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CHANGES OF THE PRICE LEVEL AND THE NOMINAL EXCHANGE RATE CAN 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 change. 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. However, as will be shown analytically in this 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 initial trade surplus, a country's increase of the price level (an appreciation) can lead to a further – and perverse – *increase* in the surplus. On the other hand, with a sufficiently high initial deficit, a country's depreciation of the nominal exchange rate can lead to a – perverse – further widening of the deficit. Formal conditions are derived under which the reaction of the trade balance is normal or perverse. As will be shown, 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 reacts in the same way to changes in the price level and 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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Changes of the price level and the nominal exchange rate can have quite different impacts on the trade balance

Fabian Lindner*

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 change. 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. However, as will be shown analytically in this 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 initial trade surplus, a country's increase of the price level (an appreciation) can lead to a further – and perverse – *increase* in the surplus. On the other hand, with a sufficiently high initial deficit, a country's depreciation of the nominal exchange rate can lead to a – perverse – further widening of the deficit. Formal conditions are derived under which the reaction of the trade balance is normal or perverse. As will be shown, 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 reacts in the same way to changes in the price level and 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 nominal trade balance independently of whether the change is due to changes in the nominal exchange rate or the domestic price level. Both change the real exchange rate and thus are seen to lead to the same reaction of the trade balance. (Lee and Chinn, 2006; Arghyrou and Chortareas, 2008; Coudert et al., 2013).

This is of great importance in a monetary union such as the European Montary Union. Since members have given up their currencies, the only way to reduce current account deficits is to decrease their domestic price (and wage) level vis--vis other monetary union members and for current account surplus countries to increase their domestic price level (for instance Belke and Gros (2017) and Carlin (2013)).

The following paper will however show that changes in the price level and in the nominal exchange rate *cannot* generally be seen as equivalent. Depending on whether countries initially have deficits or surpluses, a change of the nominal exchange rate can have fundamentally different effects than the same absolute changes in the price level.

The analytical results will show that countries with sufficiently high surpluses are in danger of increasing their surpluses when they raise their domestic price levels – the exact reverse of what one would traditionally expect. As the analysis will show, an appreciation of the nominal exchange rate could be much more effective for surplus countries wishing to reduce their surpluses. On the other hand, countries with sufficiently high deficits could further deteriorate their trade balance if they depreciated their nominal exchange rate; they might however be effective in reducing their deficits by decreasing their domestic price level.

Those perverse effects are mostly due to price effects that affect the trade balance differently for changes in nominal exchange rates and in the price level: as is traditionally known, a depreciation of the nominal exchange not only leads to an increase in exported goods and services and a decrease in imported goods and services but also to an increase in the price of imports. Since import quantities decrease but import prices increase, it is not clear ex ante whether the import *value* increases, decreases or stays the same. The classical Marshall-Lerner (ML) condition shows under which condition the import quantity effect dominates the import price effect so that the trade balance behaves normally.

However, while export and import quantity effects are the same when the domestic price level changes, the price effect is not. The price level does not influence import prices but export prices because changes in the price and wage level lead to changes in *export* – and not import – prices. Under certain conditions, this difference in the price effects leads to quite different reactions of the overall trade balance.

As will be shown, the ML condition for the normalcy of the trade balance reaction only applies to changes in the price level when the initial trade balance is zero. When it is not zero – i.e. in deficit or in surplus – the ML condition does neither apply to changes in the nominal exchange rate nor the price level, nor are the reactions of the trade balance equal for those two types of changes.

Those conclusions are as of yet only theoretical. They abstract from the interlinkages between the price level and the exchange rate with domestic income (an issue that will not be discussed here). It is however those interlinkages which are very important in the real world. However, given that much of the literature focuses on exchanges rates and price levels and just assumes the effects of both changes to be equivalant, we will show here that one has to be extremely careful. The paper's bottomline is that exchange rate and price changes do not work unambiguously on the nominal trade balance.

The paper adds to the literature in the following way: the dependence of the ML condition on the initial trade balance has already been mentioned by other authors (see for instance the classic contributions by Robinson (1950) and Harberger (1950)).[1] But its conclusions have (to my knowledge) rarely been seriously analyzed. This is especially noteworthy since changes in exchange rates are mostly pondered when there are trade deficits and surpluses and not when the trade balance is zero.

More importantly and new however is the present paper's analytical derivation of the effects of the domestic price level on the trade balance and the systematic comparison of trade balance reactions to changes of the nominal exchange rate and of the domestic price level.

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).

The paper is structured in the following way: The first part sets out the behavioral equations necessary for the analysis. In the second part, the effects of changes in the nominal exchange rate on the trade balance will be derived as well as all the partial effects

[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)

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 Changes of the nominal trade balance

In this section we will establish the central behavioral assumptions. Before presenting those assumptions let us first state the more general assumptions (see Goldstein and Khan (1985) for the different implications of those 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 because many domestic services cannot be traded and thus not be substituted for imported goods.

Third, the following analysis is conducted in terms of domestic currency and not foreign currency. One could also conduct the analysis in terms of foreign currency. This would be 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 denominated in their own currency so that the implications for foreign currency reserves are not essential here.

Fourth and last, we assume that all elasticities that will be defined later on in the paper (elasticity of quantities with respect to prices etc.) are constant, i.e. that they are independent of the initial export or import values. This is a strong assumption because it assumes a certain form of the demand curves, namely an isoelastic demand function. We make this assumption here for two reasons: First, the literature so far did also make this assumption, although mostly only implicitly. Since we already question much of the received wisdom of the literature by relaxing certain assumptions, the analysis would be even more complicated if we also relaxed this assumption.

Second, we do not know the exact form of the demand function, so we have to make some assumption about its form in order to be able to conduct an analysis in the first place. But it is clear that the following conclusions only hold under this assumption. Future research should also look at other demand functions and see whether the standard model's conclusion and this paper's conclusions might hold up to a more flexible treatment of elasticities.

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:

$$TB = P_x Q_x - e P_m Q_m \tag{1}$$

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

[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. The implications of this should be analyzed further but here is not the place to do so.

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:

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

Note that we use the export price level in the numerator, not the domestic price level. This is done because it is not always the case that the domestic price level and the export price level are equal to each other, especially if domestic and traded goods are not perfect complements – which they are often not, because many domestically produced goods are services that cannot be traded internationally.

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:

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

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

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

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

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

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.

3 Changes in the nominal exchange rate

In this section we will derive the condition under which the trade reacts behaves "normally" to changes in the nominal exchange rate e. The only addition to the literature in this section is the use of differences and not differentials. The main interest in this section is to introduce the mode of analysis and then apply it in the next section to changes in the domestic price level.

According to (9), a change in e affects the trade balance both directly – because e is part of nominal imports – and indirectly through the dependency of Q_x and Q_m on e via μ_x and μ_m. The resulting change in the trade balance can be written:[3]

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

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

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

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

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

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

Because we know the functional form ob both μ_x and μ_m (see equations (4) and (7)) we can write more explicitly:[4]

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

$$\eta_{\mu_m,e} = 1 \tag{16}$$

[3] The change in the trade balance is:

$$\Delta TB = (P_x + \Delta P_x)(Q_x + \Delta Q_x) - (e + \Delta e)(P_m + \Delta P_m)(Q_m + \Delta Q_m) - (P_x Q_x - e P_m Q_m)$$

When there is a variable that does not change according to the behavioral equations, 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:

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

and

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

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:

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

What does this equation mean? It shows how a percentage change in the nominal exchange rate ($\frac{\Delta e}{e}$) leads to an absolute change in the trade balance. The factors $\frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}}$ and $\left(1 - \eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)\right)$ are multiplied by the percentage change in the exchange rate value as well as the initial export / import values and thereby yield the absolute changes in the export / import values. The difference of those changes yields the change in the trade balance.

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. This is the case if $\frac{\Delta TB}{\Delta e} > 0$, i.e. if:

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

Equation (20) is thus the normalcy condition for the trade balance's reaction to changes in e.

If, however, the right hand side of (20) is higher than the left hand side, the trade balance will behave "perversely". Note that compared to the traditional ML condition

$(\eta_{q_x,\mu_x} + \eta_{q_m,\mu_m} \overset{!}{>} 1)$, this is the more general condition for normaly. But it is only valid for changes of e and not – as we will see in section 4 – for changes of P_d.

By making two further assumptions we can derive the ML-condition. The two assumptions are *a)* that the initial trade balance is zero, i.e. $P_xQ_x = eP_mQ_m$ and *b)* that Δe approaches zero. Substituting those two assumptions into (20) yields the ML condition. As is obvious, the ML condition is not sufficient if the two assumptions of an initial zero trade balance and higher absolute change in e are not met.

In condition (20), one can identify four different partial effects that are a play and determine the overall sign and strength of the reaction of the trade balance to changes in the nominal exchange rate.

The four effects are:

- the **export quantity effect** and the **import quantity effect**. They capture the reaction of Q_x and Q_m due to a change of e;
- The **price effect of imports** captures the change in the value of imports (eP_mQ_m) due to a change the nominal exchange rate e;
- The **base effect** captures the effect of the initial trade balance $(P_xQ_x - eP_mQ_m)$ on the trade balance's absolute change.

We will discuss each effect in turn: The **quantity effects of exports and imports** capture by how much Q_x and Q_m change when the nominal exchange rate changes. The quantity effect of exports is the term $\frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}}$ in equation (20). It gives the factor by which the initial export quantity Q_x changes.

The quantity effect of imports is the term $-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)$. It is the factor by which the initial import quantity Q_m changes. Ceteris paribus, both quantity effects lead to a *normal* reaction of the trade balance: a depreciation (appreciation) of the nominal exchange rate leads to an increase (decrease) in Q_x and a decrease (increase) in Q_m.[5]

The **price effect of imports** cetris paribus leads to a *perverse* reaction of the trade balance. In equation (20) it is the first 1 on the right hand side. The 1 means that a change of e changes the value of imports (eP_mQ_m) one-by-one. Since a depreciation

[5] The existence of the term $1+\frac{\Delta e}{e}$ in both quantity effects shows that export and import quantities react asymmetrically to changes in the nominal exchange rate. An *increase* (a depreciation) in e lowers the magnitude of the export quantity effect but increases the magnitude of the import quantity effect. That means that – ceteris paribus – imports react more strongly to a depreciation than exports. The higher the absolute change in e, the more this effects becomes important.

The opposite is the case for a decrease in e (an appreciation): It increases the export quantity effect and lowers the import quantity effect. This in turn means that – ceteris paribus – exports react more strongly to an appreciation than imports.

means that e increases, a depreciation leads to an increase of the import value which as such leads to the non-normal – i.e. perverse – deterioration of the trade balance.

The fourth effect is the **base effect**. This is the effect of the initial value of exports and imports. This effect works asymetrically. As one can see in the normality condition (equation (20)), a trade surplus ($P_xQ_x > eP_mQ_m$) is ceteris paribus more likely to lead to a *normal* reaction because (20) is more likely to be positive. On the other hand, a deficit ($P_xQ_x < eP_mQ_m$) is more likely to lead to a *perverse* reaction because then (20) is more likely to be negative.

The base effect is central to the following discussion. It will be shown later that the base effect operates in exactly the opposite way when the price level changes. The base effect is highly significant for actual economic policy: depreciations and appreciations are mostly discussed when countries have initial non-zero trade balances and want (or have to) reduce either initial deficits or initial surpluses. Since the ML condition is only valid with initially balanced trade, it is of little interest when initial balances are non-zero. And as will be shown in more detail in the remainder, non-zero balances lead to non-trivial reactions of the trade balance.

Why does the base effect have those strange properties – i.e. leading to a possible perverse reaction with high deficits and normal reactions with high surpluses? Let us take the example of a depreciation, i.e. an increase in e. When the import price effect dominates the import quantity effect, the right hand side of (20) is positive: a depreciation increases the *value* of imports by the factor $1-\eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right)$. The export value on the other hand unambiguously increases (due to the export quantity effect) by the factor $\frac{\eta_{q_x,\mu_x}}{1+\frac{\Delta e}{e}}$.

When both export and import values increase, the trade balance only reacts normally to a depreciation if exports increased more in absolute terms than imports. And this in turn is more likely the higher the initial export values are relative to the import values, i.e. the higher the initial bases are with which the factors are multiplied.

On the other hand, if there is a sufficiently high initial import surplus, the likelihood of a perverse reaction increases because with the same factors, there are now different bases with which those factors are multiplied.

The base effect is however only a possibility under one important condition, and that is if the right hand side of (20) is higher than zero, i.e. if the price effect dominates the import quantity effect:

$$1 > \eta_{q_m,\mu_m}\left(1+\frac{\Delta e}{e}\right) \tag{21}$$

This is the necessary (but not sufficient) condition for the base effect to lead to a perverse reaction of the trade balance.

The existence (and dominance) of the price effect is thus central for the base effect. Also we can see that the sign and amount of Δe (with a given elasticity of imports) determines whether the price effect dominates the import quantity effect and thus makes the base effect operable. With $\Delta e > 0$, the higher Δe is, the *less* likely is the base effect to play a role. On the other hand, with $\Delta e < 0$, a higher change in e is *more* likely bring the base effect into play.

That means that countries with high deficits might further increase their deficits when they depreciate their nominal exchange rate only a little (small positive Δe). But when they depreciate their exchange rate very much (high positive Δe), the perverse base effect is much less likely to hit. On the other hand, a large appreciation (high *negative* Δe) is more likely to lead to a perverse reaction than a small appreciation (low negative Δe).

From the above discussion we see that non-zero initial balances and discrete changes in e can lead to non-trivial reactions of the trade balance. And those might be empirically relevant because most countries tend to have non-zero balances that they want to change by changing their exchange rates. As has been shown, the ML condition is not sufficient to guarantee normalcy. The more complicated condition (20) is central.

One would thus need 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.

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

4 Changes in the domestic price level

Using behavioral equation (9), changes in the trade balance due to changes in P_d are:

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

In addition to the elasticities already defined above, we also need the following elasticities:

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

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

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

Again using the fact that we know the functional form of both μ_x and μ_m, we can write:

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

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

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) and (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):

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

Like equation (19), this equation gives us the absolute change in the trade balance due to the percentage change in the domestic price level.

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 a normal reaction of the trade balance to changes in P_d– the equivalent to equation (20) – thus is:

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

The ML condition can be derived from this condition by making three assumptions: *a)* The initial trade balance has to be zero, *b)* ΔP_d has to approach zero and *c)* the elasticity of export prices with respect to import prices, η_{p_x,p_d} has to be unity. This has an important implication: under those three conditions (and that Δe approaches zero), changes in e and P_d lead to the same effect on the trade balance – a finding that we will analyze in more detail below.

As with changes in the trade balance due to changes of e, there are again four effects that determine the overall sign of the relation between the trade balance and the domestic price level. The export and import quantity effects ($-\eta_{q_x,\mu_x}\left(1+\eta_{p_x,p_d}\frac{\Delta P_d}{P_d}\right)$ and $\frac{\eta_{q_m,\mu_m}}{1+\frac{\Delta P_d}{P_d}}$) are similar and both contribute to a normal reaction of the trade balance. However, the price effect and in consequence the base effect are fundamentally different.[6]

When e changes the price effect affects imports. But when P_d changes, the price effect affects exports. This export price effect is equal to η_{p_x,p_d}, i.e. to the elasticity of changes in export prices P_x to the domestic price level P_d. A certain percentage change of domestic prices leads to a certain percentage change of export prices and thus the value of exports. This effect works in the opposite direction of the export quantity effect and thereby contributes to a perverse reaction of the trade balance.

The difference of the price effects leads to an important difference of the base effects: whereas sufficiently high export *deficits* tend to lead to a perverse reaction when e changes, high export *surpluses* lead to a perverse reaction when P_d changes (but only if the price effect dominates the quantity effect). We will turn to this condition in a moment.

Why is there such a difference in the base effects between changes in P_d and in e? The logic is the following: when e changes, it is the *import* price effect that contributes to a perverse reaction of the trade balance. The higher absolute *imports* are relative to

[6]While the export and import price effects look quite different they are qualitatively the same as in the case of changes in the nominal exchange rate. For appreciations and depreciations due to changes in the nominal exchange rate and the domestic price level, they yield the same results: a depreciation (appreciation) increases (decreases) exports and decreases (increases) imports, thereby contributing to a normal reaction of the trade balance. The difference in signs only reflects the fact that a depreciation (appreciation) of the nominal exchange rate means that e increases (decreases) while a depreciation (appreciation) of the domestic price level means that p_d decreases (increases).

exports, the higher is the likelihood of a perverse reaction. On the other hand, when P_d changes the price effect applies to *exports*. Then, higher absolute exports relative to imports increase the export price effect: sufficiently high export surpluses render a perverse reaction more likely.

The difference in the price and base effects leads to a fundamental asymmetry between changes in e and in P_d: as long as the respective price effects dominate the respective quantity effects, countries with very high surpluses might increase their surpluses even further when they increase their domestic price level P_d. While their export quantities decrease, their overall export value will increase and thus also their trade balance – a perverse reaction. In this situation, a depreciation of their nominal exchange rate e would be more likely to lead to a normal reaction and a decrease of their surpluses.

On the other hand, countries with very high deficits might see their deficits widen even further when they depreciate their nominal exchange rate. For them, a decrease in their price level might be more effective to bring down their deficits.

Now we will discuss in more detail the condition for the base effect to come into play when P_d changes, namely that the price effect dominates the quantity effect. This is the case if the right hand side of (31) is higher than zero, i.e. if:

$$1 > \eta_{q_x,\mu_x}\left(1 + \eta_{p_x,p_d}\frac{\Delta P_d}{P_d}\right) \tag{32}$$

This is the necessary (but not sufficient) condition for the base effect to lead to perverse reactions of the trade balance. As with different signs and amounts of Δe we see an asymmetry due to the sign and amount of ΔP_d: The higher ΔP_d (with given η_{q_x,μ_x} and η_{p_x,p_d}), the less likely the base effect is to hit. That means that the higher the appreciation is, the less likely the trade balance will behave perversely. Contrast that with the finding when e changes: There, a depreciation decreased the likelihood of the base effect to play a role.

On the other hand, when ΔP_d is negative and its absolute amount sufficiently high, the likelihood of the base effect to play a – perverse – role is increased. This is again the exact opposite to changes in e where an appreciation increased the likelihood of the base effect.

Overall, we see significant differences between changes in nominal exchange rates e and the domestic price level P_d. Possible perverse effects are more likely to hit when countries with high export deficits try to devalue their nominal exchange rate; and on the other hand perverse effects are more likely when countries with high surpluses increase their domestic price level.

For both changes, the ML condition can be derived under very restrictive assumptions that limit its empirical relevance. With those assumptions the reaction of the trade balance is the same for both changes. However, in all other cases the reaction is likely to be quite different. In the remainder we will discuss this point in more detail.

4.1 Summary of qualitative results

Table 1 summarizes the qualitative results so far obtained:

- Ceteris paribus, the quantity effects on both imports and exports contribute to a normal reaction of the trade balance;
- ceteris paribus, the price effects of imports and the price effect of exports contribute to a perverse reaction;
- the base 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 when P_d changes.

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	Base effect	
					surplus	*deficit*
Δe	n	n	p	–	n	p
ΔP_d	n	n	–	p	p	n

4.2 When does the trade balance react in the same way to changes in e and P_d?

We had already shown that the reaction of the trade balance is the same for changes in e and P_d when the assumptions for the ML condition are met. In this section we derive the general 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 an appreciation of the nominal exchange rate this gives:

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

For an appreciation due to a change in the price level, this gives:

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

Setting equations (33) and (34) equal to each other yields this condition for an equal reaction of the trade balance to the same percentage changes in nominal exchange rates and in the price level:

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

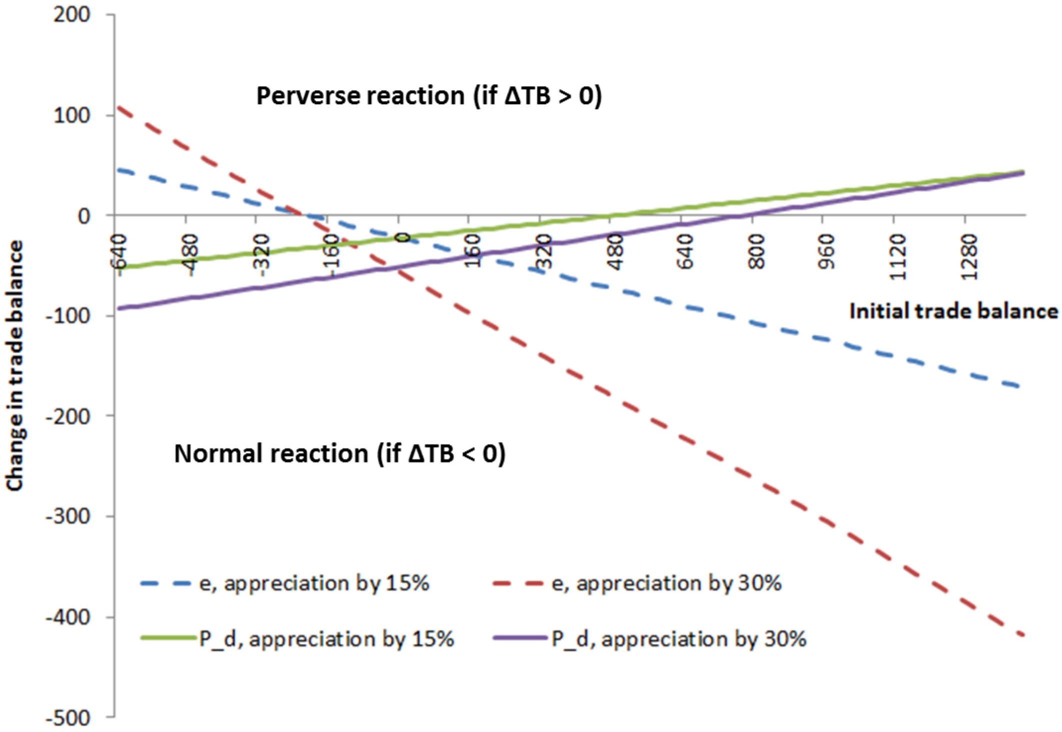
There might be a lot of solutions to this equality, but one important solution would be the aforementioned conditions for the ML condition to hold. If the trade balance was zero (so that $\frac{eP_mQ_m}{P_xQ_x} = 1$), changes in e and P_d close to zero ($a \to 0$) and the elasticity of export prices 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. If the preceding theoretical discussion is valid, the reaction might be quite different in many empirical cases. A simple simulation will illustrate the theoretical possibilities.

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 of e and P_d; Figure 2 shows the reaction to a depreciation of e and P_d.

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 $\eta_{p_x,p_d} = 1$



The Figures 1 and 2 show by how much the trade balance changes (on the y-axis) with a given initial trade balance (on the x-axis). The reaction of the trade balance due to changes of e are the dotted lines; changes due to P_d are the straight lines.[7] The general idea of the Figures 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 of e (Figure **??**) would be a negative change of the trade balance (i.e. below the x-axis). However, as one can clearly see in Figure 1, 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

[7]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.

more the trade balance improves. 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 an initial 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.

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 $\eta_{p_x,p_d} = 1$

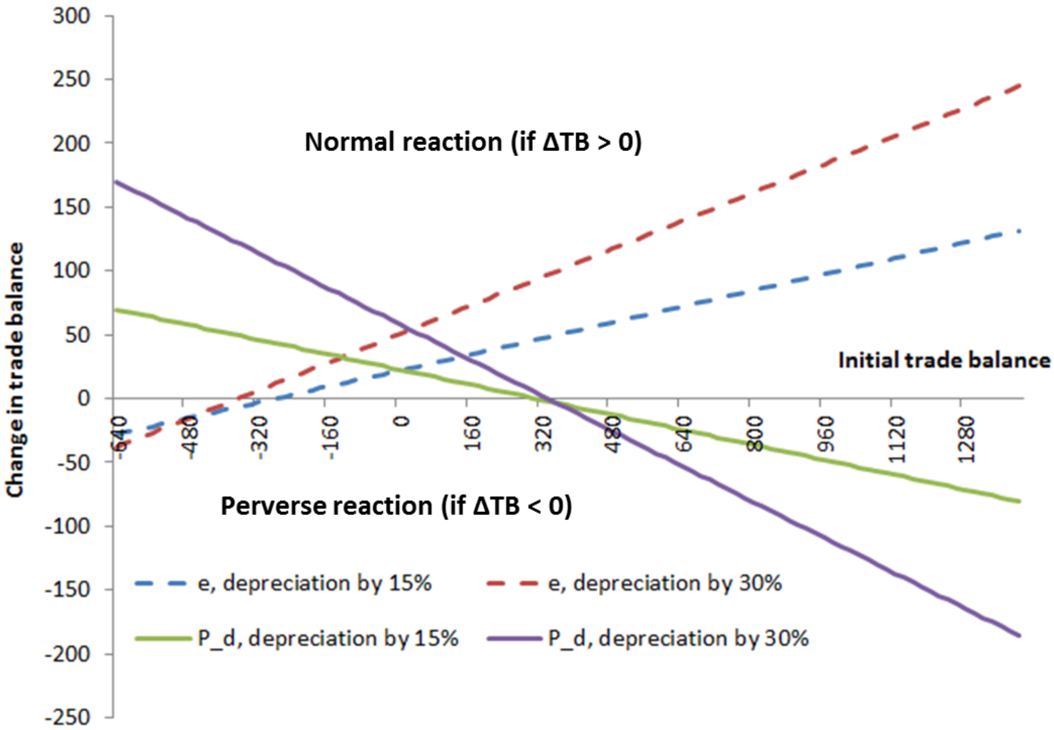


Figure 2 shows the case of a *depreciation* by 15 % and 30 % under otherwise identical conditions. A normal reaction to a depreciation would in this case mean a positive reaction of the trade balance (i.e. points above the x-axis). All the effects already described in Figure 1 can also be seen. However, 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 (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 to depend on many different factors. There is thus no clear cut way to anticipate how the trade balance will 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.

6 Conclusion

The paper has analysed the different impacts 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 appreciated 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 observed 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 also empirically relevant. 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.

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