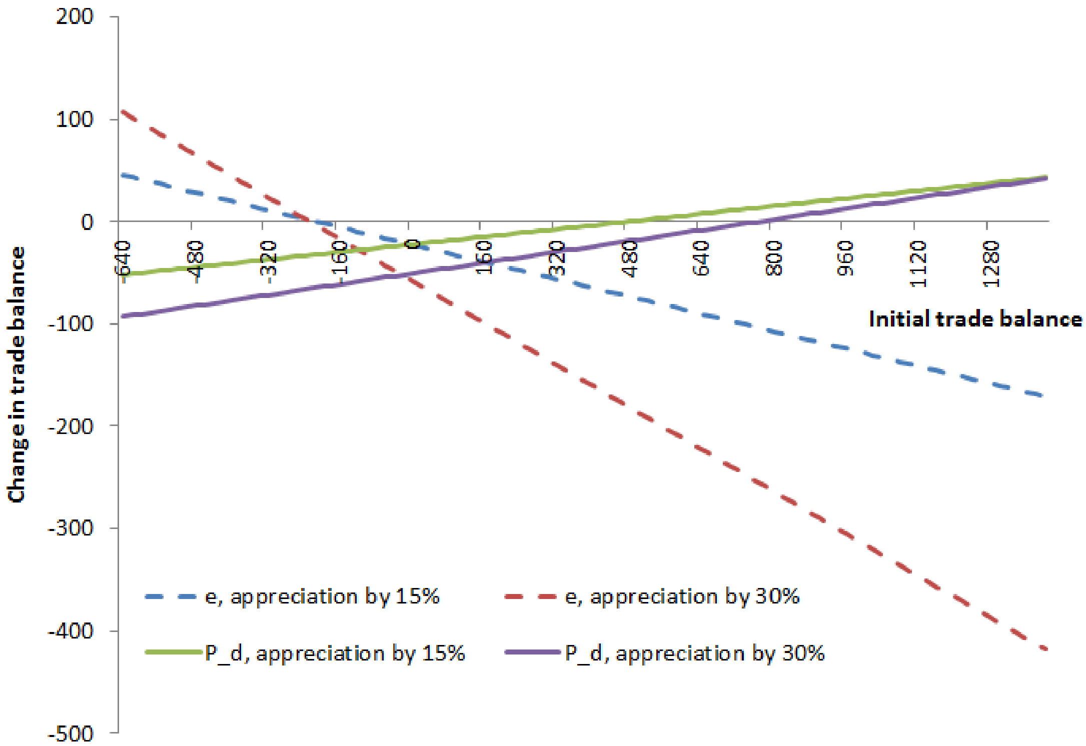
In order to illustrate the different reactions of the trade balance to changes in e and P_d, a simple simulation has been conducted in which η_{q_x,μ_x} and η_{q_m,μ_m} are each set to 0.6 (so that the Marshall Lerner condition is fulfilled) and η_{p_x,p_d} is set to unity. Changes in the nominal exchange rate and the domestic price level of 15 % and 30 % are assumed. The formal fulfillment of the ML condition is used in order to illustrate that this condition is *not* sufficient to postulate a normal reaction of the trade balance. Figure 1 shows the reaction of the trade balance to an appreciation; figure 2 shows the reaction to a depreciation.

Figure 1 shows by how much the trade balance changes (on the y-axis) with a given initial trade balance (on the x-axis).[5] The general idea of the figure does not change when the elasticities are changed as long as they each take a value of lower than one.

The normal reaction to an appreciation would be a negative change of the trade balance. However, as one can clearly see in the figure, at sufficiently high initial deficits, an appreciation of the nominal exchange rate leads to an improvement of the trade balance. And the stronger the appreciation is, the higher is the improvement

[5] However, not only the initial amount of the balance is of importance but also the initial amount of both exports and imports separately. Here, exports have been changed in increments of 20 and imports stay the same at a value of 1000. When only imports are changed and not exports, the lines look differently but the general conclusions are the same.

Figure 1: Changes in the trade balance with an appreciation of 15 % and 30 %, $\eta_{q_x,\mu_x} = \eta_{q_m,\mu_m} = 0.6$ and $\eta_{p_x,p_d} = 1$



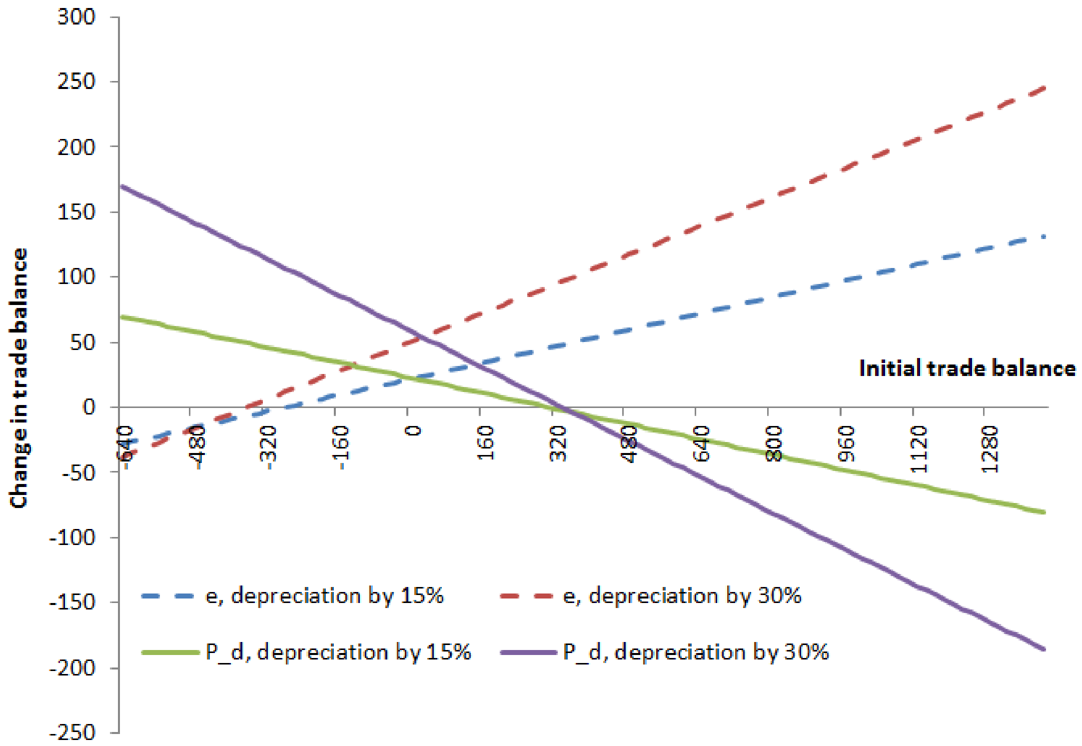
of the trade balance. On the other hand, at sufficiently high surpluses, an appreciation of the domestic price level also leads to a non-normal improvement of the trade balance.

This means that it depends on the specific situation of the country how the trade balance will react. Countries that want to reduce surpluses might have to pursue other strategies than countries that want to reduce their deficits.

One can also see that – for given percentage changes in e and P_d – the change in the trade balance is equal when the initial trade balance is roughly at zero. This again shows the centrality of the analytical result derived above that a zero trade balance is a crucial condition for the equality of the reaction of the trade balance to changes both in e and P_d. As the figure nicely shows, such an equality cannot be assumed for other values of the initial trade balance.

Figure 2 shows the case of a depreciation of 15 % and 30 % under otherwise identical conditions. A normal reaction to a depreciation would in this case mean a positive reaction of the trade balance. All the effects already described in figure 1 can also be seen. However, by comparing both figures one can see that the reaction of the trade balance is clearly asymmetric between appreciation and depreciation: When there is an appreciation of the nominal exchange rate, the trade balance reacts by much more

Figure 2: Changes in the trade balance with a depreciation of 15 % and 30 %, $\eta_{q_x,\mu_x} = \eta_{q_m,\mu_m} = 0.6$ and $\eta_{p_x,p_d} = 1$



(dotted red and blue line in figure 1) than it does when the exchange rate depreciates (dotted red and blue line in figure 2).

The reverse is true with changes in the domestic price level: With an appreciation (purple and green line in figure 1) the trade balance reacts less strongly than with a depreciation (purple and green line in figure 2).

Overall, the figures make clear that reactions of the trade balance tend to be quite complex and depend on many different factors. There is thus no clear cut way to anticipate how the trade balance wil react to an appreciation or depreciation. The details of the specific situation matter and the ML condition is not sufficient to make predictions of the trade balance's reaction.

3 Conclusion

The paper has analysed the different impact of changes of the nominal exchange rate and the price level on the trade balance. It has shown analytically that there might be a big difference of the trade balance's reaction to different kinds of changes in the real exchange rate, depending both on the absolute amount of changes in the rate, the sign of the change and the initial position of the trade balance. Thus, for countries with sufficiently high deficits wishing to reduce that deficit a decrease of their price level might be the best way to achieve their target. A depreciation of their nominal exchange rate might on the other hand even increase their deficits. Vice versa for countries with high surpluses wishing to reduce those surpluses: they might be best served if they appreciate their nominal exchange rate. An increase in their price level might even increase their surplus further.

The asymmetry between surplus and deficit countries is of course of importance in a monetary union. Since nominal exchange rates cannot be changed between its members, only the price level is an instrument that can be influenced. If the present paper's analytical conclusions also hold for empirically sensible deficits and surpluses, the policy implications for an adjustment of deficits and surpluses within a monetary union are quite important.

The paper has of course left out many issues that should be tackled in future research: the most obvious point is to test empirically whether the above conclusions are empirically valid. Also, the role of financial factors – i.e. flows in the financial account – have not been analyzed. It is most likely that they tend to influence income and thereby imports. For instance, a country which is cut off from external financing will not be able to have the same domestic income as before so that imports automatically decrease independent of changes in the price level or the nominal exchange rate. Further, here the assumption of an infinite elasticity of supply was made. It would be necessary to also draw the conclusions for finite elasticities of supply and see what implications they have for the results obtained so far.

References

Arghyrou, Michael G. and Georgios Chortareas, “Current account imbalances and real exchange rates in the euro area,” *Review of International Economics*, 2008, *9* (5), 747–764.

Bahmani-Oskooee, Mohsen and Artatrana Ratha, “The J-Curve: a literature review,” *Applied Economics*, 2004, *36* (13), 1377–1398.

Coudert, Virginie, Cécile Couharde, and Valérie Mignon, “On Currency Misalignments within the euro area,” *Review of International Economics*, 2013, *21* (1), 35–48.

Gandolfo, Giancarlo, *International Finance and Open-Economy Macroeconomics*, Springer, 2002.

Harberger, Arnold C., “Currency depreciation, income, and the balance of trade,” *Journal of Political Economy*, 1950, *58* (1), 47–60.

Lee, Jaewoo and Menzie D. Chinn, “Current account and real exchange rate dynamics in the G7 countries,” *Journal of International Money and Finance*, 2006, *25*, 257–274.

Robinson, Joan, “The Foreign Exchanges,” in Lloyd A. Ellis, Howard S. Metzler, ed., *Readings in the Theory of International Trade*, George Allen and Unwin, 1950, pp. 83–103.