On the Geometric Relationship between the Price-Specie-Flow Mechanism and Offer Curves

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This paper shows the geometric relationship between the price-specie-flow mechanism and offer curves which is not known correctly to the economics literature even today. In the neo-classical international monetary model with two countries trading two consumption commodities, the price-specie-flow mechanism proceeds along the trade-contract curve, not along offer curves. But the shapes of offer curves are critical for the stability of the price-specie-flow mechanism, because of the correspondence principle whose geometric expression is shown correctly for the first time by this paper.

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Introduction

As many economists know, the *price-specie-flow mechanism* (PSFM) and the *offer curve* are two of the most important theoretical concepts that have shaped the main history of international economics. Surprisingly, however, the correct relationship between the PSFM and offer curves in the classical and/or neo-classical context had been unknown to the literature for a long time, both algebraically and geometrically. About a decade ago, Anderson & Takayama (1977, 1979) elucidated *algebraically* the correct relationship between the

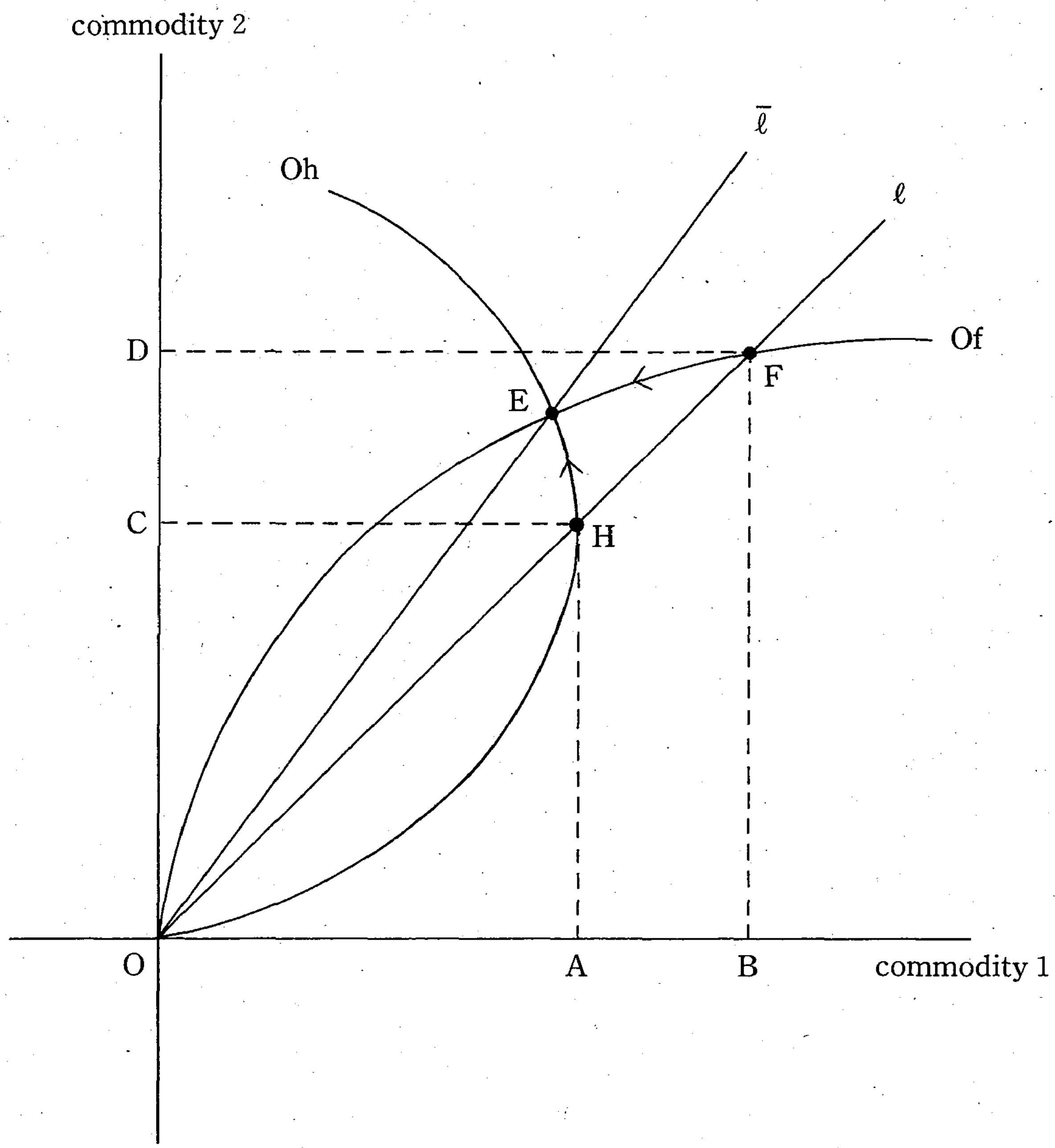
PSFM and offer curves in the neo-classical international monetary model with two countries trading two consumption commodities, but then they didn't show their analysis *geometrically*. Today, the geometric relationship between the PSFM and offer curves is not known correctly to the literature. Now, this paper aims to show the correct geometry (geometric explanation) on the relationship between the PSFM and offer curves, which forms a striking contrast to the traditional geometry.

In Section 1, the traditional geometry is briefly sketched and criticized. In Section 2, the correct geometry is shown. Finally in Section 3, the transfer problem is analyzed by the correct geometry shown in Section 2.

1. Traditional Geometry

Figure 1 shows the traditional geometry on the relationship between the PSFM and offer curves. The traditional geometry assumes the world where two countries (the home country and the foreign country) trade two consumption commodities (commodity 1 which the home country exports and commodity 2 which the foreign country exports). In Figure 1, the curve O_h is the home country's offer curve and the curve O_f is the foreign country's offer curve. When the relative price of commodity 1 has the value indicated by the slope of the line ℓ, the home country imports commodity 2 by the amount HA and exports commodity 1 by the amount FD, while the foreign country imports commodity 1 by the amount FD and exports commodity 2 by the amount HA. Therefore, the home country has the trade surplus and the foreign country has the trade deficit, whose amount is AB measured in commodity 1. (The inventory of commodity 1 decreases in

Figure 1



the home country by the amount AB, while the inventory of commodity 2 increases in the foreign country by the amount CD.) Consequently, under the fixed exchange rate system neither with sterilization policies nor with international capital transactions, the domestic money supply of the home country increases and that of the foreign country decreases. Therefore, if each country is completely specialized in the production of her exportable commodity, the absolute price of commodity 1 *rises* and that of commodity 2 *declines*, because of the "Quantity Theory of Money". Accordingly, the relative price of commodity 1 *rises*, and each country's economy moves along her own offer curve towards the point E (as is indicated by the arrows in Figure 1).

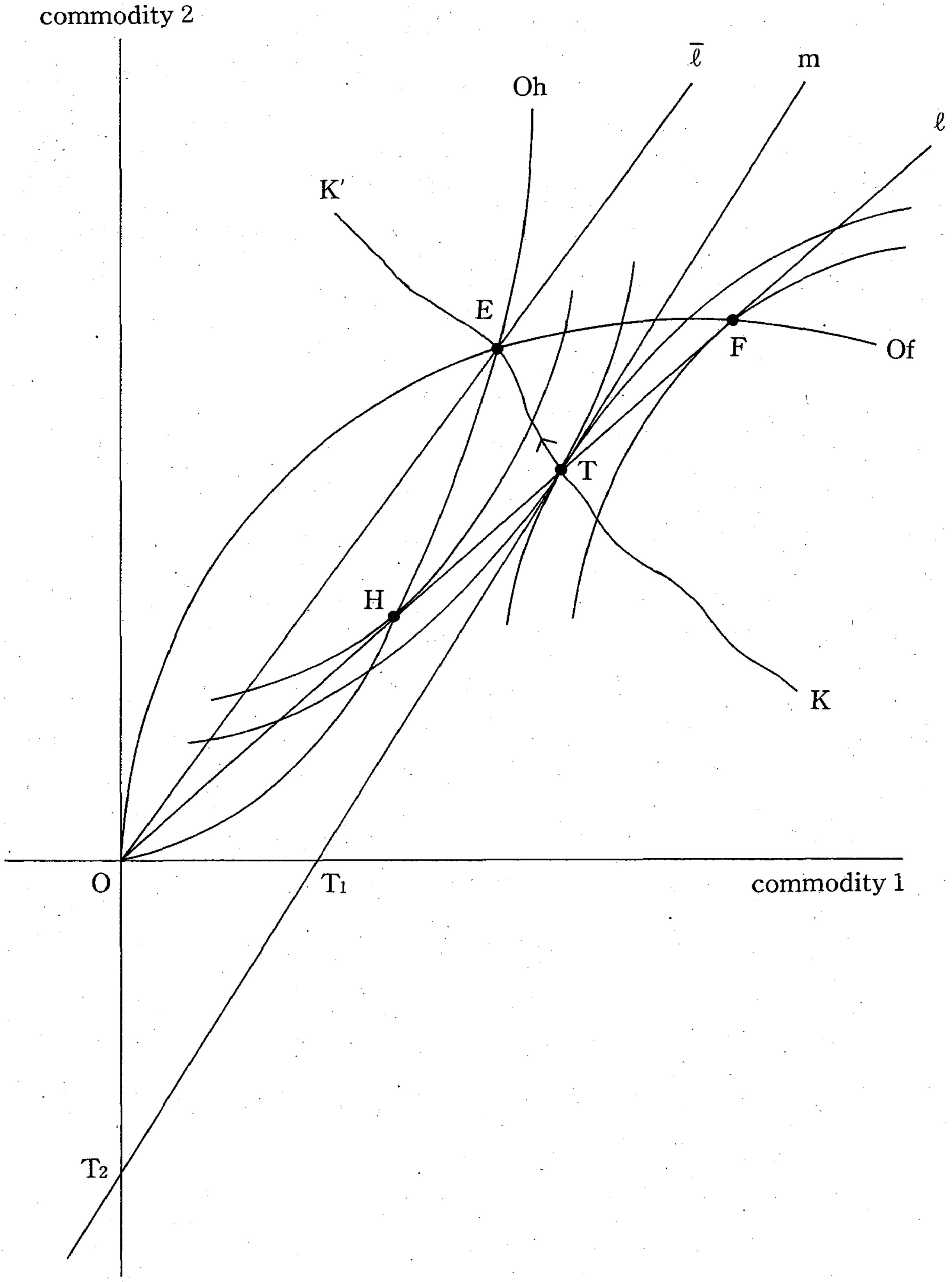
This is the traditional geometry on the relationship between the PSFM and offer curves. This type of geometry (or explanation) has been prevalent in the literature since the age of Viner (1937), but has the following defects. *First*, as Collery (1971, p. 26n) pointed out, "this analysis crucially depends on the assumption of complete specialization." *Second*, as Mundell (1968, p. 116) and Chacholiades (1972, pp. 463 – 466) pointed out, the Quantity Theory of Money is misused in this type of explanation. As they pointed out, the absolute price of commodity 1 (the home country's exportable good) may not rise and the absolute price of commodity 2 (the foreign country's exportable good) may not decline by the monetary redistribution from the foreign country to the home country, if the marginal propensity to import is sufficiently high in each country. *Third*, the traditional geometry cannot explain the PSFM without the terms-of-trade change. [This defect was named "Terms-of-trade fallacy" by Samuelson (1980, p. 146).] As Samuelson (1971, p. 5) pointed out, "there is no necessity for the terms-of-trade to change" during the trade-balance adjustment process[1].

Judging by these defects[2], it might be said that the traditional geometry (or explanation) on the relationship between the PSFM and offer curves is incorrect. Collery (1971, p. 27) writes, "The analysis is so implausible that it would not deserve any mention here at all if it had not been what Professor Viner and other economists had considered the classical theory of adjustment."

2. Correct Geometry

About a decade ago, Anderson & Takayama (1977, 1979) elucidated algebraically the correct relationship between the PSFM and offer curves, which is free from the traditional defects mentioned in Section 1. Figure 2 shows the geometry which corresponds to Anderson & Takayama (1977)'s algebraic analysis. Anderson & Takayama (1977) assume, like the traditional explanation, the world where two countries (the home country and the foreign country) trade two consumption commodities (commodity 1 which the home country exports and commodity 2 which the foreign country exports). But, different from the traditional explanation, Anderson & Takayama (1977) require neither the assumption of complete specialization nor commodity inventories. In Anderson & Takayama (1977)'s model, two countries trade with each other on the trade-contract curve. The curve KK' in Figure 2 is the trade-contract curve on which a trade-indifference curve of the home country is tangential to a trade-indifference curve of the foreign country. When the two countries trade at the trading point T on the curve KK', the relative price of commodity 1 is indicated by the slope of the terms-of-trade line m, and the home country has the trade surplus whose amount is OT_1 meas-

Figure 2



ured in commodity 1. Therefore, under the fixed exchange rate system neither with sterilization policies nor with international capital transactions, the domestic money supply of the home country increases and that of the foreign country decreases. By this international monetary redistribution, the trading point moves along the trade-contract curve KK', and the terms-of-trade line shifts.(This shift may or may not change the slope of the terms-of-trade line, depending on the "transfer condition".)[3] The trading point moves towards the *north-west* (as the arrow in Figure 2 indicates) if the terms-of-trade line cuts the horizontal axis in the *right* side of the point O, while the trading point moves towards the *south-east* if the terms-of-trade line cuts the horizontal axis in the *left* side of the point O[4]. When the terms-of-trade line has come to pass through the point O, the trade between two countries balances and the trading point stops moving. We shall call the "trade-balanced point" the place where the trading point stops moving. As is obvious by this definition, the trade-balanced point not only lies on the trade-contract curve but also is the intersection point of both countries' offer curves. Needless to say, there can be two or more trade-balanced points on the trade-contract curve. If the trading point can arrive at *a* trade-balanced point whether from the north-west vicinity or from the south-east vicinity, *the* trade-balanced point is "locally stable". This is the geometric interpretation of Anderson & Takayama (1977)'s PSFM[5].

Now we are ready to show the correct geometry on the relationship between the PSFM and offer curves. We shall prove geometrically the following proposition. "A trade-balanced point is locally stable, *if and only if* a country's offer curve cuts the other country's offer curve at *the* trade-balanced point *from the inside*."

The proof is as follows. In Figure 2, the home country's offer curve O_h cuts the foreign country's offer curve O_f at the trade-balanced point E from the inside. If we draw a line ℓ which passes through the point O and is flatter than the line OE, the line ℓ cuts the curves O_h and O_f at the points H and F, respectively. Because the curve O_h cuts the curve O_f from the inside, the distance OH must be shorter than the distance OF. Furthermore, by the definition of offer curves O_h and O_f, one of the trade-indifference curves of the home country is tangential to the line ℓ at the point H, and one of the trade-indifference curves of the foreign country is tangential to the line ℓ at the point F. Therefore, there must be the point T at which a trade-indifference curve of the home country is tangential to a trade-indifference curve of the foreign country, between the points H and F on the line ℓ. In addition, because of the convexity of trade-indifference curves, the terms-of-trade line m (which passes through T) must be steeper than the line ℓ. In summary, the line m cuts the line ℓ between the points H and F, and is steeper than the line ℓ. Therefore, the line m must cut the horizontal axis in the *right* side of the point O. Accordingly, if the trading point is put on the place T in Figure 2, the trading point begins to move along the trade-contract curve KK' towards the point E by the PSFM. That is, the trading point can arrive autonomously at the point E from the south-east vicinity. Likewise, we can prove (in Figure 2) that the trading point can arrive autonomously at the point E from the north-west vicinity, too.

Thus we have proved that "a trade-balanced point is locally stable, *if* a country's offer curve cuts the other country's offer curve at *the* trade-balanced point *from the inside*." This proposition is shown in Figure 3a, where the arrow ⇒ means that " the left side situation is the sufficient condition for the right side situation" and the arrow

Figure 3a

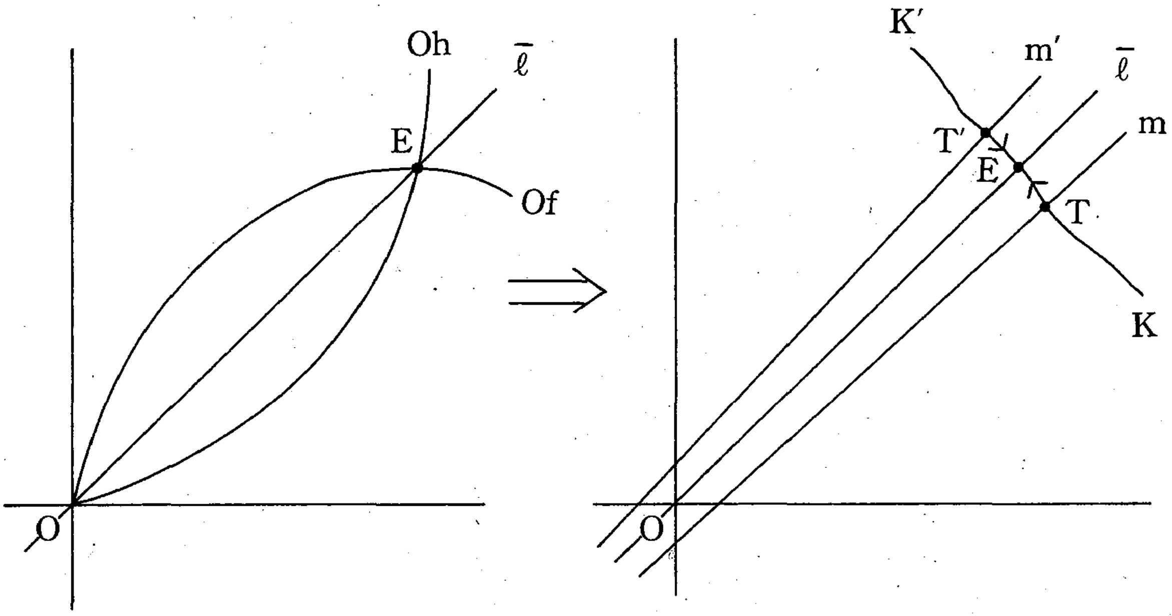


Figure 3b

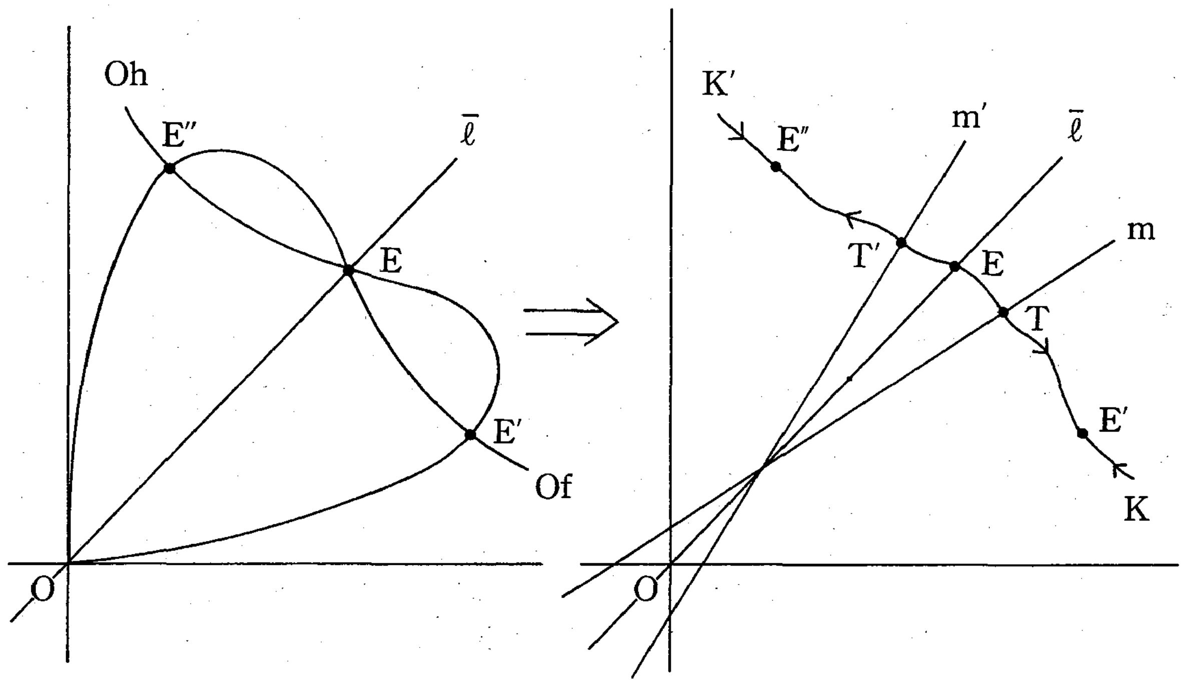
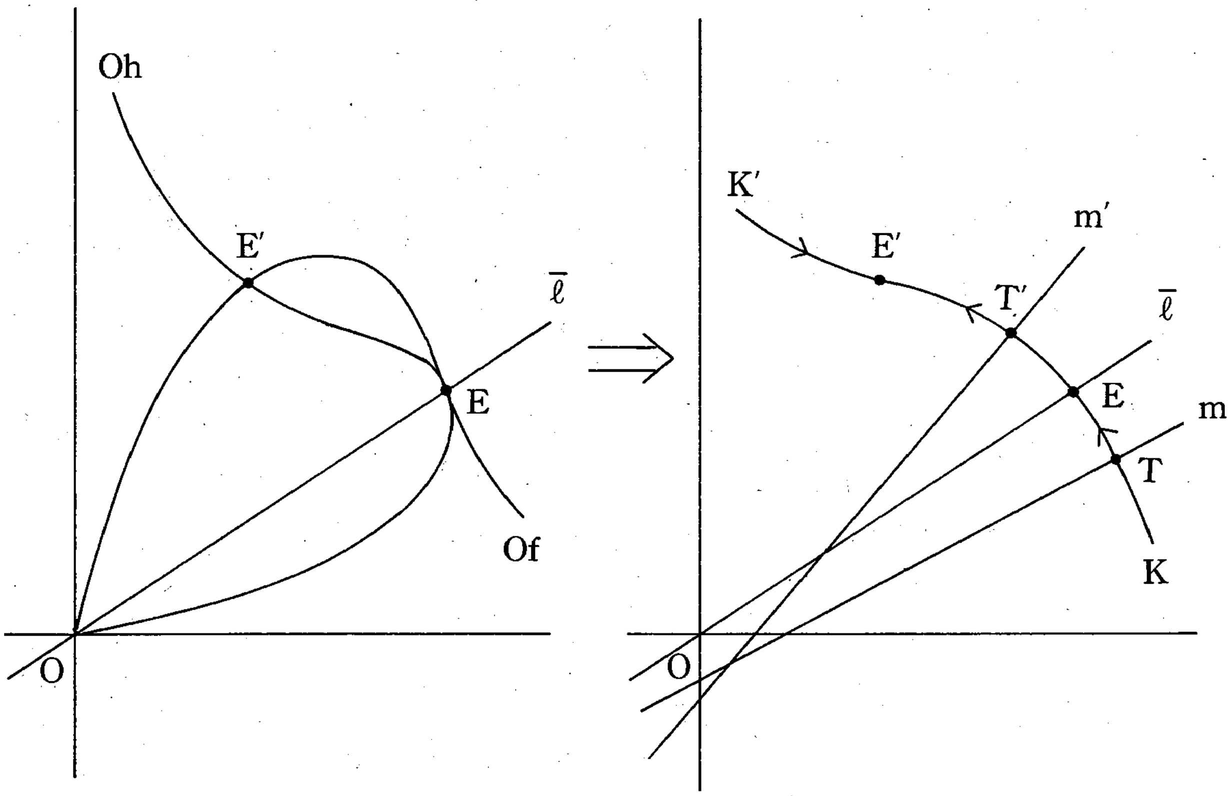


Figure 3c



—>— indicates the direction into which the trading point moves by the PSFM.

In the same way, we can draw such figures as Figure 3b,Figure 3c, and the like. As is obvious by these figures, "a trade-balanced point is locally stable, *if and only if* a country's offer curve cuts the other country's offer curve at *the* trade-balanced point *from the inside*."

In other words (as is widely known *algebraically*), "the Marshall-Lerner condition is the *necessary and sufficient* condition for the stable behaviour of the PSFM in the vicinity of the trade-balanced point."

But this proposition does *not* mean that the trade-imbalance is adjusted *along* offer curves. (Compare Figure 2 or 3a with Figure 1.) Surprisingly, this *geometric* fact is not known to the economics literature even today[6]. The trade-imbalance is adjusted along the trade-contract curve, not along offer curves. It's because of the correspondence principle that the shapes of offer curves are critical for the stability of the PSFM. And the geometric meaning of the "correspondence" is expressed as in Figures 2, 3a, 3b, 3c, and the like, *not* as in Figure 1[7].

3. Transfer Problem

In this section, we shall prove the following famous proposition geometrically. "The purchasing-power transfer will make the donor country worse off and the recipient country better off, *if* the Marshall-Lerner condition is met at the initial (i. e. pre-transfer) trade-balanced point."

Suppose, in Section 2's [i. e., Anderson & Takayama (1977)'s] model, that the home country must pay a certain amount of international reserve to the foreign country every period hereafter as, say, reparations or grants. At the new steady state including the transfer delivery, the home country will have the trade surplus whose amount will be equal (both in real terms and in monetary terms) to the transfer's amount. That is, at the new steady state including the transfer delivery, the terms-of-trade line will cut the horizontal axis somewhere in the *right* side vicinity of the point O, as the line m in Figure 2.

In Figure 2, the home country's offer curve cuts the foreign country's offer curve at the trade-balanced point E *from the inside*, so that the line m can *not* cut the line $\bar{\ell}$ between the points O and E. Therefore, the line m *must* cut the trade-contract curve KK' to the *south-east* of the point E. That is, at the new steady state including the transfer delivery, the trading point (T) will have to lie to the *south-east* of the initial (pre-transfer) trade-balanced point (E). That is, "the donor country will become worse off and the recipient country will become better off by the transfer, *if* the Marshall-Lerner condition is met at the initial (pre-transfer) trade-balanced point."

Remark, however, that the Marshall-Lerner condition is not the *necessary* condition for the transfer to make the donor country worse off and the recipient country better off. See, for example, Figure 3c where the home (donor) country may become worse off and the foreign (recipient) country may become better off at the new steady state including the transfer delivery (the point T) than at the initial trade-balanced state (the point E), though the Marshall-Lerner condition is *not* met at the initial trade-balanced point E.

Concluding Remark

The referees of *The Review of Economic Studies* (in 1987) and *The Economic Studies Quarterly* (in 1988, 1989) rejected this paper, commenting that this paper "does not……correct existing results, merely providing an alternative presentation of Anderson & Takayama's analysis" (R.E.S.) and that this paper "merely reaffirms geometrically an already well-known matter" (E.S.Q.) and that this paper has not "made a significant contribution on this topic" (E.S.Q.).

But neither Samuelson (1980) nor Ethier (1983, 1988) nor Caves & Jones (1985) nor Chipman (1989) refers to Anderson & Takayama (1977) at all, though these textbooks and treatises are dealing with the same (or similar) matter as (or to) what Anderson & Takayama (1977)'s "well-known" analysis dealt with. Furthermore, the traditional incorrect geometry (just like Figure 1 of this paper) is seen in Ethier (1983, pp. 301–303) and Ikema (1979, pp. 31–37) *without* the recognition that the traditional geometry is incorrect, while the correct geometry (like

Figure 2 or 3a of this paper) is *not* seen in any of Anglo-American and Japanese textbooks and treatises published today [as of April 1989, including Ethier (1988)] .

Considering the comments by the above referees, it is surprising that such a "well-known matter" as the relationship between the PSFM and offer curves (especially the "mere" geometric "reaffirm"-ation) is *not* dealt with "correct"-ly in the "existing" economics literature even today.[8]

Notes

1) As Samuelson (1980, p.155) says, "even in the absence of any terms-of-trade shifts (or indeed of *any* price changes at all), a gold drain will shut itself off when people run out of the excess money supply that is causing them as a nation to consume more than they produce." Therefore, the term "specie-flow mechanism" rather than the term "price-specie-flow mechanism" would be more suitable for the automatic trade-balance adjustment process, though this paper uses the latter term because of the prevalence.
2) The traditional geometry doesn't hold without introducing commodity inventories. In the early draft of this paper, the author counted this as the fourth defect of the traditional geometry. But the referee(s) of *The Economic Studies Quarterly* commented that this should *not* be counted as a defect. Incidentally, Dixit & Norman (1980, p.197) writes, "Even within the logic of the model, it is unsatisfactory that features which were not part of the original story of exchange, namely stocks, have to be grafted on if the state of real disequilibrium is to be actually achieved."
3) See Meade (1952, pp.85–87 and Figure XXXVII), for the geometric

expression of the "transfer condition" or the "marginal propensity to import". Meade (1952)'s geometric analysis, however, didn't go into the explanation of the PSFM.

4) See Appendix 1 of this paper for the proof.

5) Strictly speaking, the geometric expression shown in Figure 2 of this paper corresponds to the case where the *separability hypothesis* is assumed in Anderson & Takayama (1977)'s model. If the relationship between the PSFM and offer curves is to be discussed, the separability hypothesis is indispensable. See Anderson & Takayama (1977) and Dixit & Norman (1980, chap. 7) for the separability hypothesis.

6) See Concluding Remark of this paper.

7) Dixit & Norman (1980, p.229) writes, "In those models (involving real disequilibria), a devaluation worked by worsening the commodity terms of trade, i. e. the Marshall-Lerner condition also ensured that the devaluing country's terms of trade deteriorated. In the monetary model (not involving real disequilibria), that need not be the case". Because the devaluation and the money supply change are *dual* with each other in the classical and neo-classical context, the geometric meaning of the above quotation reduces to the difference between Figure 1 and Figure 2 or 3a of this paper, though Dixit & Norman (1980) themselves did not show the geometric analysis.

8) The referee(s) of *The Economic Studies Quarterly* also commented that Appendixes of this paper are "entirely unnecessary" and that Section 3 of this paper "should be eliminated". They also criticized that the global stability of Anderson & Takayama (1977)'s PSFM is not at all analyzed in this paper whereas the proposition 4 of

Anderson & Takayama (1977, p.356) pertains to the global stability. But the proposition 4 of Anderson & Takayama (1977, p.356, "*The steady-state value of M under the specie flow mechanism is unique and globally stable, if the devaluation of the home currency with initial payments equilibrium always improves the balance of payments*") only maintains essentially (considering the duality between the devaluation and the money supply change) as follows : "*if all of the trade-balanced points are locally stable, then there is only one trade-balanced point and the only one trade-balanced point is globally stable*". To the author, this is a matter of course which is obvious in Figures 3a, 3b, 3c and the like. See also the note 2 of this paper, for another comment by the referee(s) of *The Economic Studies Quarterly*.

Appendix 1

By Meade (1952, pp.85–87 and Figure XXXVII)'s analysis, we have the following geometric proposition ① concerning Figure 2 of this paper.

"If the sum of the marginal propensity to import in the home country and that in the foreign country is

$$\left\{\begin{array}{l}\text{greater than}\\ \text{equal to}\\ \text{smaller than}\end{array}\right\}\ \text{unity}$$

at the point T, the slope of the terms-of-trade line (in turn)

$$\left\{\begin{array}{l}\text{gets flatter and flatter}\\ \text{remains unchanged}\\ \text{gets steeper and steeper}\end{array}\right\}$$

as the trading point moves (along the curve KK') from the south-east towards the north-west in the vicinity of the point T."……①

In addition, algebraically, we can derive the following equations ② and ③ from Anderson & Takayama (1977)'s model (See Appendix 2 of this paper for the derivation procedure) :

$$\left. dp/dM \right|_{dM+dM_f=0} = (1-m_h-m_f)\ \mu\mu_f\ (M+M_f)\ /J\ (\tau) \quad \cdots\cdots ②$$

$$\left. d\overline{B}/dM \right|_{\substack{dM+dM_f=0 \\ m_h+m_f=1}} = -\mu\mu_f\ (M+M_f)\ /\ (\mu M+\mu_f M_f) \quad \cdots\cdots ③$$

,where the definitions of p, $\overline{B}$, m_h, m_f, M,M_f are as follows. p is the relative price of commodity 1 (i. e. the slope of the terms-of-trade line m in Figure 2 of this paper). $\overline{B}$ is the real trade-balance of the home country measured in commodity 2 (i. e. the distance OT_2 in Figure 2 of this paper). m_h is the marginal propensity to import in the home country and m_f is that in the foreign country. M is the nominal money supply in the home country and M_f is that in the foreign country. dM $+dM_f=0$ means that M and M_f change by the balance of trade settlement, where the fixed exchange rate is set equal to unity by the proper choice of currency units. As for the definitions of μ, μ_f, and J (τ), see Anderson & Takayama (1977), according to which μ, μ_f, and J (τ) are all positive.

By the proposition ① and the equations ② and ③, we have the following conclusion.

"The trading point moves (along the trade-contract curve) towards the *north-west* by the PSFM when the home country has the trade *surplus* (as in Figure 2 of this paper), while the trading point moves towards the *south-east* by the PSFM when the home country has the trade *deficit*."

Appendix 2

The derivation procedure of the equation ② (in Appendix 1 of this paper) is as follows.

When the "separability hypothesis" is assumed, the equation (8) of Anderson & Takayama (1977, p.349) can be rewritten like the following (8)', where the denotations are all the same as those in Anderson & Takayama (1977).

$$E_i\ (p,\ \overline{H}\ (p,\ M/p_2))\ + E_{if}\ (p,\ \overline{H}_f\ (p,\ eM_f/p_2))$$
$$=0,\ i=1,\ 2 \cdots\cdots (8)'$$

By differentiating (8)' with respect to p, p_2, M, and M_f, we have the following (8)'', where the definitions of η_h, η_f, τ, ℓ, and ℓ_f are all the same as those in Anderson & Takayama (1977).

$$\begin{bmatrix} -E_2\ \{\eta_h+\tau\ (\eta_f-1)\}\ +\ (m_h-1)\ \ell-m_f\ell_f & (m_h-1)\ \mu M-m_f\mu_f M_f \\ E_2\ \{\eta_h+\tau\ (\eta_f-1)\}\ -m_h\ell+\ (m_f-1)\ \ell_f & -m_h\mu M+\ (m_f-1)\ \mu_f M_f \end{bmatrix}$$
$$\begin{bmatrix} dp \\ dp_2 \end{bmatrix}$$
$$=\begin{bmatrix} (m_h-1)\ \mu dM-m_f\mu_f dM_f \\ -m_h\mu dM+\ (m_f-1)\ \mu_f dM_f \end{bmatrix} \cdots\cdots (8)''$$

Solving (8)'', we get the following (8)'''.

$$\left.\begin{aligned} \partial p/\partial M &= -\ (m_h+m_f-1)\ \mu\mu_f M_f/J\ (\tau) \\ \partial p/\partial M_f &= (m_h+m_f-1)\ \mu\mu_f M/J\ (\tau) \end{aligned}\right\} \cdots\cdots (8)'''$$

From (8)''' and $dM+dM_f=0$, we can derive the equation ② (in Appendix 1 of this paper) as follows.

$$dp/dM\Big|_{dM+dM_f=0} = \partial p/\partial M + (\partial p/\partial M_f)(dM_f/dM)$$

$$= (1-m_h-m_f)\,\mu\mu_f\,(M+M_f)\,/J\,(\tau) \quad \cdots\cdots ②$$

The derivation procedure of the equation ③ (in Appendix 1 of this paper) is as follows.

From the equation (13a) of Anderson & Takayama (1977, p.349), we get the following (13a)'.

$$\left.\begin{aligned} \partial\overline{B}/\partial M &= -(1/M)\,\partial\overline{B}/\partial e \\ \partial\overline{B}/\partial M_f &= (1/M_f)\,\partial\overline{B}/\partial e \end{aligned}\right\} \cdots\cdots (13a)'$$

Substituting the equation (34) of Anderson & Takayama (1977, p.352) into the above equation (13a)', we have the following (13a)".

$$\left.\begin{aligned} \partial\overline{B}/\partial M &= -[\eta_h+\tau(\eta_f-1)]\,\mu\mu_f M_f E_2/J(\tau) \\ \partial\overline{B}/\partial M_f &= [\eta_h+\tau(\eta_f-1)]\,\mu\mu_f M E_2/J(\tau) \end{aligned}\right\} \cdots\cdots (13a)''$$

In addition, the equation (35) of Anderson & Takayama (1977, p.352) gives us the following (35)'.

$$J(\tau)\Big|_{m_h+m_f=1} = [\eta_h+\tau(\eta_f-1)]\,E_2\,(\mu M+\mu_f M_f) \quad \cdots\cdots (35)'$$

From (13a)" and (35)', we can derive the equation ③ (in Appendix 1 of this paper) as follows.

$$d\overline{B}/dM\Big|_{\substack{dM+dM_f=0 \\ m_h+m_f=1}} = \partial\overline{B}/\partial M\Big|_{m_h+m_f=1}$$

$$+ \left(\partial\overline{B}/\partial M_f\Big|_{m_h+m_f=1}\right)(dM_f/dM)$$

$$= -\mu\mu_f M_f/(\mu M+\mu_f M_f)$$

$+ \{\mu\mu_f M / (\mu M + \mu_f M_f)\} (-1)$

$= -\mu\mu_f (M + M_f) / (\mu M + \mu_f M_f) \cdots\cdots③$

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