Complementary Credit Networks and Macro-Economic Stability: Switzerland's *Wirtschaftsring*[1]

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Abstract: The Swiss Wirtschaftsring ("Economic Circle") credit network, founded in 1934, provides residual spending power that is highly counter-cyclical. Individuals are cash-short in a recession, and economize by greater use of WIR-credits. A money-in-the-production-function (MIPF) specification implies that transactions in WIR form a stabilizing balance that makes up for the lack of ordinary currency. Thus, unlike the ordinary money, WIR money is negatively correlated with GDP in the short run. This implication is confirmed by empirical estimates. Such credit networks play a stabilizing role that should be considered in monetary policy. *JEL Codes*: E51, G21, P13.

> "…central banks in their present form would no longer exist; nor would money….The successors to Bill Gates could put the successors to Alan Greenspan out of business." - Mervyn King (1999)

I. Introduction

Large scale moneyless clearing, as portrayed by the Walrasian auctioneer, flourished in the "storehouse" economies of the ancient Middle East and Americas (Polanyi, 1947) when all relevant information could be *centralized*. *Decentralized monetary* systems evolved as the information for a complex economy became too great to be centrally managed with ancient information technology (Stodder 1995a, 1995b). Modern IT is again making *centralized exchange* plausible, however, on sites like www.irta.com, www.barter.net, www.swap.com, and www.itex.com.

A few prominent macro-economists have speculated that computer-networked exchange might eventually replace decentralized money, as well as central banking (King, 1999; Beattie, 1999; Friedman, 2001; *Economist,* 2000a, 2000b; World Bank, 2000). The purpose of this paper is not to gauge the likelihood of such change, but to explain why centralized exchange is counter-cyclical.

This paper's subject, the Swiss *Wirtschaftsring*, or "WIR", is sometimes called an alternative or complementary *currency*. It is really a centralized credit system for multilateral exchange, however, with no physical currency. The present paper is not based on a microeconomic search model of a *decentralized* currency, such as the work of Kiyotaki and Wright (1998, 1993). Their model has been applied to the conditions under which a national currency is replaced, in whole or in part, by a foreign currency, as in several Latin American and East European economies (Calvo and Végh, 1992; Trejos and Wright, 1995; Curtis and Waller, 2000; Feige, 2003). This dual-currency literature is well surveyed by Craig and Waller (2000).

These Kiyotaki-Wright (KW) type models are not appropriate for our study of the Swiss WIR, however, for at least two reasons. First, KW models show the costs of matching holders of goods with holders of a *decentralized* and freely circulating currency. But these search costs approach zero for

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members of WIR, an informationally *centralized* exchange network. A second point, emphasized in Clower and Howitt's transaction-based monetary models (1978, 1996, 1998, 2000), is that WIR-credit is a consciously designed system of exchange, rather than one that emerges as the lowest transaction-cost medium:

> In our view what characterizes a monetary economy is not so much that different transactors all choose to accept the same exchange intermediary for their production commodities, as in search theory, but that the shops they deal with don't give them any choice. (2000, p. 58).[2]

The KW literature models dual-currency *equilibrium* and does not usually consider *persistent shortages of the primary currency*. An exception to this is the KW model of Colacelli and Blackburn (2006), analyzing surveys of Argentine users of *creditos* or localized currencies, during that country's recession of 2002-2003 (cf. Gomez, 2008). These surveys show *credito* usage especially common among less skilled employees and women, who may be more economically vulnerable. Importantly for the counter-cyclical thesis of the present paper, Colacelli and Blackburn (2006) show that:

a) The circulation of *creditos* was strongly correlated with *shortages* of the national currency, as was the growth of local 'script' currencies in the US depression of the 1930s (Fisher 1934);
b) Real income gains to *credito* users were substantial, averaging 15% of Argentina's mean personal income.

There are hundreds of alternative-currency examples in existence today, described in the literature on Local Exchange and Trading Systems, or LETS (Williams, 1996; Greco, 2001; Gomez, 2008); some of these use a centralized credit system with no circulating currency. The Swiss WIR-Bank is the largest such system, operating on the basis of centralized credit, rather than a circulating currency. The WIR is also longer-lived than any LETS or corporate barter network (Stodder, 1998; Studer, 1998).

The thesis of this paper is that WIR exchange has been strongly counter-cyclical within the Swiss Economy. The paper is organized as follows: Section II explains how exchange works with WIR-credits and outlines my basic argument. Section III translates this thesis into formal propositions and empirical specifications. Section IV presents the empirical tests of the counter-cyclical thesis. Section V summarizes my conclusions and suggests that a WIR-type system – centralized exchange plus multilateral trade credits – should have a similarly stabilizing effect in any advanced economy.

II. The WIR-Bank Exchange System: Statement of the Argument

The Swiss WIR-Bank or *Wirtschaftsring* ("Economic Ring"), founded in 1934 (Studer, 1998, p. 14), is the world's largest and oldest exchange based solely on a private or 'club' form of money, with

[2] Similarly, transactions within the WIR network are required to be settled for at least 30 percent of their value in the form of WIR-credits, rather than in Swiss Francs (Studer 1998, p. 36).

more than 77,000 small firm and household members in 2003 (see Table 1 below). All types of goods and services are exchanged – house painting, hotel stays, used cars, legal services – with offerings posted online and in publications like WIR-Plus. Prices are quoted in units of WIR-credit, which for ease of comparison are denominated in – but not redeemable for – Swiss Francs (SFr). The WIR-Bank keeps accounts for each household or firm in terms of its WIR credits or debits. From the individual's point of view, an account in WIR is much like an ordinary checking account with clearing balances and limits on how large a negative balance can be run. (WIR-Bank is, in fact, a bank under Swiss law, and also provides ordinary banking services in SFr.)

WIR-credits can be seen as an extension of the trade credits widely used between firms.[3] In the US, for example, trade credits are commonly given by a seller on terms of "2% 10, net 30," whereby the buyer gets a 2% discount by repaying within 10 days, with full settlement due in 30 days (Nilsen, 2002). The main use of demand deposits for most businesses, according to Clower and Howitt (1996, pp. 26-28), is to clear such trade credits:

> …firms that organize markets in real life typically function on the basis of trade credit, and no modern exchange system exists in which the stock of bank and fiat money is not swamped by other media of exchange… indeed, it appears that bank deposits serve mainly as clearing 'reserves' for settling interbusiness trade debts, not as a means of payment as traditionally conceived.

Clower and Howitt are unusual in this stress. In a Philadelphia Fed publication, Mitchel Berlin (2003) notes that there has been little work on trade credits. This despite the findings of Petersen and Rajan (1994, 1997) that an average of between 11 and 17 percent of large-firm assets in each of the G7 countries is dedicated to accounts payable, and between 13 and 29 percent of their accounts receivable – a measure of such trade credits. As Petersen and Rajan note (1997), accounts receivables exceed accounts payable for most large firms, so they are in effect extending trade credit. Contrariwise, receiving trade credits is most important for smaller firms, in their role as customers or distributors.

Nilsen (2002) finds that use of trade credits is counter-cyclical for small firms, since they are more likely to be credit-rationed by banks when money is tight, and trade credits are often the only form of credit left to them. This is consistent with the central finding of the present paper: that turnover in the WIR network – limited to small and medium businesses by its constitution (Defila, 1994) – is also highly counter-cyclical.

There are two crucial differences between ordinary trade credits, and WIR-credits, however. First, unlike an ordinary trade credit, which would be payable in Swiss Francs, a WIR-credit is itself final payment. Thus, a firm getting WIR-credits for its product sold can never see its check "bounce."

3 This trade credit connection is mentioned by other writers on alternative currencies (Greco 2001, p. 68).

Second, the WIR-bank is a system of multilateral, not bilateral credits. That is, a WIR-creditor's value is ensured, not by her debtors' ultimate willingness to settle in cash, but by the immediate willingness of thousands of firms to accept her credits as final payment. As Studer (1998, p. 32) puts it, "every franc of WIR credit automatically and immediately becomes a franc of WIR payment medium."[4]

Since every WIR-credit is matched by an equal and opposite debit, the system as a whole must net to zero. Individual traders will have either positive or negative balances ("overdrafts"), the latter, in effect, a loan from the WIR-Bank. Short-term overdrafts are interest-free, with limits "individually established" (Studer, 1998, p. 31). As long as the average value of these limits is maintained, the WIR-Bank can be quite relaxed about variations in its *Turnover*, or total money in circulation. The system is highly flexible: while the individual's debit position is set by overdraft limits, the absolute value of all credits and debits is determined only by economic need. The *net* of this total, meanwhile, is identically zero.[5]

This balancing of excess demands – at least within WIR – is of macroeconomic significance, since it implies an identity of *notional* and *effective* demand. Robert Clower's best-known essay, "The Keynesian counterrevolution: a theoretical appraisal" (1965), raised this distinction between notional and effective demand to explain the contradiction between Keynesian aggregate demand and Walras' law. Walras' law states that as long as each individual budget constraint holds with equality, all excess demands must sum up to zero. This law must hold even at disequilibrium prices, so long as traders are still at the *bidding stage*, each putting forward a *planned* excess demand. But these *notional* demands, as Clower calls them, cannot all be *effective* (backed by actual spending power) if prices are not in fact market-clearing. This, says Clower, is the idea behind the Keynesian consumption function, with demand contingent on currently realized income.

An early attempt to build micro-foundations for macro used this "Clower constraint," or more simply, the "cash-in-advance constraint," giving rise to a family of disequilibrium models associated with Lucas (1980). Clower himself, along with Peter Howitt (1996), however, criticized this cash-in-advance literature as empirically vacuous, since it ignores alternative means of payment, specifically

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4 Silvio Gesell, the German-Argentine economist whose ideas inspired the founding of the WIR-Bank, would have been familiar with trade credits from his decades of international trade experience in Buenos Aires. Gesell's use of the term *demurrage* was borrowed directly from international shipping, where it denotes a reduction in payment to compensate for an unscheduled delay in the delivery of goods. Gesell applied a *demurrage* charge to the holding of money, with the aim of increasing its velocity.

Most trade credits provide discounts for early payment (Nilsen 2002, Berlin 2003), rather than fines for paying late, but the opportunity cost is the same. A form of bank-mediated trade credit particularly common in international trade is the banker's acceptance, which allows the exporter to be paid upon embarkation, while the importer does not have to pay until taking possession of the goods. Credits from the WIR-bank can be seen to extend the banker's acceptance principle in time, and from bilateral to multilateral.

5 This balanced flexibility of an "automatic plus-minus balance of the system as a whole" (Studer 1998, p. 31) is shown in a pedagogical experiment by LETS founder Michael Linton (2007), available at www.openmoney.org/letsplay/index.html.

trade credits. They have proposed models based on the market-making and payment-form-instituting activity of merchants (2000).

The WIR, an association of small businesses, suggests itself as an empirical test of Clower's ideas. For WIR members in good standing, there is no distinction between notional and effective demand.[6] Thus, if Clower is right that too little (too much) aggregate demand means effective demand is less than (greater than) notional demand, then economic activity carried out in WIR should be more stable than that effected in SFr. Indeed, if WIR are a substitute for SFr, then transactions in the former should be counter-cyclical. The credit flexibility and macroeconomic stability of WIR are our chief interests here.

A centralized credit exchange like the WIR-Bank combines the functions of both a commercial bank, and for its own WIR-currency, a central bank. It will thus have more detailed knowledge of credit conditions in its own currency than either a commercial or a central bank alone. Of course it can still make mistakes, extending too much in overdrafts or in direct loans. Such credit "inflation" has occurred in WIR's history (Defila, 1994; Stutz, 1984; Studer, 1998), but now appears contained by sensible overdraft limits.

The WIR was inspired by the ideas of an early 20th-century economist, Silvio Gesell (Defila 1994, Studer 1998), to whom Keynes devoted a section of his General Theory (1936; Chapter 23, Part VI). Despite his criticisms, Keynes saw Gesell as an "unduly neglected prophet" who anticipated some of his own ideas as to why the money rate of interest might exceed the marginal efficiency of capital.[7]

This link between Keynesian and Gesellian *theory* might have made Gesellian *institutions,* like the WIR-Bank, of more interest to contemporary economists.[8] Only one, however, seems to have studied the macroeconomic record of WIR. Studer (1998) finds a positive long-term correlation between WIR credits and the Swiss money supply – a correlation we also find. But Studer's data (1998) stops in 1994, and he does not test for cointegration, or for the short-term effects of changes in the Swiss money supply. The present study uses Error Correction Models (ECMs) to show that WIR turnover is strongly counter-cyclical, which makes it negatively correlated with Swiss M2 in the short run.

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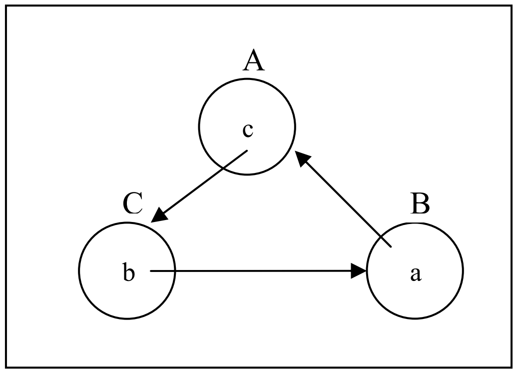
[6] To be sure, there is an issue of trust whenever a member asks for credit, and persistent defaulters will see their credit frozen.

[7] Keynes noted (1936, p. 355) that "Professor Irving Fisher, alone amongst academic economists, has recognised [this] significance," and makes a prediction that "the future will learn more from the spirit of Gesell than from that of Marx."

[8] Gerhard Rösl of the German Bundesbank (2006) does looks at Gesellian currencies – with zero interest rates and explicit holding costs. These holding costs were called *demurrage* by Gesell, a term he borrowed from his experience in commercial shipping. Rösl uses the German term *Schwundgeld*, or 'melting currency'. Demurrage currencies have grown in popularity in low inflation environments like the current Euro area (as Rösl documents), but especially in deflationary environments like Argentina or the US in the 1930s, as previously mentioned. Rösl's criticisms of demurrage do not apply to the Swiss WIR, however, since (a) the WIR stopped charging demurrage in 1948, and (b) charges interest on large overdrafts and commercial loans (based on one's credit history), (Studer 1998, pp. 16, 31). Interestingly, Rösl uses a "money in the production function" (MIPF) model, as in the current paper.

For a simple model of informationally centralized barter, consider firms, A, B, and C, each of which lacks one good -- a, b, and c, respectively. Let us say that A currently holds c, B holds a, and C holds b. This failure of the "Double Coincidence of Wants" (Starr, 1989) is shown in Figure 1 below.

Figure 1: The Failure of Double-Coincidence



If units are chosen so that competitive equilibrium prices are unity, Pa = Pb = Pc = 1, then the direction of mutually improving trade is shown by the arrows in the picture: A gives a unit of c to C, C a unit of b to B and, and B a unit of a to A. If these are the only goods of interest for each firm, then there are no *bilaterally* improving barter trades. The formal conditions for the failure of bilaterally improving barter (Eckalbar, 1984; Starr, 1989) are: (i) no *single good* is held in sufficient quantity by *all agents* to be used as a "money", (ii) no *single agent* holds sufficient quantity of *all goods* to serve as a central "storehouse", and (iii) *cyclical preferences* exist for at least three agents over at least three goods; e.g., firm A prefers $a \succ b \succ c$, B prefers $b \succ c \succ a$, and C prefers $c \succ a \succ b$.

These conditions for the failure of mutually improving bilateral trade are almost certain to be met in an economy with a modest diversity of endowments, preferences, and specialization (Stodder, 1995a). Non-bilateral trade can still take place, but only if the economy is simple enough to allow all transactions to be accounted for in a *centralized credit* system, such as a traditional *gift* economy where everyone's credit score is, in effect, common knowledge (Mauss, 1923; Stodder, 1995a). In larger and more complex economies, however, the historic and anthropological literature shows a virtual coincidence of decentralized monetary exchange and decentralized markets (Davies, 2002; Stodder, 1995b). Modern information technology, however, may be weakening this link – completely centralized credit accounting again being feasible in decentralized markets.

III. Functional Specifications

III.1 Theoretical Basics – Money in the Production Function

A convenient way of showing the macroeconomic role of money is the "money in the production function" (MIPF) specification, analogous to "money in the utility function" (MIUF). Either MIPF or MIUF can be justified by the transactions-cost-saving role that money plays, to move an economy closer to its efficiency frontier. (Patinkin, 1956; Sidrauski, 1967; Fischer, 1974, 1979; Short, 1979; Finnerty, 1980; Feenstra, 1986; Hasan and Mahmud, 1993; Handa, 2000; Rösl, 2006). We will not develop the search-theoretic model required to thoroughly ground such a formalization, but the literature is large and the intuition straightforward.

Finnerty (1980) shows the general conditions under which a MIPF specification can be derived from the solution to the firm's cost minimizing problem. With some minor changes in his notation, we can write the cost minimization problem as:

$$\text{Min: } c \cdot K + r \cdot m(\overline{Q}, K)$$

$$\text{s.t.: } \overline{Q} \leq g(K), \qquad (1)$$

where K is a vector of productive inputs needed to produce $\overline{Q}$, the later being defined exogenously; c is a vector of input costs, and r is the opportunity cost of holding real money balances. The function m( ) determines these balances. Thus m( ) is a transactions cost relationship – the minimum cash balances required to coordinate the physical transformation of inputs K into output $\overline{Q}$. Finnerty (1980, p. 667) calls this function the stochastic "time pattern of cash outflows for the purchase of inputs and cash inflows from the sale of output can be used to determine *the minimum level of real cash balances*, m > 0, that will facilitate all such transactions" *(emphasis added).* As he notes, the necessity for money can be seen as equivalent to the existence of uncertainty.[9]

The existence of a *secondary currency* m_s, which will complement the functioning of the *primary currency* m_p, gives us a natural extension of Finnerty's notation. Consider the costs of transacting and purchasing inputs with both the primary money, m_p, and the secondary currency, m_s:

$$c_pK_p + c_sK_s + r_pm_p(\overline{Q}_p, K_p) + r_sm_s(\overline{Q}_s, K_s)$$

If m_p and m_s are freely exchanged, then m_s is convertible to m_p by the formula $m_p/m_s = c_p/c_s$. Thus the above can be rewritten in terms of m_p alone, the values c_sK_s and $m_s(\overline{Q}_s, K_s)$ multiplied by (c_p/c_s) to yield c_pK_s and $m_p(\overline{Q}_s, K_s)$, respectively, for the minimization:

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[9] Finnerty further notes that the precise details of this real balance minimization problem may be left unspecified, just as they are in the economist's use of a generalized production function. As in the generalized production function, however, some of the necessary *mathematical* properties of the function m( ) can be developed.

$$\text{Min: } c_p(K_p + K_s) + m_p[r_p(\overline{Q}_p, K_p) + r_s(\overline{Q}_s, K_s)] \tag{1a}$$

$$\text{s.t.: } \overline{Q} = \overline{Q}_p + \overline{Q}_s \leq g(K_p, K_s) = g_p(K_p + \overline{K}_s) + g_s(\overline{K}_p + K_s),$$

$$\text{where } r_p > r_s \text{ and } c_p \leq c_s$$

These inequality assumptions are now explained. The first inequality, $r_p > r_s$, shows the relative opportunity cost of holding each kind of money. Recall that m_p is far more useful than m_s, since the former is universally fungible, while the latter is accepted only within an exchange community. Thus, there must be a higher opportunity cost of holding balances of m_p. This is consistent with the observation that most supplementary currencies like WIR charge no interest on short-term overdrafts (Studer, 1998, pp. 15-16), and charge less than normal money interest rates on longer-term loans (Studer, 1998, p. 31).

The second (weak) inequality, $c_p \leq c_s$, is related to the first one. In the monthly WIR magazine (WIR-Plus, 2005) it is common for the prices of goods and services to be quoted in both WIR and SFr, with prices in the WIR usually *higher* than in SFr. Although they are counted in units of SFr, WIR are clearly less useful than the actual SFr, and thus worth less. In the period prior to 1973, when the so-called "discount trade" was permitted, WIR were discounted in market exchange for a smaller number of SFr (Studer, 1998, p. 21).

To verify this pattern of pricing, I surveyed automobiles for sale on the French-language WIR website.[10] I then checked a British website (www.autoweb.co.uk) for the same make, model, and year. (If there were several British prices for similar cars, I took the highest price.) This British-Swiss comparison is conservative: a recent survey puts average car prices 10 percent lower in Switzerland, with the lowest prices in Western Europe.[11] Of the 20 used cars surveyed, only 2 had their price lower in WIR (by less than 10 percent). The average price of the 20 cars was 47 percent higher in WIR than with the British price in SFr., with a standard deviation of 29 percent. Using a one-tailed t-test, the null hypothesis that the SFr. price is greater than the WIR price can be rejected at the 6.2 percent level.

Although the currencies are assumed freely exchangable, we will define K_p as purchased with primary currency, m_p, at cost of c_p, while K_s is purchased with the secondary money, m_s, at cost $c_s \geq c_p$. In our specification $g(K_p + K_s)$, the inputs K_p, K_s are physically indistinguishable in *production*, just as a unit of $\overline{Q}_p$ is indistinguishable from a unit of $\overline{Q}_s$. For purposes of *accounting*, however, we will keep

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[10] "*Annonces Online: Chercher*," February 27, 2008, http://www.wir.ch/index.cfm?D4666DE751CD11D6B9960001020761E5 .

[11] "Average car prices in Ireland are 30% higher than in the rest of the 12-country euro currency zone," By Finfacts Team, May 8, 2006; http://www.finfacts.com/irelandbusinessnews/publish/article_10005755.shtml.

track of units of Q_p as being produced exclusively by K_p and Q_s exclusively by K_s – because these inputs will typically be purchased and used at different times.

The notation $g = g_p(K_p + \overline{K}_s) + g_s(\overline{K}_p + K_s)$, with the bar indicating exogeneity, is meant to convey that K_p and K_s can be evaluated separately along the way. So if K_s is purchased and used *after* K_p, we would have, *at different times,* $\partial g/\partial K_p > \partial g/\partial K_s$, since g( ) is concave. For example, $\partial g/\partial K_p$ could be evaluated *first* (at $K = K_p + \overline{K}_s$ where $\overline{K}_s = 0$), and then *second,* $\partial g/\partial K_s$ would be evaluated (at $K = \overline{K}_p + K_s$, where $\overline{K}_p > 0$, and K_s is at its peak). Of course the sequence could also be reversed.

From the function $m(\overline{Q}, K)$ in (1), one can derive the implicit function $Q = h(K, m)$. This can be considered a *monetary transaction function*. The optimization of (1a) makes explicit a cost-minimizing tradeoff between inputs, so that minimizing the expenditures of c_pK_p and c_sK_s will in general *not* imply the minimal real balance opportunity costs of r_pm_p plus r_sm_s, nor the cost-minimizing solution overall. Finnerty goes on to show how a *convex combination* of this *monetary transaction function,* in our terms, $Q = h(K_p, K_s, m_p, m_s)$, and the *physical input function* $Q = g(K_p + K_s)$ – both of which are assumed convex and monotonically increasing – give us a convex and monotonic "Money in the Production Function" (MIPF) of the form:

$$Q = f(K_p, K_s, m_p, m_s).\text{[12]} \qquad (2)$$

Using (2), and implicit differentiation, it is easy to verify that the solution to the problem

Min: $c_pK_p + c_sK_s + r_pm_p + r_sm_s$ (or equivalently, $c_p(K_p + K_s) + m_p(r_p + r_s)$) (2a)

s.t.: $\overline{Q} = \overline{Q}_p + \overline{Q}_s \leq f(K_p, m_p, K_s, m_s) = f_p[(K_p, \overline{K}_s), m_p] + f_s[(\overline{K}_p, K_s), m_s]$,

is identical to that of problem (1a), since first order conditions are the same. (Note that in the second expression of the minimand in (2a), we have converted secondary into primary money units, by multiplying the c_s and m_s terms in the former by c_p/c_s). The splitting of f( ) into f_p( ) and f_s( ) is similar to that of the original g( ) production function shown in (1a). This yields the following:

<u>Lemma 1</u>: *For a cost minimizing firm, the marginal productivity of K_s is at least as great as that for K_p, and that of m_s is less than m_p.*

<u>Proof</u>: Using inequality (1a) and the first expression for the minimand in (2a), first order conditions are $(c_s/c_p) = (\partial f/\partial K_s)/(\partial f/\partial K_p) \geq 1$. Similarly, $1 > (r_s/r_p) = (\partial f/\partial m_s)/(\partial f/\partial m_p)$.

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[12] Finnerty shows that a sufficient condition for the montonicity of f( ) is that $\partial m/\partial K < 0$. In this sense, K inputs and real money balances are *transactional substitutes* – that by purchasing larger quantities of inputs K at any one time, a firm can economize on its real money balances, or vice versa. This is the tradeoff between inventory and real balance costs.

<u>Lemma 2</u>: *For a firm producing* $Q_p \neq \overline{Q}_p$ *, cost minimizing transactions in* m_s *and* K_s *will adjust total output to the optimum* $Q_p + Q_s = \overline{Q}_p + \overline{Q}_s = \overline{Q}$ *, so long as final real balances in* m_s *achieve their optimal level,* $m_s = m_s^*$.

<u>Proof</u>: The first order conditions of (2a) yield Marginal Rates of Substitution (MRS) of $(\partial f/\partial K_p)/(\partial f/\partial m_p) = (c_p/r_p) < (c_s/r_s) = (\partial f/\partial K_s)/(\partial f/\partial m_s)$. The inequality is by (1a), which shows $(c_p/c_s) \leq 1 < (r_p/r_s)$. If $Q_p \neq \overline{Q}_p$, then $K_p \neq \overline{K}_p$. But if $m_s = m_s^*$, then the optimal MRS between m_s and K_s implies that $(\partial f/\partial K_s)$ is evaluated at its optimum level $K_p + K_s = \overline{K}$, so $Q_p + Q_s = \overline{Q}$.

<u>Proposition 1</u>: *If firms are cost-minimizing, then turnover in* m_s *will be counter-cyclical.*

<u>Proof</u>: If there is a slump $Q_p < \overline{Q}_p$, then by Lemma 2 a cost-minimizing firm can still produce $\overline{Q}$ in terms of Q_s, by K_s bought with m_s. Thus, the greater the slump $\overline{Q}_p - Q_p$, the greater are K_s and turnover $\widetilde{m}_s = c_s K_s$. The result is symmetric: a boom with $Q_p > \overline{Q}_p$ implies less K_s and $\widetilde{m}_s$. In either case $\overline{K}_p - K_p = K_s - \overline{K}_s$: shortages or gluts of K_p are offset by K_s, while $\overline{K}_p + \overline{K}_s = K_p + K_s$ is fixed. This establishes $\widetilde{m}_s$ as counter-cyclical.

Notice that there is a fundamental symmetry to these results. That is, nothing in them suffices to show *why* the secondary currency, m_s, should be any more counter-cyclical than the primary one, m_p. The crucial step is in Lemma 2, which grants this counter-cyclical power to m_s turnover "*so long as* final real balances in m_s achieve their optimal level, $m_s = m_s^*$." But why should WIR have this remarkable power of self-adjustment? Studer (1998, p. 31) claims this elasticity is "due to the automatic plus-minus balance of the system as a whole." So long as an individual has not exceeded his/her overdraft limits, WIR turnover varies automatically with demand itself. In Clower's original (1965) terms, notional demand and effective demand are no longer distinct. Perhaps then, rather than calling WIR "complementary" (the currently preferred term), we should call it a *residual* currency, one ready to 'take up the slack' between notional and effective demand in primary currency. WIR thus has potential not only as a counter-cyclical tool, but as a test of Clower's theory of effective demand.

But consider a counterargument. Many banking systems – the British, for example – allow for overdrafts. Why should these not show the same "practically unlimited potential" (Studer, 1998, p. 31) for expansion as the WIR? The question, once posed, almost answers itself. The money supply created by a system of demand deposits is fixed by its reserve requirements. As long as most overdraft limits are not exceeded, however, the total of WIR credits can grow – or shrink – without limit. As Studer

(1998, p. 32) puts it, "every [extra] franc of WIR credit automatically and immediately becomes a franc of WIR payment medium" to be used anywhere in the system.

We next show that any countercyclical potential of this secondary currency is likely to vary directly with its transactional effectiveness.

Proposition 2: *Assume that the ratio c_s/c_p is set by transactions technology and institutions, and does not vary with the economic cycle. If the time required to buy or sell K_s, compared to an equal amount of K_p, varies proportionately with the relative cost of transactions in m_s, $c_s/c_p \geq 1$, turnover in m_s will be less counter-cyclical the greater is c_s/c_p.*

Proof: Consider the countercyclical substitution, $\Delta K_p = -\Delta K_s$. Since $c_s/c_p \geq 1$, turnover in m_s must eventually be at least as great as the amount of m_p it replaces: $|\Delta \tilde{m}_s| = |c_s \Delta K_s| \geq |\Delta \tilde{m}_p| = |c_p \Delta K_p|$. By our assumptions, however, the K_s transacted is less than an equivalent amount of K_p transacted over the same period t: $|\Delta K_s/\Delta t| / |\Delta K_p/\Delta t| < 1$, this ratio falling as c_s/c_p rises. By Lemma 1, the marginal productivity of m_s is less than m_p, so the previous inequality implies $|\Delta Q_s/\Delta t| / |\Delta Q_p/\Delta t| < 1$.

Corollary to Proposition 2: *A fall in the relative marginal productivity of m_s, $(\partial f/\partial m_s)/(\partial f/\partial m_p) = r_s/r_p < 1$, means Q_s will take more time to match the quantity $(\overline{Q}_p - Q_p)$. Thus turnover $\tilde{m}_s$ shows less counter-cyclicality.*

Proof: Immediate from Proposition 2.

III.2 Empirical Specifications

The counter-cyclical element of our residual currency is not the balances of m_s, which Lemma 2 shows tend to be quite stable. It is rather *Turnover,* $\tilde{m}_s$, or total WIR-money in circulation – essentially the *WIR-credit balances times velocity*: $\tilde{m}_s = v_s m_s = c_s K_s$. Since the WIR-Bank keeps track of this Turnover, we can estimate its correlation with GDP and Unemployment.

If $\tilde{m}_s = c_s K_s = c_s(K^* - K_p)$, there is a clear counter-cyclical implication. That is, if full potential output $\overline{Q} = g(K_p, K_s)$ is not reached, then both $\tilde{m}_s$ (Turnover) and $\tilde{m}_s/m_s$ (Velocity) should be:

- inversely correlated with variation in output Q (below, GDP),
- inversely correlated with variation in broad money supply m_p (below, M2), and
- directly correlated with variation in the number of unemployed (below, UE)

– all in the short-term. In the longer term, m_p, m_s, and Turnover $\tilde{m}_s$ should all grow along with Swiss GDP. This distinction between short-term and long-term variation suggests an Error-Correction Model (ECM) specification.

As will be seen, there is strong evidence for Granger causality of the broad Swiss money supply measure M2 upon GDP and upon WIR-Turnover – but not *vice-versa*. This makes sense in terms of our model, since variations in Turnover $\tilde{m}_s$ are driven by variations in m_p – not *vice-versa*. It is also only sensible, given the comparatively small amounts of WIR in the Swiss national economy. Swiss M2 measured 475.1 billion Swiss Francs (SFr) in 2003,[13] whereas m_s, WIR Credits in Table 1, were 784.4 million SFr. Thus the ratio of WIR "money supply" to M2 is only 0.165%, or about one sixth of one percent.

In our MIPF formalization (2a), what signs do we expect on the derivatives with respect to m_p and m_s? Due to the limitation on exchange to the *Wirtschaftsring*; i.e., only to members of the reciprocal exchange community, m_s will of course be less fungible. Lemma 1 shows that m_s will also be less *transactionally productive* than m_p in realizing Q *in the long run*. That is, in the error-correction portions of our specifications, for the effect of the terms m_p, m_s, and $\tilde{m}_s$ (i.e., M2 money supply, WIR Credit balances, and WIR Turnover, respectively) upon GDP:

$$\frac{\partial f}{\partial m_p} > \frac{\partial f}{\partial m_s} > \frac{\partial f}{\partial \tilde{m}_s} > 0 \tag{3}$$

In many MIPF estimates (not shown here), there is clear evidence for the positive signs in (3). Evidence for their relative ordering, however, is mixed.

Numerous estimates (not shown) also show that money *supplies* (as opposed to turnover) m_p and m_s are *pro-cyclical* in the VAR portion of an Error Correction Model (ECM). This pro-cyclical pattern is well known for the normal money supply (Mankiw, 1993; Mankiw and Summers, 1986; Bernanke and Gertler, 1995; Gavin and Kydland, 1999). We will concentrate our presentation on the estimates showing that Turnover, $\tilde{m}_s$, is *counter-cyclical*. By the substitutability of m_p and m_s shown in Lemma 2, their turnover should be negatively correlated in the short-term or cyclical sense: $\tilde{m}_p - \tilde{m}_p^* = \tilde{m}_s^* - \tilde{m}_s$.

From our result on Turnover we have $\tilde{m}_s = c_s K_s = c_s(K^* - K_p)$, so that $\partial \tilde{m}_s / \partial K_p = -c_s < 0$. Since K_p in our model varies directly with m_p and Q_p (the overwhelming bulk of output), and indirectly with unemployment in the short-term, we expect to find short-term countercyclical derivatives of the form:

$$\partial \tilde{m}_s / \partial Q < 0, \tag{4.1}$$

$$\partial \tilde{m}_s / \partial m_p < 0, \text{ and} \tag{4.2}$$

$$\partial \tilde{m}_s / \partial UE > 0, \tag{4.3}$$

where UE is the number (not the rate) of Unemployed persons.

As noted, $\tilde{m}_s$, Q, m_p, and UE should all grow together in an expanding economy. We are not so concerned about the functional forms of this long-term relationship – i.e., the error-correction portion of

13 Swiss National Bank (SNB) *Monthly Statistical Bulletin* (August 2005), Table B2, Monetary aggregates: www.snb.ch/e/publikationen/publi.html?file=/e/publikationen/monatsheft/aktuelle_publikation/html/e/inhaltsverzeichnis.html

an ECM. As long as this relationship is cointegrated, we can concentrate on the coefficients of the *lagged, first-differenced values* of these RHS terms (i.e., in the VAR portion of the ECM), which are clearly exogenous. Derivatives (4.1) - (4.3) would thus be derived from:

$$D\tilde{m}_s = \alpha_1[\tilde{m}_s(-1) - \alpha_{1s}Q(-1)] + \sum^{N}_{t=1}\{\beta_1 D\tilde{m}_s(-t) + \gamma_1 DQ(-t)\}, \quad (4.1a)$$

$$D\tilde{m}_s = \alpha_2[\tilde{m}_s(-1) - \alpha_{2s}m_p(-1)] + \sum^{N}_{t=1}\{\beta_2 D\tilde{m}_s(-t) + \gamma_2 Dm_p(-t)\}, \quad (4.2a)$$

$$D\tilde{m}_s = \alpha_3[\tilde{m}_s(-1) - \alpha_{3s}UE(-1)] + \sum^{N}_{t=1}\{\beta_3 D\tilde{m}_s(-t) + \gamma_3 DUE(-t)\}, \quad (4.3a)$$

where $D\tilde{m}_s$ (-t) is the first-differenced term from t periods ago, summed over N periods, etc.

Applying this reasoning to the error-correction portion [in square brackets] of the ECM equations (4.1a) - (4.3a), we expect the α coefficients on Q, m_p, and UE to be positive.[14] But in the VAR portion {in curly brackets} of the equations, we expect γ_1 and γ_2 to be negative, and γ_3 to be positive, according to (4.1-4.3), if $\tilde{m}_s$ is counter-cyclical. That is, in the long-term error-correction term of the ECMs above, we expect:

$$-\alpha_{1s} = \partial\tilde{m}_s(-1)/\partial Q(-1) < 0, \quad -\alpha_{2s} = \partial\tilde{m}_s(-1)/\partial m_p(-1) < 0, \quad -\alpha_{3s} = \partial\tilde{m}_s(-1)/\partial UE(-1) < 0. \quad (4.4)$$

Looking at the short-term, in the VAR portion of the ECMs, (4.1a)-(4.3a) would be expressed by:

$$\gamma_1 = \partial D(\tilde{m}_s)/\partial D(Q(-1)), \;\; \gamma_2 = \partial D(\tilde{m}_s)/\partial D(m_p(-1)) \; < \; 0 \; < \; \gamma_3 = \partial D(\tilde{m}_s)/\partial D(UE(-1)). \quad (4.5)$$

As will be shown, these short-term counter-cyclical effects are present throughout the period of our study, but were much stronger in the earlier period (1948-1972), when WIR and SFr were closer substitutes, and both c_p/c_s and r_s/r_p were likely to have been higher. WIR's greater counter-cyclical effectiveness pre-1973 follows from Proposition 2 and its corollary.

In summary, the counter-cyclical activity of WIR can be seen as extending the usefulness of ordinary money, especially when the latter is limited by anti-inflationary policy. This of course raises the serious question of whether such alternative-money activity is itself inflationary – a question to which I will return in this paper's conclusion.

IV. Empirical Tests

IV.1. Data and Initial estimates

Because the WIR record is not widely available, I provide the basic data. The WIR bank has provided 56 years of data on *Nombre de Comptes-Participants* ("Number of Account-Participants"), *Chiffre (o Volume) d'Affaires* ("Turnover" activity), and *Autres Obligations Financières envers Clients en WIR* (or "Credit" advanced in the form of credit to one's reciprocal exchange account). Turnover and

[14] Note that while α_{1s}, α_{2s}, $\alpha_{3s} > 0$, there is a negative sign placed before them in (4.1a - 4.3a).

Credit are equivalent to $\tilde{m}_s$ and m_s in our model, respectively, and are given in terms of WIR; i.e., their Swiss Franc (SFr) equivalents. Other macro-economic time series used in this paper are from Madison (1995), Mitchell (1998), the IMF (2007) and World Bank (2008).

Table 1: Participants, Total Turnover, and Credit, WIR-Bank, 1948-2003
(Total Turnover and Credit Denominated in Millions of Current Swiss Francs)

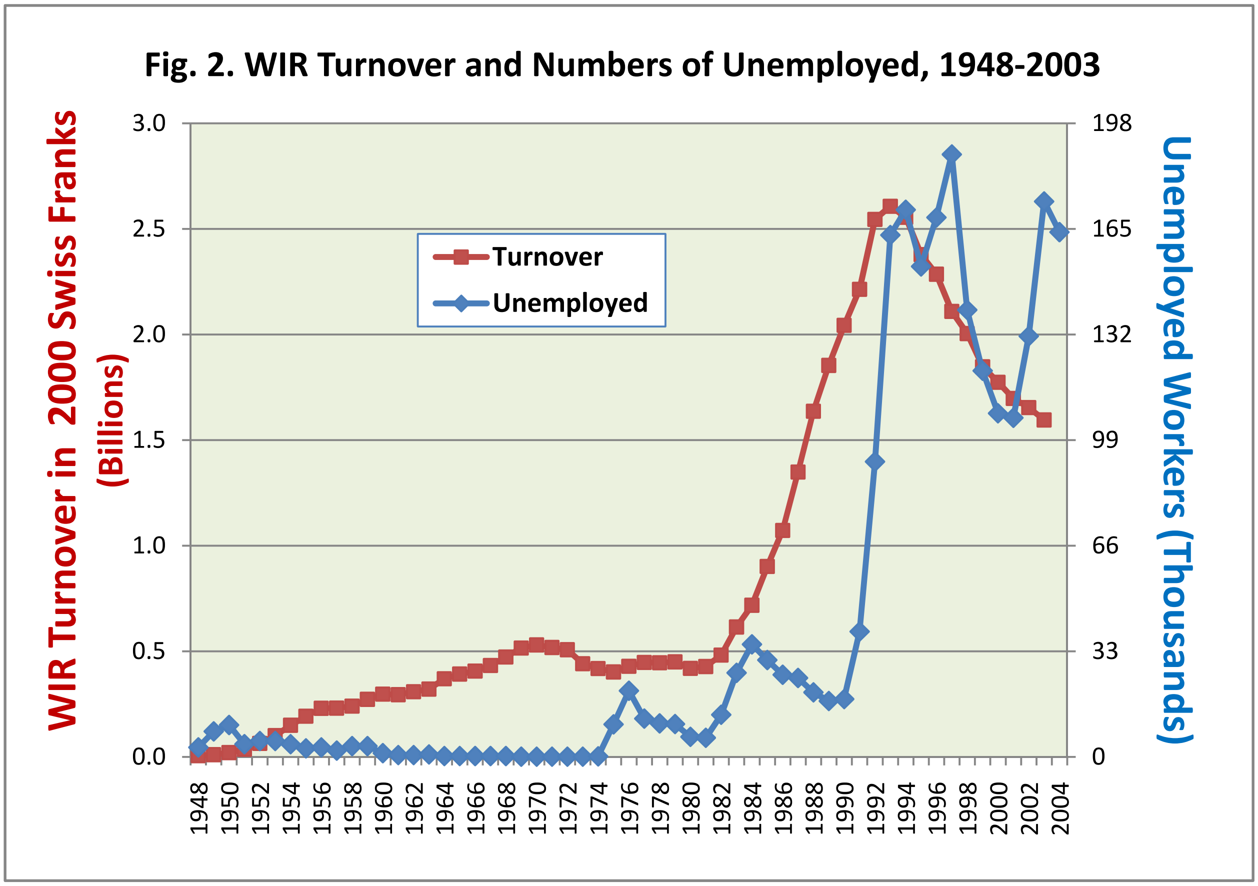
Year	Participants	Turnover	Credit	Year	Participants	Turnover	Credit
1948	814	1.1	0.3	**1976**	23,172	223.0	82.2
1949	1,070	2.0	0.5	**1977**	23,929	233.2	84.5
1950	1,574	3.8	1.0	**1978**	24,479	240.4	86.5
1951	2,089	6.8	1.3	**1979**	24,191	247.5	89.0
1952	2,941	12.6	3.1	**1980**	24,227	255.3	94.1
1953	4,540	20.2	4.6	**1981**	24,501	275.2	103.3
1954	5,957	30.0	7.2	**1982**	26,040	330.0	127.7
1955	7,231	39.1	10.5	**1983**	28,418	432.3	159.6
1956	9,060	47.2	11.8	**1984**	31,330	523.0	200.9
1957	10,286	48.4	12.1	**1985**	34,353	673.0	242.7
1958	11,606	53.0	13.1	**1986**	38,012	826.0	292.5
1959	12,192	60.0	14.0	**1987**	42,227	1,065	359.3
1960	12,567	67.4	15.4	**1988**	46,895	1,329	437.3
1961	12,445	69.3	16.7	**1989**	51,349	1,553	525.7
1962	12,720	76.7	19.3	**1990**	56,309	1,788	612.5
1963	12,670	83.6	21.6	**1991**	62,958	2,047	731.7
1964	13,680	101.6	24.3	**1992**	70,465	2,404	829.8
1965	14,367	111.9	25.5	**1993**	76,618	2,521	892.3
1966	15,076	121.5	27.0	**1994**	79,766	2,509	904.1
1967	15,964	135.2	37.3	**1995**	81,516	2,355	890.6
1968	17,069	152.2	44.9	**1996**	82,558	2,262	869.8
1969	17,906	170.1	50.3	**1997**	82,793	2,085	843.6
1970	18,239	183.3	57.2	**1998**	82,751	1,976	807.7
1971	19,038	195.1	66.2	**1999**	82,487	1,833	788.7
1972	19,523	209.3	69.3	**2000**	81,719	1,774	786.9
1973	20,402	196.7	69.9	**2001**	80,227	1,708	791.5
1974	20,902	200.0	73.0	**2002**	78,505	1,691	791.5
1975	21,869	204.7	78.9	**2003**	77,668	1,650	784.4

Sources: Data to 1983 are from Meierhofer (1984). Subsequent years are from the annual *Rapport de Gestion* and communications with the WIR public relations department (2005a, 2005b). The first three series (Participants, Turnover, and Credit) are given in the annual report in French as *Nombre de Comptes-Participants, Chiffre (o Volume) d'Affaires,* and *Autres Obligations Financières envers Clients en WIR*, respectively. Both Turnover and Credit are denominated in Swiss Francs, but the obligations they represent are payable in WIR-accounts. In the regressions, all WIR and monetary series are divided by the 2000 GDP deflator. Post-2003 data have not been made available.

These data raise a number of questions. Consider Figure 2 below, which plots WIR Turnover relative to the number of Unemployed in Switzerland:

1) What explains the turning points in WIR Turnover in the early 1970s, '80s, and '90s?
2) WIR Turnover tracks the number of Unemployed fairly closely. Is this a counter-cyclical trend?

As will be seen in what follows, this paper may help explain a change in WIR trend in the early 1970s, but not the later turning points. WIR's long-term correlation with Unemployment is cointegration, not a counter-cyclical trend. We will show a short-term counter-cyclical tendency, however.



Estimates of the Swiss GDP production function (not shown here) were consistent with our basic MIPF equation (2), when specified with inputs of Capital, Labor, and Money (M2). Furthermore, all coefficients had the expected positive signs in most specifications of the underlying error-correction equation, Q = f(L, K, m), and also in the VAR portion of the ECM.

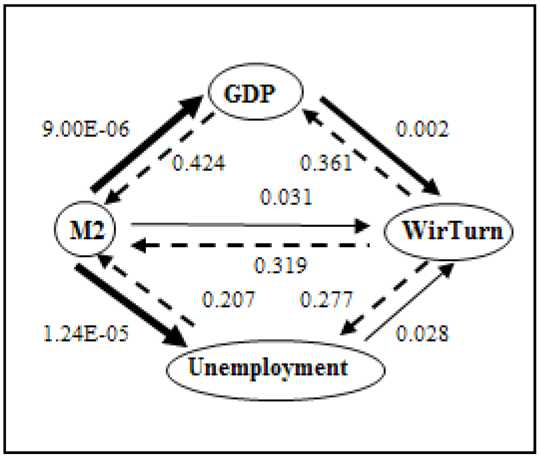
IV.2. Effect of GDP upon WIR Turnover

Our estimates of equation (4.1a) in Table 3 below show that lagged GDP has the expected positive sign in the error correction component of each regression, with cointegration highly significant in 3(A), less so in (B) and (C).[15] In the VAR portions of the regressions, coefficients on the first lag of differenced GDP in 3(A) and (B), and differenced 2-year average growth in 3(C), have the expected (counter-cyclical) negative sign from equation (4.5). The test statistics on cointegration and the 1973 break-point are encouraging. But the Lagrange Multiplier tests are not so, as one can reject no serial

[15] Recall that the coefficients in the estimated error-correction form are *negatives* of those in the underlying equation.

correlation at the 10 percent level. As illustrated in Figure 3, Granger/Exogeneity tests are at or near significance in all three columns. Granger causality can be rejected in the 'reciprocal' direction, however, leading from WIR to GDP.

Figure 3: Granger Causality Relationships: Switzerland, 1950-2003



Note: Numbers are P-values on the null hypothesis of *no* Granger causality shown by directional arrow between variables. Solid arrows indicate that the null is rejected at 5 percent level, with their thickness proportional to significance. Broken arrows show the null cannot be rejected at the 5 percent level. Granger causality tests here shown are not from any particular regression, but on the log-normal form of the variables with two lags. Granger/Wald Block Exogeneity tests are given in the paper's regression tables. All variables used in this paper are non-stationary in their levels.

Table 4 shows evidence of a structural break in the relationship between GDP and WIR Turnover. Notice that the Chow statistics in the 'split' estimations of 4(A1) and 4(A2) are taken from the 'un-split' 3(A), and similarly the splits 4(B1)-(B2) and 4(C1)-(C2) pairs are taken from 3(B) and 3(C), respectively. What explains this apparent structural break around 1973?

Table 2: Notation for Tables 3-6

LnWirTurn(-t)	Natural Log of WIR Turnover, lagged t period(s)
LnGDP(-t)	Natural Log of GDP, lagged t period(s)
LnGDP_ma2(-t)	Natural Log of 2-Period Moving Average of GDP, lagged t period(s)
LnUE(-t)	Natural Log of Unemployment, lagged t period(s)
LnUE_ma2(-t)	Natural Log of 2-Period Moving Average of Unemployment, lagged t period(s)
LnM2(-t)	Natural Log of M2, lagged t period(s)
LnM2_ma2(-t)	Natural Log of 2-Period Moving Average of M2, lagged t period(s)
D( )	First Difference of any of the previous variables

According to official histories, Defila (1994) and Studer (1998), 1973 was a turning point for the WIR-Bank. A conflict arose over the "discounting" of WIR – unused credits sold directly for SFr, usually at substantial discount. WIR introduced measures to detect and prohibit such trading in the fall of 1973.[16] Of course WIR will usually be worth less than SFr in direct trade, since it cannot be used as widely. Studer reports (1988, p. 21) that a counter-cyclical argument was raised to defend this discount trade: "that it created additional turnover and facilitated members' ability to ride out periodic currency-liquidity bottlenecks." Our estimates show that these counter-cyclical arguments may have had a point.

Recall that Proposition 2 and its corollary show how higher relative transaction costs and lower productivity in the secondary currency, expressed as a growth in c_s/c_p or a fall in r_s/r_p, make that currency less counter-cyclically effective. The ban on discounting is likely to have led to such changes in the value of WIR, and Table 4 gives some evidence of a break in counter-cyclical effectiveness. The coefficients on the first lagged difference of GDP are more significant and larger in absolute value in 4(B1) and 4(C1), compared with 4(B2) and 4(C2), respectively, although the coefficient difference is not significant.

Now there are certainly other events, besides the ban on discounting, which might be affect the cost of carrying out transactions in m_s, and could have caused a structural break. From Figure 4 below, some of the turning points in the volume in WIR turnover, in the early 1970s, '80s, and '90s, appear to coincide with changes in the value of the SFr that could have worked along similar lines – since the appreciation of the SFr would tend to raise, and its depreciation lower, c_s/c_p.[17] Our initial regressions did not support the conjecture on this causing structural breaks, but it remains plausible.[18]

Note that in the underlying cointegrating equations of Table 4, WIR is positively correlated with GDP, both pre-1973 and post-1973, as in inequality (4.4). The absolute value of the coefficients on the error-correction term are greater pre-1973 than in the post-1973 estimates, although only in 4(C1) and (C2) is the difference significant.

Lagrange multiplier tests for serial correlation show the regressions in Table 4 are more reliable pre-1973, rather than post-1973: the null hypothesis of no serial correlation for the latter can be rejected at the 10 percent level, but for all of the former only at a the 25 percent level, and at over 65 percent for (A1) and (B1). Granger/exogeneity tests in Table 4 are highly significant, most at the 1 percent level.

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[16] Of course, the fact that the same goods are available for sale within the network for WIR *or* outside the network for SFr. creates an opportunity for buying in the former and reselling in the latter – and thus effectively converting WIR into SFr., usually at a discount. Studer recognizes (1998, p. 52) that direct selling of WIR, though prohibited, sometimes occurs. Nevertheless, the formal ban on full convertibility clearly raises the transactions cost of using m_s, and should raise c_s/c_p.

[17] A negative correlation between Swiss Franc's foreign exchange rate (IMF, 2007) and WIR Turnover is evident for the periods 1970-75, 1980-85, and 1993-96 – around the turning points for the WIR series.

[18] The identification of a structural break in 1973 does not tell us what *caused* that break. There were many big changes in the world economy around these turning points: collapse of the Bretton Woods agreements, devaluation of the US dollar, the formation of OPEC, high levels of inflation, negative real interest rates, growth of the Eurodollar market, and the increased 'disintermediation' of traditional financial institutions. All of these could raise the relative opportunity cost of holding Swiss Francs, r_p/r_s and raise the SFr's relative value, c_s/c_p – implying reduced marginal productivity (Proposition 1), and a diminished counter-cyclical role (Proposition 2) for m_s.

Table 3: Change in Turnover in the WIR Exchange Network,
as Explained by GDP, 1951-2003 †

*t-statistics in [ ]; P-Values in { }****: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10, °: p-val <0.15*

Dependent Variable: lnWirTurn	**(A)** 1951-2003 N=53	**(B)** 1951-2003 N=53	**(C) ‡** 1951-2003 N=53
Cointegrating Eq:			
lnWirTurn(-1)	1.0000	1.0000	1.0000
lnGDP(-1) ‡	-3.1255 [-7.645]***	-1.8874 [-1.725]*	-1.6098 [-1.842]*
TIME Trend		-0.0282 [-1.095]	-0.0380 [-1.843]*
Constant	10.9928	4.9520	3.6616
Independent Variables:			
Cointegrating Eq.	-0.0453 [-2.514]**	-0.0533 [-2.728]***	-0.0631 [-3.06]***
D(lnWirTurn(-1))	0.7195 [5.472]***	0.7045 [5.384]***	0.6289 [4.602]***
D(lnWirTurn(-2))	0.1641 [1.268]	0.1550 [1.223]	0.2215 [1.703]*
D(lnGDP(-1)) ‡	-0.7521 [-2.192]**	-0.7224 [-2.121]**	-0.7952 [-1.551] °
D(lnGDP(-2)) ‡	0.5353 [1.655] °	0.5833 [1.808]*	1.2237 [2.566]**
Constant	0.0024 [0.181]	0.0027 [0.209]	-0.0136 [-0.938]
R-squared	0.8703	0.8730	0.8431
Adjusted R-squared	0.8565	0.8595	0.8261
F-statistic	63.0936	64.6166	49.4521
Log likelihood	79.3161	79.8671	78.0642
Akaike AIC	-2.7667	-2.7874	-2.7717
Schwarz SC	-2.5436	-2.5644	-2.5466
(a) Johansen P-Values (*)	{0.0258}	{0.1092}	{0.0323}
(b) Serial LM P-Value (*)	{0.0677}	{0.0901}	{0.0026}
(c) Granger P-Value (*)	{0.0524}	{0.0482}	{0.0372}
(d) Chow Breakpoint	{0.0898}	{0.0223}	{0.0628}
(e) Chow Forecast	{0.0241}	{0.0084}	{0.0065}

(†) P-values {in curly brackets} are given for the null hypotheses of (a) no cointegration, (b) no serial correlation, and (c) no Granger Causality. For (a), the p-value reported is always the *higher* of the Johansen trace and eigenvalue tests. For (b), the Lagrange Multiplier p-value is for the number of lags in the particular ECM. For (c), the Granger Causality/Block Exogeneity Wald test, the p-value is for a Chi-squared on the joint significance of all lagged endogenous variables in the VAR portion of the regression, *except* the dependent variable from the error correction term. In (d) and (e) the Chow Breakpoint and Forecast tests, respectively, show p-values for their F-test statistics on the null hypothesis of no structural break in 1973. Thus, although they are derived from regressions spanning the entire period, these same Chow tests are also relevant for the two sub-periods (pre-1973 and thereafter) as shown in subsequent tables.

(‡) For Column 3(C), substitute the 2-year moving average terms for GDP, LnGDP_ma2(-t), and D(LnGDP_ma2(-t)).

Table 4: Change in Turnover in the WIR Exchange Network, as Explained by GDP, 1951-2003 †

*t-statistics in [ ]; P-Values in { };***: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10, °: p-val <0.15*

Dependent Variable: lnWirTurn	**(A1) 1951-1972** N = 22	**(A2) 1973-2003** N = 31	**(B1) 1951-1972** N = 22	**(B2) 1973-2003** N = 31	**(C1) ‡ 1973-2003** N = 31	**(C2) ‡ 1973-2003** N = 31
Cointegrat. Eq:						
LnWirTurn(-1)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
LnGDP(-1) ‡	-1.2139 [-3.368]***	-4.2392 [-8.794]***	-9.3769 [-2.142]*	7.2798 [1.779]*	-5.466 [-3.629]***	17.3717 [2.983]***
TIME Trend			0.3631 [1.846]*	-0.1734 [-2.798]**	0.1915 [2.805]***	-0.3225 [-3.662]***
Constant	0.8129	17.7226	37.8888	-42.3819	19.8842	-95.0266
Indep. Variables:						
Cointegrating Eq	-0.15867 [-3.804]***	-0.1316 [-3.595]***	-0.1147 [-3.305]***	-0.0633 [-3.029]***	-0.2218 [-5.277]***	-0.0485 [-2.856]***
D(LnWirTurn(-1))	0.2867 [1.354]	0.5922 [3.865]***	0.3844 [1.788]*	0.6262 [3.914]***	0.2687 [1.504]°	0.4473 [2.368]**
D(LnWirTurn(-2))	0.1469 [0.913]	0.4826 [2.750]**	0.1583 [0.921]	0.3235 [1.927]	0.0745 [0.537]	0.4492 [2.254]**
D(LnGDP(-1)) ‡	-1.1049 [-2.298]**	-1.5442 [-3.435]***	-1.4836 [-2.720]**	-1.2074 [-2.598]**	-1.9444 [-3.241]***	-1.4894 [-1.884]*
D(LnGDP(-2)) ‡	-0.2617 [-0.608]	0.6911 [1.575]°	-0.6750 [-1.414]	1.4179 [3.090]***	-0.5876 [-1.035]	2.5289 [3.116]***
Constant	0.1267 [3.260]***	0.0077 [0.646]	0.1421 [3.133]***	-0.0033 [-0.263]	0.1845 [4.078]***	-0.0154 [-1.017]
R-squared	0.9456	0.8284	0.9385	0.8096	0.9512	0.7692
Adj. R-squared	0.9287	0.7941	0.9193	0.7715	0.9350	0.7231
F-statistic	55.6648	0.0586	48.8141	21.2592	58.5213	16.6667
Log likelihood	38.6343	0.0484	37.2733	51.5936	40.6703	48.6138
Akaike AIC	-2.9668	-3.0455	-2.8430	-2.9415	-3.3019	-2.7493
Schwarz SC	-2.6692	-2.7680	-2.5455	-2.6640	-3.0035	-2.4717
(a) Johansen P-Values	{0.0249}	{0.1006}	{0.0609}	{0.0976}	{8.971e-06}	{0.0310}
(b) Serial LM P-Value	{0.6951}	{0.0171}	{0.7571}	{0.0629}	{0.2892}	{0.0038}
(c) Granger P-Value	{0.0646}	{0.0019}	{0.0155}	{0.0016}	{0.0021}	{0.0077}
(d) Chow Breakpoint	{0.0898}		{0.0223}		{0.0628}	
(e) Chow Forecast	{0.0241}		{0.0084}		{0.0065}	

(†) See Note for Table 3.
(‡) For Columns 4(C1) and (C2), substitute the 2-year moving average terms for GDP, LnGDP_ma2(-t), and D(LnGDP_ma2(-t)).

GDP Granger-causes WIR in both periods, and this causation can be shown to usually be *reciprocal*; i.e., Granger causality is also significant in the 'reverse' WIR-to-GDP direction, with P-values (not shown) significant in 4(A1), (B1), (B2), (C1), and (C2). To repeat, however, WIR is too small to be an important determinant of Swiss GDP.

IV.3. Effect of Unemployment on WIR Turnover

As Figure 2 has already shown, growth in the number of Swiss Unemployed workers tracks the number of WIR Participants very closely. This closeness of Unemployment to WIR's trend probably reflects its exclusion of "large" businesses, another important change in the bank's rules since 1973 (Defila, 1994). Employees in smaller, less diversified firms are more subject to unemployment risk in most countries, including Switzerland (Winter-Ebmer and Zweimüller, 1999; Winter-Ebmer, 2001). Smaller firms also typically have less access to formal credit institutions (Terra, 2003), and their owners must rely proportionately more on self-financing (Small Business Administration, 1998) and, as we have seen, WIR-like trade credits (Nilsen, 2002; Petersen and Rajan, 1997).

From Table 5 below, it can be seen that the long-term ("secular") cointegrated relationship between WIR Accounts and the Number of Unemployed Workers is positive, as in inequality (4.4).

Similarly to the previous regressions on GDP, the relationship of Turnover to Unemployment can be shown to undergo a structural break around 1973, and become less counter-cyclical thereafter. If we run a single regression over the entire 1954-2003 period split by the regressions in columns 5(A1) and (A2), the Chow Breakpoint and the Chow Forecast Chi-squared tests give contradictory results on the null hypothesis of no structural break: the Breakpoint test fails to reject the null in 5(A), while the Forecast rejects.[19] On regressions 5(B1) and (B2), however, both tests are significant at 10 percent.

The lagged first-difference on Unemployment is significantly larger in 5(A1) than in (A2), and somewhat so in (B1) compared to (B2). The size of coefficients on the error correction terms are also several times greater pre-1973, and much more significant. This is similar to the period contrast for our regressions in Table 4.

Note further that the null hypothesis of no serial correlation can be rejected for 5(B2). Also Granger-causality is more significant in 5(A1) and (B1) than in 5(A2) and (B2).

[19] It is not unusual for the two Chow tests to yield qualitatively different results. While the Breakpoint test on 5(A) does not reject the null, other evidence of structural change in the Table 5 is consistent with the Forecast test.

Table 5: Change in Turnover in the WIR Exchange Network, as Explained by Number of Unemployed, 1952-2003 †

*t-statistics in [ ]; P-Values in { };***: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10, °: p-val <0.15*

Dependent Variable: lnWirTurn	**(A1) 1952-1972** N = 21	**(A2) 1973-2003** N = 31	**(B1) ‡ 1952-1972** N = 21	**(B2) ‡ 1973-2003** N = 31
Cointegrating Eq:				
LnWirTurn(-1)	1.0000	1.0000	1.0000	1.0000
LnUE(-1) ‡	0.2276 [4.717]***	-0.3907 [-7.497]	0.5043 [1.756]°	-0.2252 [-2.135]**
TIME Trend			0.0730 [1.045]	-0.0296 [-1.191]
Constant	-5.5137	-5.7420	-6.5539	-5.0943
Independ. Variables:				
Cointegrating Eq	-0.2200 [-4.489]***	-0.0360 [-1.466]	-0.1954 [-4.581]***	-0.0693 [-2.588]**
D(LnWirTurn(-1))	0.3434 [1.786]*	0.6425 [3.137]*	0.3703 [1.981]*	0.5172 [2.811]**
D(LnWirTurn(-2))	0.0569 [0.258]	0.3827 [1.701]°	-0.1294 [-0.838]	0.3752 [1.973]*
D(LnWirTurn(-3))	-0.1106 [-0.724]	-0.1988 [-0.893]		
D(LnUE(-1)) ‡	0.0828 [2.848]***	0.0187 [1.149]	0.1038 [2.717]**	0.0430 [1.999]*
D(LnUE(-2)) ‡	0.0527 [2.006]*	-0.0220 [-1.337]	0.0482 [1.379]	-0.0527 [-2.472]**
D(LnUE(-3))	0.0154 [0.6060]	-0.0151 [-0.928]		
Constant	0.1174 [4.00]***	0.0105 [0.797]	0.1239 [4.105]***	0.0055 [0.471]
R-squared	0.9477	0.7632	0.9407	0.7587
Adj. R-squared	0.9196	0.6911	0.9209	0.7105
F-statistic	33.6683	10.5892	47.5727	15.7236
Log likelihood	39.9399	48.2133	38.6126	47.9241
Akaike AIC	-3.0419	-2.5944	-3.1060	-2.7048
Schwarz SC	-2.6440	-2.2243	-2.8075	-2.4272
(a) Johansen P-Values	{0.0013}	{0.0124}	{0.0718}	{0.0563}
(b) Serial LM P-Value	{0.9874}	{0.5613}	{0.6075}	{0.0235}
(c) Granger Causality	{0.0172}	{0.1493}	{0.0118}	{0.0379}
(d) Chow Breakpoint	{0.7624}		{0.0785}	
(e) Chow Forecast	{0.0256}		{0.0009}	

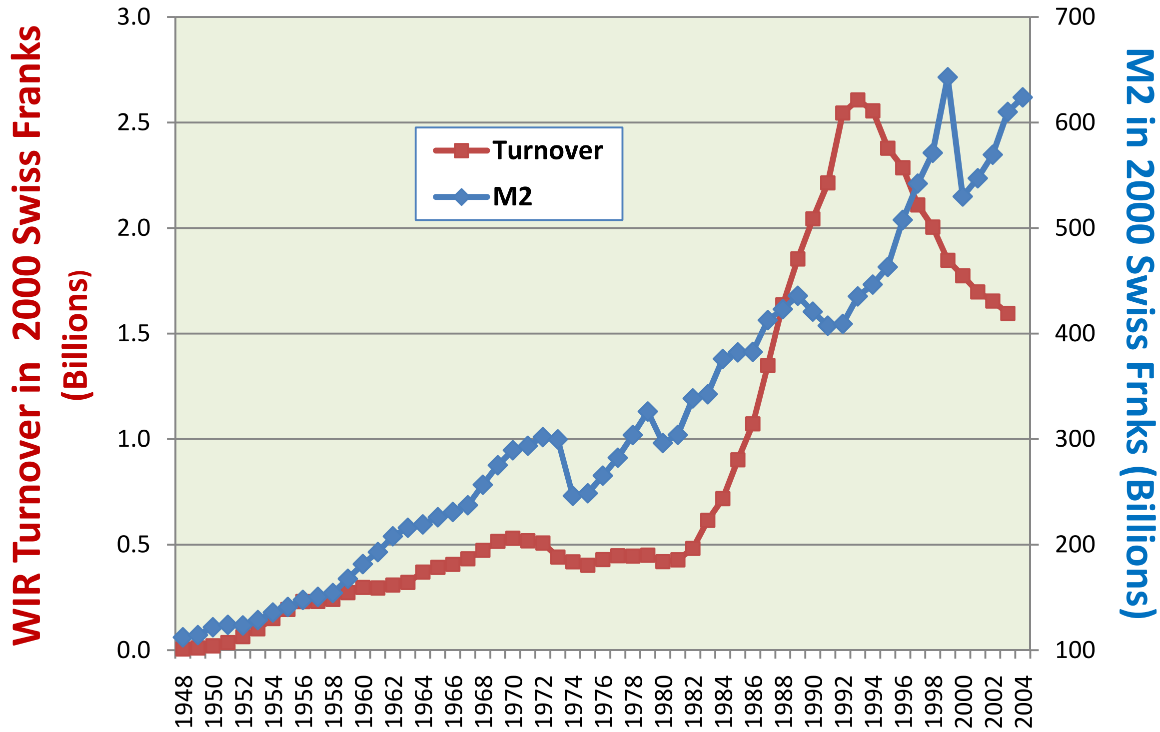
Note: (†) See Table 3

(‡) For Columns 5(B1) and (B2), substitute the 2-year moving average terms for UE, LnUE_ma2(-t) and D(LnUE_ma2(-t)).

IV.4. Effect of M2 on WIR Turnover

We next come to an obvious question: If WIR became less tradable for Swiss Francs after 1973, what happened to the correlation between WIR and the Swiss money supply? Figure 4 suggests that WIR followed Swiss M2 very closely up to about 1972, but may have "decoupled" since then.

Fig. 4. WIR Turnover and Money Supply, 1948-2003



The pre-1973 error correction components in Table 6 (A1) and (B1) show significant positive correlation between M2 and WIR, as in equation (4.4) and as one would expect in a growing economy. But this relationship appears to break down completely post-1973: In regressions (A2) and (B2), not only does the correlation become strongly negative, but there is no longer strong evidence of cointegration: the Johansen test is in the former only at 10 percent, and completely insignificant in the latter. The Chow tests give contradictory results on the null hypothesis of no structural break, however, the Forecast test rejecting, and the Breakpoint test failing to reject this null. The LM test shows no evidence of serial correlation in either time period.

As in our previous Tables, the coefficient on the error correction term is larger, and here only significant in the earlier pre-1973 period. Here, comparing columns 6(A1) and (A2), the coefficient on the error correction component is two orders of magnitude greater than in the former. The estimates of columns 6(A1) and (B1) appear more reliable than those in 6(A2) and (B2), since the latter fail to show Granger causality or cointegration. Thus it appears that WIR was much more closely tied to M2 before 1973 in the long-term, secular, cointegrated sense.

Table 6: Change in Turnover in the WIR Exchange Network,
as Explained by Swiss Money Supply (M2), 1953-2003 †

*t-statistics in [ ]; P-Values in { };***: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10, °: p-val <0.15*

<u>**Dependent Variable**</u>: **lnWirTurn**	**(A1)** **1954-1972** N = 19	**(A2)** **1973-2003** N = 31	**(B1) ‡** **1953-1972** N = 20	**(B2) ‡** **1973-2003** N = 31
Cointegrating Eq:				
LnWirTurn(-1)	1.0000	1.0000	1.0000	1.0000
LnM2(-1) ‡	-8.5830	40.7099	-3.0387	60.6091
	[-4.229]***	[3.531]***	[-2.123]*	[2.904]***
TIME Trend	0.3379	-1.1995	0.0921	-1.7459
	[3.588]***	[-3.923]***	[1.363]	[-3.229]***
Constant	34.5737	-201.7202	8.8734	-297.8748
Independent Variables:				
CointEq	-0.3889	-0.0086	-0.5971	-0.0057
	[-4.530]***	[-1.647]	[-5.620]***	[-1.423]
D(LnWirTurn(-1))	-0.0750	0.7163	0.1677	0.6937
	[-0.299]	[3.708]***	[0.999]	[3.155]***
D(LnWirTurn(-2))	-0.3050	0.6076	-0.3283	0.5427
	[-1.456]	[2.415]**	[-1.962]*	[2.141]**
D(LnWirTurn(-3))	-0.3090	-0.5140	-0.3588	-0.3805
	[-1.477]	[-2.186]**	[-2.108]*	[-1.579]°
D(LnWirTurn(-4))	0.4902	0.0325	0.2086	-0.0345
	[3.162]**	[0.170]	[1.837]°	[-0.163]
D(LnM2(-1)) ‡	-1.5213	0.0096	-1.6850	-0.1254
	[-2.866]**	[0.050]	[-2.264]*	[-0.457]
D(LnM2(-2)) ‡	-2.1889	-0.0438	-0.0542	-0.0892
	[-2.895]**	[-0.234]	[-0.059]	[-0.246]
D(LnM2(-3)) ‡	-1.8448	0.1803	-2.7368	0.5721
	[-2.885]**	[1.058]	[-3.193]**	[1.608]°
D(LnM2(-4)) ‡	-2.0668	0.5235	-0.7267	0.2662
	[-3.084]**	[2.477]**	[-1.033]	[0.709]
Constant	0.4424	-0.0122	0.3568	-0.0104
	[4.588]***	[-0.749]	[4.686]***	[-0.582]
R-squared	0.9479	0.8020	0.9480	0.7915
Adj. R-squared	0.9009	0.7172	0.8961	0.7022
F-statistic	20.1999	9.4526	18.2428	8.8594
Log likelihood	42.6010	50.9895	45.0908	50.1891
Akaike AIC	-3.2601	-2.6445	-3.6938	-2.5928
Schwarz SC	-2.7622	-2.1819	-3.1967	-2.1303
(a) Johansen P-Values	{0.0015}	{0.0987}	{1.15e-08}	{0.3196}
(b) Serial LM P-Value	{0.8110}	{0.2642}	{0.3258}	{0.3503}
(c) Granger Causality	{0.0001}	{0.0897}	{4.22e-05}	{0.1222}
(d) Chow Breakpoint	{0.5757}		{0.4529}	
(e) Chow Forecast	{0.0952}		{0.0008}	

Note: (†) See Table 3
(‡) For Columns 6(B1) and (B2), substitute the 2-year moving average terms for M2, LnM2_ma2(-t), and D(LnM2_ma2(-t)).

The short-term elasticities are more negative, more significant, and more persistent pre-1973. Comparing the coefficients on M2 in the VAR portion of the pre-1973 6(A1) and (B1) and the post-

1972 6(A2) and (B2), we see that the former are generally greater in absolute value and more significant. The counter-cyclical sign of WIR in the short-run makes sense via equation (4.5) – since we know that M2 is pro-cyclical. Our model also explains, via Proposition 2 and Lemma 2, why these counter-cyclical coefficients on $\tilde{m}_s$ are more significant pre-1973. The "decoupling" of WIR and M2 suggested by Figure 4 shows the loss of both these long- and short-term effects: the more positive long-run elasticity, and the more negative short-run elasticity pre-1973.

V. Conclusions and Discussion

This linkage between WIR and M2 begs the question of which was more effective as a counter-cyclical tool. There is clear evidence of M2's *pro*-cyclical performance (not shown here) for the entire period 1952-2003. This is consistent with our theory, which shows that short-term variation in m_p can be pro-cyclical. And it is reinforced by a considerable literature (Mankiw, 1993; Mankiw and Summers, 1986; Bernanke and Gertler, 1995; Gavin and Kydland, 1999) finding that the broad money supply is highly pro-cyclical. Even less controversial is the finding that the *velocity* of money is pro-cyclical (Tobin, 1970; Goldberg and Thurston, 1977; Leão 2005). Our key variable, WIR Turnover, is WIR-money times Velocity, so the counter-cyclical trend of WIR Turnover (pre-1973) is doubly impressive.[20]

Our estimates suggest that WIR-Bank's creation of purchasing power could become an instrument of more effective macro-economic stabilization. There is nothing in our model, furthermore, that suggests this result is scale-dependent. (Recall that by our 2003 data, WIR-Credit/M2 = 0.165%.) Rather, it is a result of the automatic net-zero balance of WIR (Studer, 1998, p. 31). If, as we have argued, WIR-Credit can be seen as a form of multilateral, bank-mediated trade credit, then the scope for expansion is large. Petersen and Rajan (1997) estimate that the total volume of trade credits for large US companies, their accounts payable and receivable, are one-third of their total assets. Like trade credits, WIR are a lifeline for small firms, those most likely to be credit-rationed (Nilsen, 2002).

In assessing whether its experience might apply elsewhere, one must ask if there is something peculiarly Swiss about the WIR-Bank. Switzerland is home to some of the largest, technologically advanced, globally networked financial institutions in the world. And at the opposite extreme, it also has a strong network of smaller banks with more specialized focus (cooperative, regional, or industrial). That tens of thousands of small businesses and households across Switzerland have kept banking with WIR over many decades suggests that it is viable in the face of quite vigorous financial competition.

Just as trade credits are more likely on a national than international scale for small businesses, the WIR-Bank does not have foreign branches. Nevertheless, the best evidence for this type of

[20] Further regressions (not shown here) show that WIR velocity is in fact highly counter-cyclical, while WIR credits are, like M2, somewhat pro-cyclical. The net effect on Turnover is counter cyclical.

network's viability elsewhere may be its very "pan-Swiss" nature. That is, unlike many other Swiss cooperatives (Ostrom, 1990), the WIR does *not* exist solely in one region, or language. It has long functioned across the country, with German, French, and Italian-speaking members in rough proportion to their regional populations. This suggests that similar institutions can work in different countries.

Although the scale of the WIR does not seem to have been replicated elsewhere, there are analogies. The International Reciprocal Trade Association (IRTA) – a US-based association of regional barter rings – estimates that $8.25 billion was traded within its regional exchanges worldwide in 2004 (Stodder, 1998) and claims 400,000 member companies doing $10 billion of trade annually (IRTA 2009). This is not directly comparable to WIR's turnover of 1.7 billion SFr in 2003, however, since the IRTA is not a single exchange. The smaller National Association of Trade Exchanges (NATE 2009) claims 50,000 member companies. Both the IRTA and NATE provide members their own centralized credit currencies, called Universal Currency (UC) and Barter Association National Currency (BANC), respectively. Far larger in total value is bilateral countertrade (incompletely monetized international trade); Austrian economists Marin and Schnitzer (1995) claim that it represents at least 10 percent of world trade.

The counter-cyclical nature of WIR may help answer a basic question within macroeconomic theory – whether macro-instability is more due to price rigidity, or to instability in money and credit. Keynes (1936) recognized that both conditions can lead to instability. Macroeconomists like Colander (1996, 2006) stress monetary and credit conditions. The consensus, however, as represented by Mankiw (1993), puts the blame more on rigid prices. Our model is clearly in the monetary camp, with a recession due to the "wrong" level and distribution of M2 – which can be counteracted by WIR Turnover and its more precise targeting of credit.

Reflecting the macroeconomic consensus, most commentary on e-commerce has stressed its improved price flexibility (Greenspan, 1999).[21] However, telecommunications networks show increasing returns to scale (Romer, 1986; Aghion and Howitt, 2002; Arthur, 1996). That increasing returns to scale can yield an unemployment equilibrium was a point made early by Weitzman (1982). It is also the implication of several recent models and simulations (Azariadis and Chakraborty, 1998; Chichilnisky and Gorbachev, 2004; Sterman *et al.,* 2006). The WIR exchange network is also subject to increasing returns and network externalities, yet its activity appears counter-cyclical.

[21] Magenheim and Murrell (1988) see the persistence of barter as explained by its lack of transparency, providing greater scope for price discrimination. The WIR record does not record support this hypothesis, however since: (a) WIR activities are openly advertised and centrally recorded – and thus inappropriate for "confidential" price discrimination. (b) As previously noted, prices for goods and services advertised in WIRPlus (2000-2005) are often *higher* in WIR than in Swiss Francs, so this is not obviously *downward* price flexibility. (c) WIR's bylaws restrict membership to *small and medium businesses* (Defila 1994), and these will have little price-setting power. Thus, while the Magenheim-Murrell (1988) may hold for other forms of 'countertrade', WIR's counter-cyclical trend is not likely to stem from improved price flexibility.

What about the inflationary potential of such a network? An obvious point is that at current scale, it is unlikely to have any measurable effect. More theoretically interesting issues are worth considering, however. First, since WIR Turnover is counter-cyclical and M2 turnover is pro-cyclical, changes in WIR should be less inflationary than those in M2 itself. Second, if Credit limits are stable, then the automatic net balancing of WIR Turnover – where new credits are matched by new debits – allows short-term fluctuations in real output to be matched by velocity. This is consistent with price neutrality. In terms of the quantity equation (for the WIR system itself), Turnover = MV = PY. If M (money) is unchanged, and the change in V (velocity) is matched by a change in Y (real goods and services), then the change in P (price) must be zero. This "practically unlimited potential" (Studer, 1998, p. 31) for self-balancing credit creation would be strictly true only for a closed WIR-type system.

In fact, however, WIR coexists with SFr., as a secondary or "residual" currency. Our estimates show that it is most likely to be accepted when ordinary (pro-cyclical) money is in short supply. Thus, WIR turnover is likely to be concentrated most where its inflationary potential is the least. WIR money does not 'top up' the supply of Swiss Francs – it *substitutes* for Swiss Francs that are otherwise unavailable. If this is true, then the effect of increased WIR Turnover on prices is not inflationary, but rather *anti-deflationary*.

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