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Residual Barter Networks and Macro-Economic Stability: Switzerland's *Wirtschaftsring*

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Abstract: The experience of the Swiss Wirtschaftsring ("Economic Circle"), founded in the early 20th century, suggests that the "residual" spending power it provides during recessions is highly counter-cyclical, with important implications for monetary theory and policy.

A money-in-the-production-function (MIPF) specification implies that the quantity of WIR-barter credits should grow with GDP in the long-run, as do ordinary Swiss Franks. Unlike transactions in Swiss Franks, however, the transactions in WIR are *negatively* correlated with GDP in the short-run. Individuals are cash-short in a recession, and economize by greater use of WIR-credits. This counter-cyclical pattern is confirmed in the empirical estimates. *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, actually flourished in the "storehouse" economies of the ancient Middle East and Americas (Polanyi 1947) – when all the 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 1995).[2] Modern IT is again making *centralized barter* plausible, however, on sites like www.barter.net, www.swap.com, and www.itex.com (Anders 2000).

1 I would like to thank Marusa Freire, Michael Linton, Daniel Flury, Tobias Studer, and Gerhardt Rösl for their help and encouragement; all remaining errors are my responsibility.

2 The word "monetary" may derive from the Latin *Moneta*, surname of the mother goddess Juno, in whose temple Roman coins were cast (Onions, 1966). Her epithet *Moneta* is from *monere*, "to remind, admonish, warn, advise, instruct." In addition to being maternal functions, these are consistent with what economic anthropologists have seen as the information purpose of the most primitive monies: primarily a debt record, rather than a means of exchange (Davies, 1984, pp 23-27).

A few prominent macro-economists have speculated that computer-networked barter might eventually replace decentralized money – as well as central banking (King, 1999; Beattie, 1999). Benjamin Friedman's (1999) view that central banking may be challenged was a topic at a World Bank conference on the "Future of Monetary Policy and Banking" (*World Bank* 2000). The purpose of this paper is not to gauge the likelihood of such a regime change. Its focus is rather the macroeconomic character of centralized barter, and, more precisely, its counter-cyclical nature.

This paper's subject, the Swiss *Wirtschaftsring*, or "WIR", is sometimes grouped under the topic of alternative or dual *currencies*. It is really a centralized credit system for barter, however, and there is no physical currency. Unlike most of the literature on dual currencies, 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) models are not appropriate for our study of the Swiss WIR, however, for at least two reasons. First, KW models the costs of matching holders of goods with holders of a *decentralized* and freely circulating currency. Such search costs approach zero for members of an informationally *centralized* barter network. Second, the KW literature models dual-currency *equilibrium*, and does not usually consider the impact of introducing a secondary currency when there are *persistent shortages of the dominant currency*.

The one exception to this equilibrium focus is the work of Colacelli and Blackburn (2006). Although using a KW model, it does consider such shortages. It analyses surveys of Argentine users of *creditos,* a generic term for localized currencies, during that country's recession of 2002-2003. 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 present evidence that:

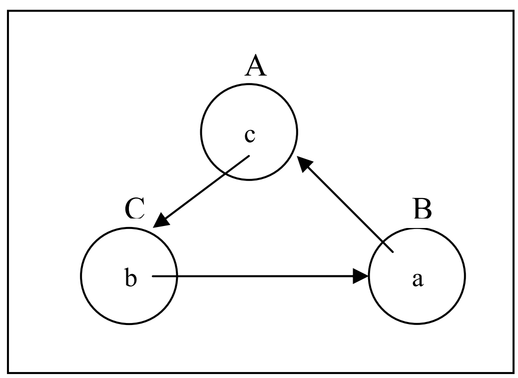
a) The circulation of *creditos* was strongly correlated with *shortages* of the national currency, as was the growth of local 'script' currencies in the US depression of the 1930s (Fisher, 1934);
b) Real income gains to *credito* users were substantial, averaging 15% of Argentina's mean personal income.

This is still a decentralized *currency*, however. Tobias Studer's (1988 [2006]) study of the Swiss WIR is the only economic analysis (in English) we know on a current large-scale centralized barter system.

II. Statement of the Argument

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, 1988) is shown in Figure 1 below.

Figure 1: The Failure of Double-Coincidence



If competitive equilibrium prices are normalized at 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 gives a unit of b to B and, and B a unit of a to A. But if these are the only goods of interest for each firm, then there are no *bilaterally* improving barter trades. The three formal conditions for the failure of bilaterally improving barter (Eckalbar, 1984; Starr, 1988) are that there is (i) no *single good* held in sufficient quantity by *all agents* to be used as a "money", (ii) no *single agent* holding sufficient quantity of *all goods* to serve as a central "storehouse", and (iii) *cyclical preferences* 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 $c \succ a \succ b$.

The Eckalbar conditions are almost certain to be met in any economy with a modest diversity of endowments, preferences, and specialization – unless there are institutional arrangements to ensure the existence of (i) a money, or (ii) a storehouse (Stodder, 1995). Lacking such, non-bilateral trade can take place in very simple economies, but some form of *centralized credit accounting* is still necessary. In reasonably complex economies, however, the historic and anthropological literature shows a virtual coincidence of decentralized monetary exchange and market exchange (Davies, 1994; Stodder, 1995).

Modern information technology, however, may be changing this coincidence. The WIR-bank or *Wirtschaftsring* ("Economic Ring") in Switzerland is the world's largest barter exchange (Studer, 1998). It keeps centralized accounts for each household or firm, in terms of its credits, also called "WIR". From the individual's point of view, this functions very much like an ordinary bank account, with credit inflows and debit outflows, and "overdraft" allowances determined by one's credit history. The exchange problem is solved with a virtual money.

It is the macroeconomic performance of such a money, however, which is of chief interest here. Such a centralized barter exchange combines the functions of both a commercial bank, and for its currency at least, a central bank. It will thus have more detailed knowledge of credit conditions 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 the WIR (Defila 1994, Stutz 1994, Studer 1998). As we will see, however, the clearing credit, or "Turnover" advanced by the WIR is highly flexible, and automatically balanced by the transactions themselves. Under such centralized credit conditions, Say's Law – supply creating its own demand – is trivially true, even in its Keynesian version that Clower and Howitt (1998) have termed oversimplified.

The WIR was inspired by the ideas of an early 20th-century economist, Silvio Gesell (Defila 1994, Studer 1998), to whom Keynes devoted a chapter of his General Theory (1936; Chapter 23). Despite criticisms, Keynes saw this "unduly neglected prophet" as anticipating some of his own ideas.[3]

This link between Keynesian and Gesellian *theory* might have made Gesellian *institutions,* like the WIR-Bank, of more interest to contemporary economists.[4] 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 in the long-run. But Studer's data (1998) stops in 1994, and he does not test for cointegration. The present study uses Error Correction Models (ECMs) to show that WIR activity is strongly counter-cyclical.

III. Functional Specifications – Money in the Production Function

III.1 Theoretical Basics

A convenient way of estimating macroeconomic role of money is the "money in the production function" (MIPF) specification, analogous the "money in the utility function" (MIUF). Either MIPF and 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.

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[3] 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."

[4] 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 seems to have borowwed 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 2006, pp. 16, 31). Interestingly, Rösl uses a "money in the production function" (MIPF) model, as in the current paper.

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:

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

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

where K is a vector of productive inputs needed to produce $\overline{Q}$, the later being defined exogenously; c is a vector of these 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.[5]

The existence of a "residual" currency m_s, which will complement the functioning of the original currency m_p, gives us a natural extension of this notation. Consider the costs of transacting and purchasing goods with ordinary money, m_p, and residual 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 $m_p = (c_p/c_s)m_s$. Thus the above can be rewritten in terms of m_p alone, the values c_sK_s and $m_s(\overline{Q}_s, K_s)$ both being multiplied by (c_p/c_s) to yield c_pK_s and $m_p(\overline{Q}_s, K_s)$, respectively, for the minimization:

$$\text{Min: } c_pK_p + c_pK_s + r_pm_p(\overline{Q}_p, K_p) + r_sm_p(\overline{Q}_s, K_s)$$

[5] 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 and will be developed.

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

where $r_p > r_s$ and $c_p \leq c_s$ (1a)

The notation and 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 – the former is universally fungible, while the latter is only accepted within a reciprocal exchange community such as WIR. 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, 1981, pp. 15-16), and charge less than normal money interest rates on longer-term loans (Studer, p. 31).

The second inequality, $c_p \leq c_s$, stems from the first. It is commonly observed in the monthly WIR magazine (WIR-Plus, various issues) that the prices of goods and services are quoted in both WIR and SFr. Prices in WIR are usually for a *higher* number of units than those in SFr, typically about 20 percent higher. This is reasonable, given the lower fungibility of WIR.

Although the currencies are freely exchangable, we will assume that for this firm, K_p is purchased just with ordinary money, m_p, at cost of c_p, while K_s is purchased with just residual credits, m_s, at cost c_s. 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 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(K_p, K_s) = $g_p(K_p, \overline{K}_s) + g_s(\overline{K}_p, K_s)$, with the bar indicating exogeneity, is meant to convey that K_p and K_s can be evaluated separately along the way, their marginal contribution depending on the timing of their use. So, for example, 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. In this sequence, $\partial g/\partial K_p$ would 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 $K = \overline{K}_p, K_s$, when $\overline{K}_p > 0$, and K_s is at its peak). Of course the sequence of inputs could also have been reversed, with K_s added first. In equilibrium, the marginal productivities of K_p and K_s must be identical – since they are physically indistinguishable. (A corollary in our results will confirm this.)

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*, analogous to the indirect utility 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 and $r_s(c_p/c_s)m_s$, 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:

$$Q = f(K_p, K_s, m_p, m_s).^{6} \tag{2}$$

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

Min: $c_pK_p + c_sK_s + r_pm_p + r_sm_s = c_pK_p + c_pK_s + r_pm_p + r_s(c_p/c_s)m_s$

s.t.: $\overline{Q} = \overline{Q}_p + \overline{Q}_s \le f(K_p, m_p, K_s, m_s) = f_p[(K_0, \overline{K}_1), m_p] + f_s[(\overline{K}_0, K_1), m_s],$ (2a)

is identical to that of problem (1), since first order conditions are the same. (Note that in the second expression of the minimand for (2a), we have converted secondary into primary money units, multiplying the m_s and c_s terms by c_p/c_s). This yields the following:

<u>Lemma 1</u>: For a cost minimizing firm, the marginal productivity of m_s is lower than that for m_p.

<u>Proof</u>: Using the first expression of the minimand in (2a), the first order conditions are $(r_s/r_p) = (\partial f/\partial m_s)/(\partial f/\partial m_p) < 1$, since (r_s/r_p) is less than 1. Or, using the second expression for the minimand, we have $(c_p/c_s)(r_s/r_p) = (\partial f/\partial m_s)/(\partial f/\partial m_p) < 1$, since additionally, $(c_p/c_s) \le 1$.

[6] 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. This, implicitly, is the tradeoff between input inventory and real balance costs.

<u>Corollary to Lemma 1:</u> *If either ratio (r_s/r_p) or (c_p/c_s) diminishes, then so will the marginal productivity of m_s relative to m_p.*

Lemma 1 will be interpreted, in the empirical section of the paper, as predicting the effects of a prohibition on the direct conversion of m_s to m_p. Such a prohibition of converting WIR to SFr. did occur in in the early 1970s, in the banning of the so-called 'discount trade' (Studer, p. 21). Lemma 1 the counter-cyclical

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

<u>Proof</u>: First order conditions of (2a) yield Marginal Rates of Substitution (MRS) for m_p, K_p and m_s, K_s: $(\partial f/\partial K_p)/(\partial f/\partial m_p) = (c_p/r_p) < (c_s/r_s) = (\partial f/\partial K_s)/(\partial f/\partial m_s)$; with the inequality shown by $(c_p/c_s) \leq 1 < (r_p/r_s)$. If $Q_p \neq \overline{Q}_p$, then $K_p \neq K_p*$. But if $m_s = m_s*$, then an optimal MRS for m_s and K_s, implies that $(\partial f/\partial K_s)$ be evaluated at the optimum level $K_p + K_s = K*$, and the result follows.

<u>Corollary</u>: *The marginal productivity of capital is the same in equilibrium, regardless of its financial origin; i.e., $\partial f/\partial K_p = \partial f/\partial K_s$.*

<u>Proof</u>: Using a result of Lemma 1, $(r_s/c_s)/(r_p/c_p) = (\partial f/\partial m_s)/(\partial f/\partial m_p)$, we substitute out the marginal products of m_p and m_s from the MRS ratios of Lemma 2. The result follows.

Lemma 2 shows the counter-cyclical potential of m_s. If the quantities of output the firm can sell in the ordinary money economy are exogenously limited, so that $Q_p < \overline{Q}_p$ (or equivalently, if credit markets limit the firm's access to $m_p < m_p*$), it can nonetheless achieve full $\overline{Q}$ by using $m_s = m_s*$. The result is symmetric: if we have $Q_p > \overline{Q}_p$ and $m_p > m_p*$, then $m_s = m_s*$ will provide a reduced impetus. In either case, $m_p \neq m_p*$, but $m_s = m_s*$ implies that $K_p* - K_p = K_s - K_s*$ – so that a shortfall in K_p will be offset with K_s, while $\overline{Q}$ itself is fixed. Perhaps then, rather than calling m_s "complementary" (the currently preferred term), we should call it a *residual* currency, always ready to 'take up the slack'.

But why m_s should have this remarkable power of self-adjustment? After all, there are secondary currencies in many parts of the world – such as the US dollar in much of Latin America, or the Euro in Eastern Europe – their supplies determined by a foreign central bank. Money creation in credit/debit system like WIR, on the other hand, is completely endogenous. As Studer (1998, pp. 3031) puts it:

> opening a WIR account the new member can immediately establish a positive clearing balance by selling something for WIR, thereby gaining a means of payment for trading within the WIR barter circle. This process, it should be noted, only allows the new member to receive WIR credits from another member.

Note this credit clearing 'money' of the WIR system is automatically self-balancing; the WIR-Bank:

> can freely create money-like clearing balances and put them into circulation. …all "circulating" WIR money in fact never leaves the Central Office, but rather stays on its books in its role as creditor. Thus upon the granting of a WIR loan, an asset and an equal liability are created simultaneously. Loan recipients, at the moment the loan is activated, take on WIR assets and liabilities of equal amount. Thus WIR members always show either a positive or a negative WIR balance…

These negative balances are a loan from the WIR Bank. Short-term overdrafts are interest-free, with limits "individually established" (Studer, 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 *average individual net* debit position is set by overdraft limits, the (absolute value of) *total circulation* of credits and debits (Turnover) is determined only by economic need. The *net* of this total, meanwhile, is identically zero due to "the automatic plus-minus balance of the system as a whole" (Studer, p. 31) – a practical confirmation of Say's Law, also an identity (Clower and Howitt, 1998). It is this balanced credit flexibility – neither inflationary nor deflationary, as long as overdraft limits are maintained – that forms the promise of what Studer (p. 31) calls "practically unlimited potential" for expansion under a centralized barter system.[7]

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[7] The remarkable flexibility of an "automatic plus-minus balance" system is also shown in a pedagogical experiment designed by LETS founder Michael Linton (2007), available at www.openmoney.org/letsplay/index.html.

III.2 Empirical Specifications

The counter-cyclical element of our residual currency is not its m_s balances, which Lemma 2 shows to be quite stable. It is rather m_s *Turnover,* or total WIR-money in circulation – essentially the *WIR-net-credit balances times their velocity*. From (1a) and (2a), define Turnover as $\tilde{m}_s = c_sK_s = c_s(K^* - K_p)$, with a dominant currency value of $(c_p/c_s)\tilde{m}_s = (c_p/c_s)c_sK_s = c_pK_s$. Since the WIR-Bank keeps track of this Turnover, we can estimate its correlation with GDP and Unemployment.

If $\tilde{m}_s = c_sK_s = c_s(K^* - K_p)$, 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:

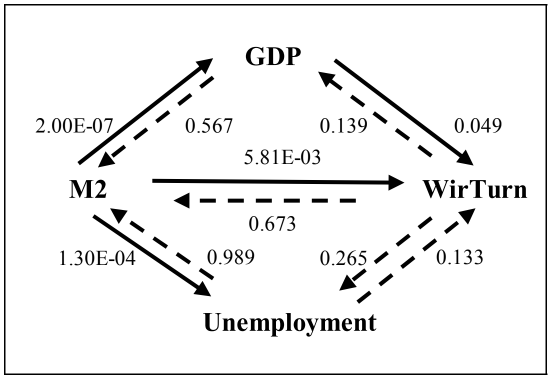
- inversely correlated with variation in output Q (below, GDP),
- inversely correlated with variation in broad money supply m_p (below, = M2), and
- directly correlated with variation in the number of unemployed (below, = UE)

– all in the short-term. In the longer term, if WIR's share of the financial system (m_s/m_p) is fairly stable, then 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 $\tilde{m}_1$ are driven by variations in m_p –not *vice-versa*. It is also probably due to the small amounts of WIR in the Swiss national economy. Swiss M2 measured 475.1 Billion Swiss Francs (SFr) in 2003,[8] whereas annual Turnover in WIR is seen in Table 1 to have been 1.65 Billion SFr that same year. Thus the ratio of WIR Turnover to M2 is only one third of one percent.

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

[8] 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



Note: Numbers are P-values on the null hypothesis of *no* Granger causality shown by directional arrow between variables. Solid arrows indicate that this null is rejected at 5 percent level; broken arrows show the null cannot be rejected at this level. Granger causality tests here are not on any particular regression, just 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.

In our MIPF formalization (2a), what signs do we expect on the derivatives of m_p and m_s? Due to the limitation on exchange to the *Wirtschaftsring*; i.e., among 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 ECM portions of our specifications, for the effect of the terms m_p, m_s, and $\widetilde{m}_s$ (i.e., M2 money supply, WIR Credit balances, and WIR Turnover, respectively) upon GDP:

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

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.

By the substitutability of m_p and m_s shown in Lemma 2, these terms should be negatively correlated in the short-term or cyclical sense: $\widetilde{m}_p - \widetilde{m}_p^* = \widetilde{m}_s - \widetilde{m}_s^*$. Numerous estimates (also not shown) show that m_p and m_s are *pro-cyclical*. This is not at all surprising: the pro-cyclical character of the normal money supply is well known (Mankiw, 1993; Mankiw and Summers, 1993; Bernanke and

Gertler, 1995; Gavin and Kydland, 1999). We will concentrate our presentation on the estimates that show $\tilde{m}_1$ ("Turnover") is *counter-cyclical.*

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 some short term partial derivatives of the form:

$$\partial \tilde{m}_s / \partial Q < 0, \quad (4.1)$$

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

$$\partial \tilde{m}_s / \partial UE > 0, \quad (4.3)$$

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. But we are not so concerned about the functional forms of this long term relationship – i.e., the error-correction portion of an Error Correction Model (ECM). As long as this relationship is cointegrated, we 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. (4.1) - (4.3) would thus be derived from:

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

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

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

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

Applying this reasoning to the ECM equations (4.1a) - (4.3a), we expect the coefficients on Q, m_p, and UE to be positive in the error-correction portion [in square brackets].[9] But in the VAR portion {in curly brackets}, we expect both γ_1 and γ_2 to be negative, and γ_3 to be positive, if $\tilde{m}_s$ is indeed counter-cyclical. That is, in the long-term error-correction term of the ECMs above, we expect:

[9] Note that while α_{11}, α_{21}, $\alpha_{31} > 0$, there is a negative sign placed before them in (4.1a - 4.3a).

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

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

$$\Gamma_1 = \partial D(\tilde{m}_s)/\partial D(Q(-1)),\ \ \gamma_2 = \partial D(\tilde{m}_s)/\partial D(m_p(-1)) < 0 < \gamma_3 = \partial D(\tilde{m}_s)/\partial D(UE(-1)). \tag{4.5}$$

As will be shown, these counter-cyclical effects are present throughout the period of our study, but strongest in the earlier period (1948-1972) when WIR and SFr were closer substitutes. This counter-cyclical activity of WIR can be interpreted as extending the transactional productivity of ordinary money, especially when the latter is limited by anti-inflationary policy. This immediately raises the question of whether such alternative-money activity is itself inflationary – a question to which I will return in this paper's conclusion.

IV. Empirical Results

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 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), OECD (2000), the IMF (2004) and World Bank (2004).

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

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

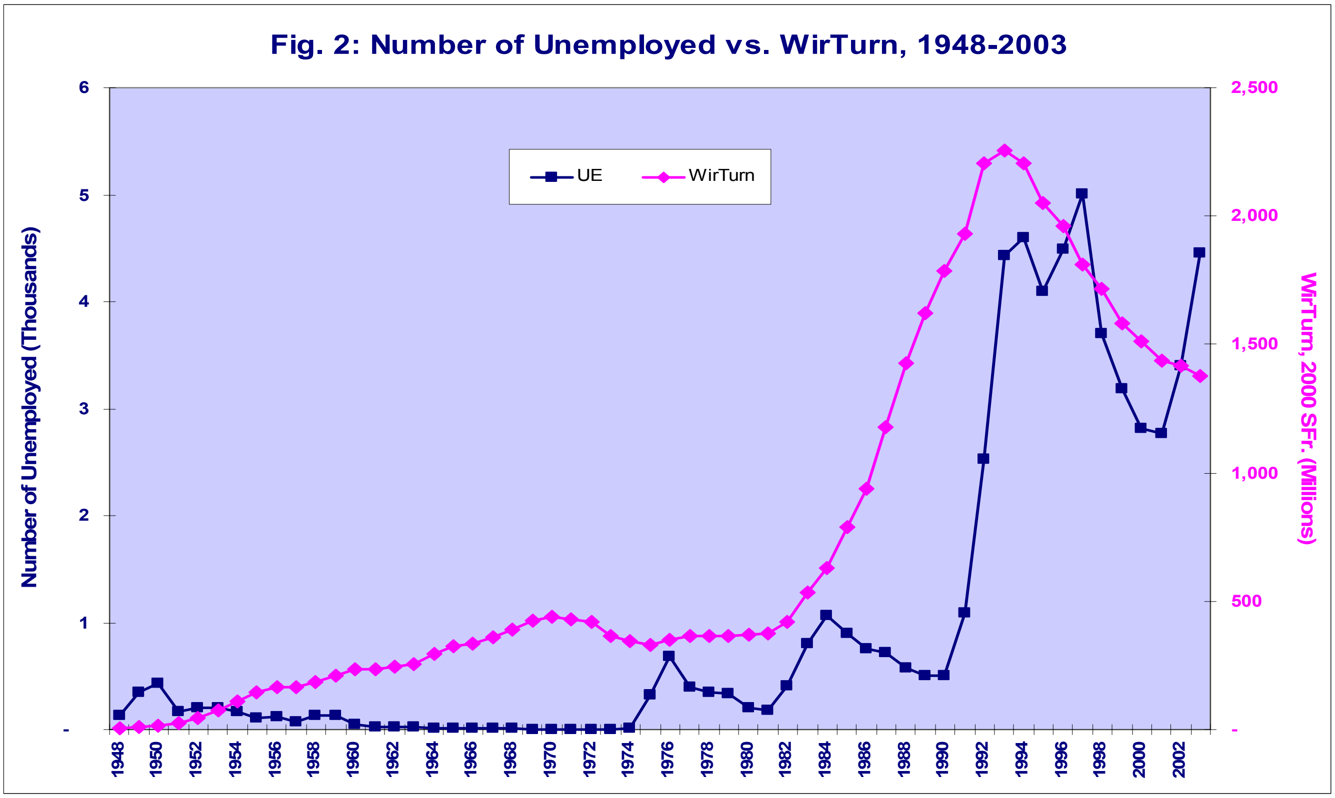
1954	5,957	30.0	7.2	**1982**	26,040	330.0	127.7
1955	7,231	39.1	10.5	**1983**	28,418	432.3	159.6
1956	9,060	47.2	11.8	**1984**	31,330	523.0	200.9
1957	10,286	48.4	12.1	**1985**	34,353	673.0	242.7
1958	11,606	53.0	13.1	**1986**	38,012	826.0	292.5
1959	12,192	60.0	14.0	**1987**	42,227	1,065	359.3
1960	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 (2000, 2005). 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 deflated by the 2000 GDP deflator. More recent 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 evidence of 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. And we do find some evidence for a counter-cyclical trend.



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 2 below show that lagged GDP has the expected positive sign in the error correction component of each regression, with cointegration significant in 2(A), but not 2(B).[10] The latter is also problematic because there is evidence of serial correlation. Granger/ Exogeneity tests are at or near 5 percent significance in both columns. In the VAR portions of the

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

regressions, coefficients on the first lag of differenced GDP, and also the lag of the first-differenced 2-year growth term have the expected negative (counter-cyclical) sign. Coefficients on first lagged difference term in 2(A) are comparable in absolute value to the coefficients on the second lag – so that the net effect appears minimal. Since we are concerned with short-term stabilization, however, this is not problematic.

Table 2: WIRTurn as Explained by GDP (*), 1951-2003

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

Dependent Variable: lnWirTurn	**(A)** 1951-2003 N=53	**(B)** 1952-2003 N=52
Cointegrating Eq:		
lnWirTurn(-1)	1.000	1.0000
lnGDP(-1)	-3.553 [-7.32]***	
lnGDP_2AV(-1)		-8.265 [-1.42]
TIME Trend		-6.57E-02 [-8.01]***
Constant	38.155	-3.964
Independ.Variables:		
Cointegrating Eq.	-4.53e-02 [-2.39]**	-0.097 [-3.88]***
D(lnWirTurn(-1))	0.585 [4.37]***	0.529 [4.01]***
D(lnWirTurn(-2))	0.303 [2.29]**	0.241 [2.00]**
D(lnGDP(-1))	-0.781 [-1.99]*	
D(lnGDP(-2))	0.684 [1.96]*	
D(lnGDP_2Av(-1))		-1.205 [-2.49]**
D(lnGDP_2Av(-2))		-4.48E-01 [-0.94]
Constant	-2.48e-03 [-0.17]	0.008 [0.76]
R-squared	0.8382	0.8379
Adjusted R-squared	0.8210	0.8203
F-statistic	48.7044	47.5569
Log likelihood	73.8485	75.3046
Akaike AIC	-2.5603	-2.6656
Schwarz SC	-2.3373	-2.4404
(a) Johansen P-Values (*)	{0.0482}	{0.1313}
(b) Serial LM P-Value (*)	{0.5795}	{0.0891}
(c) Granger P-Value (*)	{0.0544}	{0.0287}

(*) Note: 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.

Table 3: WIR (WirTurn) as Explained by GDP, 1954-2003**

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

Dependent Variable: lnWirTurn	**(A)** **1954-1972** N = 19	**(B)** **1954-1972** N = 19	**(C)** **1973-2003** N = 31	**(D)** **1973-2003** N = 31
Cointegrating Eq:				
LnWirTurn(-1)	1.000	1.000	1.000	1.000
LnGDP(-1)	-1.310 [-10.47]***	-4.330 [-3.23]***	-4.895 [-19.63]***	-13.295 [-3.34]***
TIME Trend		0.132 [2.16]**		0.119 [2.08]**
Constant	10.428	44.982	55.547	157.644
Independent Variables:				
Cointegrating Eq	-0.615 [-3.10]**	-0.678 [-2.62]*	-0.195 [-2.50]***	-0.111 [-1.75]*
D(LnWirTurn(-1))	0.226 [1.00]	0.290 [1.19]	0.517 [2.44]***	0.664 [2.96]***
D(LnWirTurn(-2))	-0.351 [-1.32]	-0.532 [-1.54]	0.601 [2.60]**	7.45e-01 [2.91]***
D(LnWirTurn(-3))	0.124 [0.65]	0.135 [0.65]	9.41e-03 [0.03]	-0.141 [-0.39]
D(LnWirTurn(-4))	-1.38e-02 [-0.07]	-0.012 [-0.06]	-0.053 [-0.17]	-0.348 [-1.20]
D(LnWirTurn(-5))	-3.12e-02 [-0.25]	0.107 [0.71]	0.288 [1.28]	0.212 [0.88]
D(LnGDP(-1))	-0.461 [-0.84]	-1.670 [-2.10]*	-1.793 [-2.98]***	-1.925 [-2.72]**
D(LnGDP(-2))	-1.618 [-2.56]**	-3.001 [-2.92]**	0.104 [0.14]	0.337 [0.41]
D(LnGDP(-3))	-7.17e-02 [-0.09]	-1.191 [-0.99]	-0.300 [-0.47]	-0.262 [-0.37]
D(LnGDP(-4))	-0.389 [-0.58]	-1.351 [-1.39]	-0.143 [-0.20]	-0.380 [-0.46]
D(LnGDP(-5))	0.753 [1.88]	0.470 [1.11]	-0.547 [-1.02]	-1.117 [-1.85]*
Constant	0.1861 [2.08]*	0.3927 [2.28]*	0.021 [1.44]	4.50e-02 [1.86]*
R-squared	0.9372	0.9247	0.8767	0.8588
Adj. R-squared	0.8385	0.8065	0.8053	0.7770

F-statistic	9.4932	7.8186	12.2793	10.5031
Log likelihood	44.1055	42.3887	58.7537	56.6519
Akaike AIC	-3.3795	-3.1988	-3.0164	-2.8808
Schwarz SC	-2.7830	-2.6023	-2.4613	-2.3257
(a) Johansen P-Values	{0.0185}	{0.0603}	{0.0279}	{0.0396}
(b) Serial LM P-Value	{0.9170}	{0.9037}	{0.5294}	{0.8724}
(c) Granger P-Value (*)	{0.0158}	{0.0063}	{0.0019}	{0.0073}

(**) Note: See Table 2.

Table 3 shows evidence of a structural break in the relationship between GDP and WIR Turnover. Rejoining the time series of columns 3(A) and 3(C) for a single regression, we find P-values of 2.55e-06 and 1.17e-03 for the Chi-Squared statistic of the Chow Breakpoint and Forecast tests, respectively. Similarly joining up 3(B) and 3(D), we find Breakpoint and Forecast P-values of 2.98e-06 and 1.29e-03, respectively. What could cause such a structural break around 1973?

According to official histories, Defila (1994) and Studer (1998), 1973 was a turning point for the WIR-Bank. A conflict arose over the widespread "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. 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 monetary argument was raised to defend this discount trade: "that it created additional turnover and facilitated members' ability to ride out periodic currency-liquidity bottlenecks." Table 3 shows that these arguments may have had a point.

There are other events, besides the ban on "discounting," which could have caused a structural break in this series, and which might also be expressed by changes in the cost of carrying out transactions in m_p and m_s. 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 contrary changes in the value of the Swiss Frank. Our initial regressions did not support this conjecture, but it remains plausible.[11, 12]

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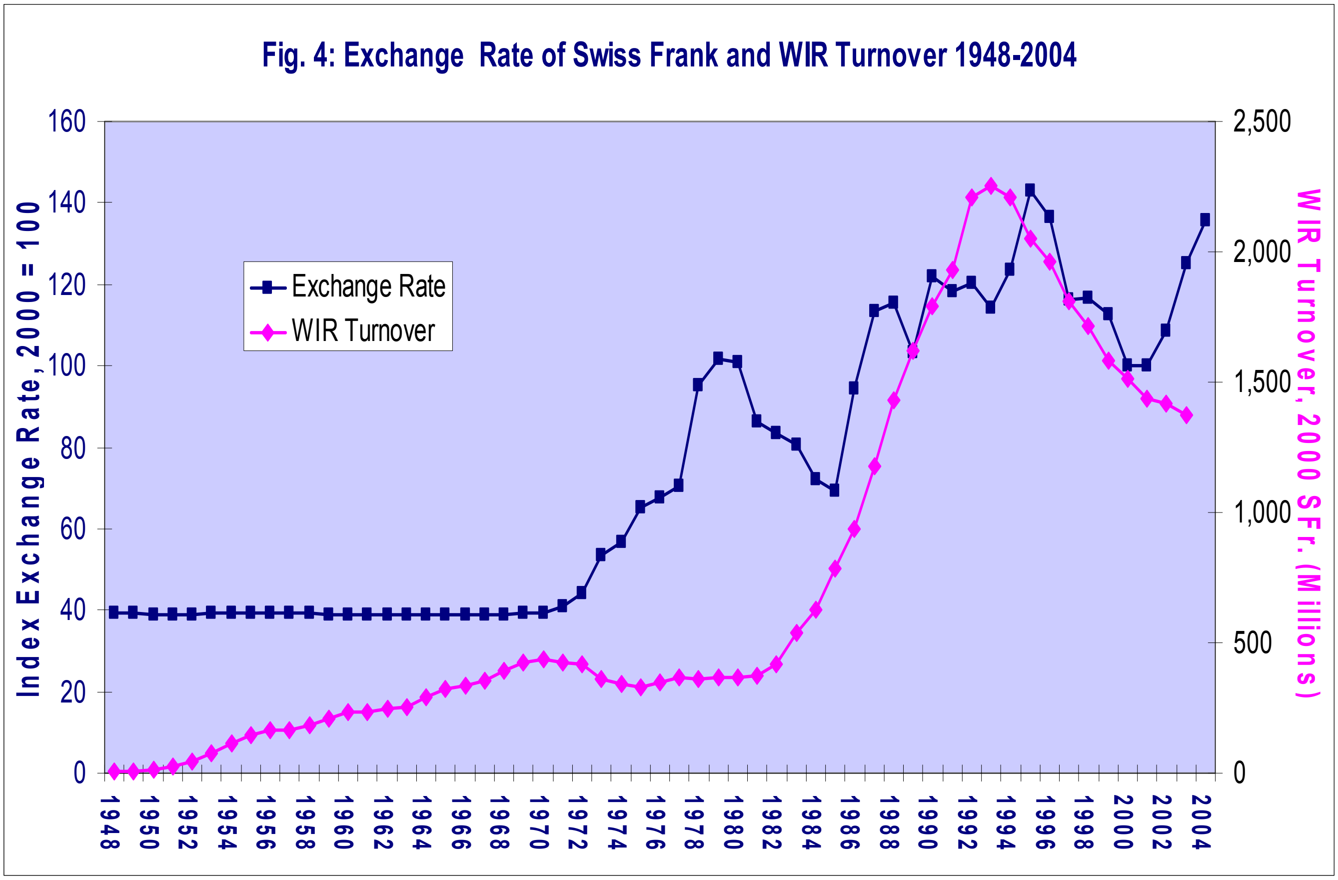
[11] The negative correlation between Swiss Franc's foreign exchange rate and WIR Turnover is quite strong for the periods 1970-75, 1980-85, and 1993-96 – around three significant turning points for the WIR series (IMF, 2007). Even the identification of a structural break in 1973, however, does not tell us what *caused* that break. There were many big changes in the world economy around that time: 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 increasing



Note that in the underlying cointegrating equations of Table 3, WIR is positively correlated with GDP, both pre-1973 and post-1973, as in inequality (4.4). But the significance and size of the coefficients on the error-correction term are much greater pre-1973: greater in 3(A) than 3(C), and in 3(B) than 3(D).

In the pre-1973 estimates of columns 3(A) and (B), the VAR coefficients on the first two lags of differenced GDP are both negative and counter-cyclical, as in (4.5) – and significant except for the first lag in 4(A). In the post-1973 columns 3(C) and (D), by contrast, only the first lagged terms are

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'disintermediation' of traditional financial institutions. All of these may plausibly be modeled as a higher r_0, the opportunity cost for holding Swiss Franks – and thus a reduced counter-cyclical role for m_1.

[12] 1973 is not even the only structural break that may be identified over this period. It can be shown that 1976 is also a significant break for the data underlying Table 4, under both Chow tests.

negative. Importantly, the *sum* of the first two periods' lags is both greater and more significant pre-1973. Thus, compare column 3(A): (sum = -2.08, p-value = 0.024) versus 3(C): (sum = -1.69, p-value = 0.111), and column 3(B): (sum = -4.67, p-value = 0.018) versus 3(D): (sum = -1.59, p-value = 0.209).[13]

The Granger/exogeneity tests in Table 3 are also highly significant, most at the 1 percent level. GDP clearly Granger-causes WIR in both periods, but this causation can be shown to also be *reciprocal* in the later period. Granger causality is even more significant in the 'reverse' WIR-to-GDP direction, with P-values of 2.84e-05 in 3(C) and 1.17e-05 in 3(D). This movement from one-way to two-way causality flows is further evidence of a structural change. To repeat, however, WIR has never been large enough to be an important determinant of Swiss GDP.

IV.3. The Effect of Unemployment Upon WIR Turnover

As Figure 2 above has already shown, growth in the number of Swiss Unemployed workers tracks the number of WIR Participants very closely, with the former about ten times as large in percentage change as the latter. This importance 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 have less human capital accumulated, and are much more subject to unemployment risk in many countries, including Switzerland (Winter-Ebmer and Zweimüller 1999, Winter-Ebmer 2001). Smaller firms also typically have more restricted access to formal credit institutions (Terra, 2003), and their owners must rely proportionately more on self-financing, which also increases their risk exposure (Small Business Administration, 1998).

From ECM estimations on these data, it can be shown that the long-term ("secular") cointegrated relationship between WIR Accounts and the Number of Unemployed Workers is positive, as in inequality (4.4). The short-term ("cyclical") effect of Unemployment upon WIR Turnover – lagged differences in the VAR portion – is highly counter-cyclical over the period 1949-2003, as seen in Table

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13 Standard error terms for these summation terms are calculated from the covariance matrix of the lagged terms.

4. Note that correlation between lagged changes in Unemployment and Turnover is positive and counter-cyclical, consistent with inequality (4.5).

Table 4: 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; ^{o}: p-val <0.15

Dependent Variable: lnWirTurn	**(A) 1952-1972** N = 21	**(B) 1952-1972** N = 21		
Cointegrating Eq:				
LnWirTurn(-1)	1.000	1.000		
LnUE(-1)	0.226 [5.81]***	0.463 [1.985]^{o}		
TIME Trend		5.90e-02 [1.02]		
Constant	-5.263	-6.117		
Independ. Variables:				
Cointegrating Eq	-0.278 [-7.48]***	-0.253 [-7.45]***		
D(LnWirTurn(-1))	0.304 [2.36]**	0.317 [2.46]**		
D(LnWirTurn(-2))	-0.029 [-0.20]	-3.32e-02 [-0.23]		
D(LnWirTurn(-3))	-0.146 [-1.35]	-0.187 [-1.71]^{o}		
D(LnUE(-1))	7.44e-02 [2.85]***	0.111 [4.01]***		
D(LnUE(-2))	7.05e-02 [3.16]***	9.39e-02 [4.10]***		
D(LnUE(-3))	2.73e-02 [1.22]	4.05e-02 [1.81]^{o}		
Constant	0.159 [6.22]***	0.182 [6.54]***		
R-squared	0.9620	0.9617		
Adj. R-squared	0.9415	0.9412		
F-statistic	46.9655	46.6935		
Log likelihood	42.0302	41.9715		
Akaike AIC	-3.2410	-3.2354		
Schwarz SC	-2.8431	-2.8375		
(a) Johansen P-Values	{0.0000}	{0.0002}		
(b) Serial LM P-Value	{0.1754}	{0.2270}		
(c) Granger Causality	{0.0030}	{0.0000}		

(**) Note: See Table 2.

Table 5: 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; º: p-val <0.15*

Dependent_Variable: lnWirTurn	**(A) 1952-1972** N = 21	**(B) 1952-1972** N = 21	**(C) 1973-2003** N = 31	**(D) 1973-2003** N = 31
Cointegrating Eq:				
LnWirTurn(-1)	1.000	1.000	1.000	1.000
LnUE(-1)	0.226 [5.81]***	0.463 [1.985]º	-0.368 [-8.84]***	-0.268 [-3.10]**
TIME Trend		5.90e-02 [1.02]		-2.11e-02 [-1.04]
Constant	-5.263	-6.117	-5.653	-5.100
Independ. Variables:				
Cointegrating Eq	-0.278 [-7.48]***	-0.253 [-7.45]***	-5.13e-02 [-2.19]**	-6.76e-02 [-2.54]**
D(LnWirTurn(-1))	0.304 [2.36]**	0.317 [2.46]**	0.544 [2.74]**	0.503 [2.57]**
D(LnWirTurn(-2))	-0.029 [-0.20]	-3.32e-02 [-0.23]	0.430 [2.03]*	0.460 [2.25]**
D(LnWirTurn(-3))	-0.146 [-1.35]	-0.187 [-1.71]º	-0.105 [-0.49]	-5.86e-02 [-0.27]
D(LnUE(-1))	7.44e-02 [2.85]***	0.111 [4.01]***	1.95e-02 [1.38]	2.45e-02 [1.88]*
D(LnUE(-2))	7.05e-02 [3.16]***	9.39e-02 [4.10]***	-1.85e-02 [-1.27]	-1.57e-02 [-1.15]
D(LnUE(-3))	2.73e-02 [1.22]	4.05e-02 [1.81]º	-2.19e-02 [-1.50]	-2.20e-02 [-1.62]º
Constant	0.159 [6.22]***	0.182 [6.54]***	9.82e-03 [0.85]	6.65e-03 [0.60]
R-squared	0.9620	0.9617	0.8132	0.8340
Adj. R-squared	0.9415	0.9412	0.7563	0.7835
F-statistic	46.9655	46.6935	14.3011	16.5077
Log likelihood	42.0302	41.9715	52.3147	54.1469
Akaike AIC	-3.2410	-3.2354	-2.8590	-2.9772
Schwarz SC	-2.8431	-2.8375	-2.4890	-2.6072
(a) Johansen P-Values	{0.0000}	{0.0002}	{0.0024}	{0.0156}
(b) Serial LM P-Value	{0.1754}	{0.2270}	{0.8387}	{0.6957}
(c) Granger Causality	{0.0030}	{0.0000}	{0.0352}	{0.0332}

(**) Note: See Table 2.

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. This is true, even though the counter-cyclical relationship is relatively strong over the entire period 1945-2003.

If we run a single regression over the entire 1954-2003 period split by the regressions in columns 5(A) and (C), the Chow Breakpoint and the Chow Forecast Chi-squared tests give contradictory results on the null hypothesis of no structural break: the Chow Breakpoint fails to reject this null, with a rather high P-value of 0.144; the Chow Forecast test rejects it decisively with a P-value of 1.26e-03. [14] However, if we regress over the entire period split by regressions 5(B) and (D), including their time trend, the Chow Breakpoint test has a P-value of 6.73e-03, and similarly, the Chow Forecast test a P-value of 9.06e-09.

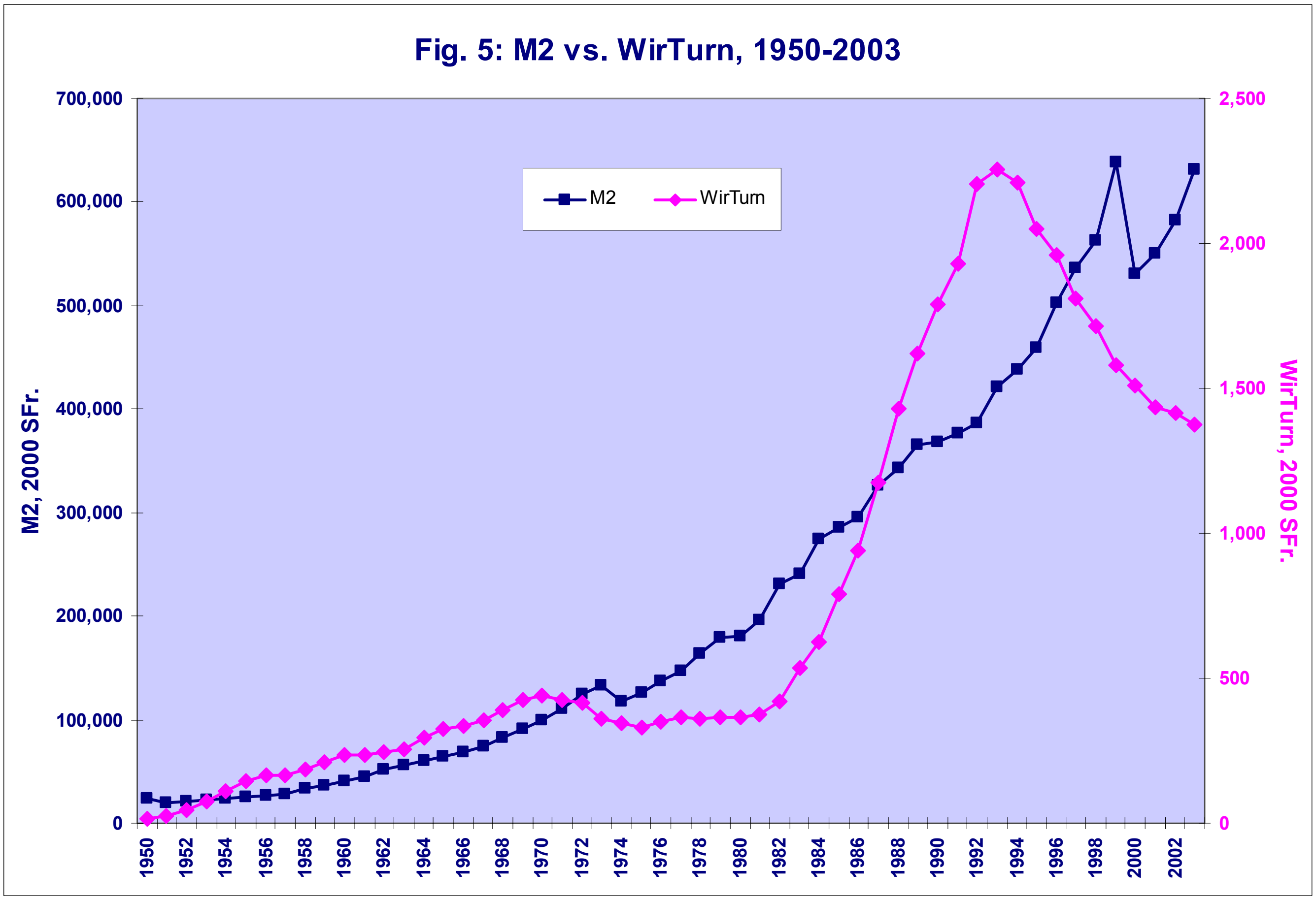
Counter-cyclical effects are far stronger pre-1973, in columns 5(A) and (B), than post-1973, in columns 5(C) and (D). The coefficients on lagged, first-differenced UE in 5(A) and (B) are also more significant, and for two periods instead of just for one, as in 5(C) and (D). Note the size of coefficients on the error correction terms are also greater pre-1973, by 4 or 5 times, and more significant by several orders of magnitude. This is similar to the period contrast for our regression on GDP, in Table 3.

Also as in Table 3, Granger-causality in Table 4 is reciprocal for the later, but not the earlier period. P-values for the opposite direction – for WIR Granger-causing Unemployment – were 0.1587 and 0.1343 for columns 5(A) and (B), but 0.0408 and 0.0369 on columns 5(C) and (D), respectively. Again, it is unlikely that WIR, of small value within the Swiss national economy, could directly cause significant changes in the number of unemployed persons. But again, this change in the directions of Granger causality does suggest some basic structural shift.

IV.4. The Effect of M2 Upon 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 5 suggests that WIR followed Swiss M2 very closely up to about 1972, but seems to have "decoupled" since then.

[14] It is not unusual for the two Chow tests to yield qualitatively different results. While the Chow Breakpoint test on this form does not meet standard significance, other evidence of structural change in the Table 5 is strong, and consistent with the Chow Forecast test.



Chow Chi-squared tests give clear confirmation of a structural break in the relation between WIR and SFr. in 1973. For a single regression over the entire period split between regressions 6(A) and (C), the Breakpoint test shows structural change significant at 1.62e-02, the Forecast test at 1.08e-04. For a single regression uniting the period of 6(B) and (D), and the Chow Breakpoint test shows a structural break is significant at 3.98e-03, the Forecast test at 9.94e-05.

All the error correction components in Table 6 show significant positive correlation between M2 and WIR, as one would expect in a growing economy. It appears that M2 was much more closely tied to WIR before 1973 in the long-term, secular, cointegrated sense. As in our previous Tables 3 and 5, the coefficient on the error correction term is larger and more significant in the earlier pre-1973 period. Here, comparing columns 6(B) and (D), the coefficient on M2 in the error correction component of 6(B) is an order of magnitude greater than in 6(D). Interpreted as long-run elasticities, a permanent one percent rise in M2 before 1973 would increase WIR-Turnover by over 70 percent in the long-term. Post-1973, by contrast, the long-term change in WIR-Turnover would be less than 7 percent. We note that the trended specification of ECM in columns 6(B) and (D) is more reliable, since the specification in 6(A) and (C) fails to show Granger causality, and also because 6(C) shows no cointegration.[15]

In contrast to the closer long-run relationship in the earlier period, however, the short term elasticities are more negative, more significant, and more persistent post-1973. Examining the short term coefficients in the VAR portion of columns 6(B) and (D), we see that the latter set are higher in absolute value for the first two lags, and more significant for three lags. The "decoupling" of WIR and M2 seen in Figure 5 can thus be seen as a combination of these two effects – a greater positive long-run elasticity pre-1973, and more negative short-run elasticity post-1973. The negativity of the short-run effect makes sense in our model, which shows $\tilde{m}_1$ counter-cyclical to the pro-cyclical m_p, in (4.5). Our model does not explain, however, why these coefficients should appear more negative post-1973.

Table 6: 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; º: p-val <0.15*

<u>Dependent Variable</u>: lnWirTurn	**(A)** **1953-1972** N = 20	**(B)** **1953-1972** N = 20	**(C)** **1973-2003** N = 31	**(D)** **1973-2003** N = 31
Cointegrating Eq:				
LnWirTurn(-1)	1.000	1.000	1.000	1.000
LnM2(-1)	-0.657 [-13.62]***	-71.235 [-4.89]***	-1.003 [-7.40]***	-6.655 [-7.84]***
TIME Trend		6.553 [4.87]***		0.341 [6.53]***
Constant	1.571	658.048	5.822	62.912
Independent Variables:				
CointEq	-0.630 [-3.17]***	-2.05e-02 [-2.20]*	-0.127 [-2.53]**	-0.219 [-4.17]***

15 Note that, as in our previous Tables 3 and 5, Granger causality can also flow in the reverse direction post-1973, column (D) showing a reverse causality significant at the 1 percent level.

D(LnWirTurn(-1))	0.435	0.130	0.595	0.393
	[1.82]*	[0.38]	[3.21]**	[2.30]**
D(LnWirTurn(-2))	-0.177	-0.221	0.382	0.161
	[-0.60]	[-0.63]	[1.53]	[0.72]
D(LnWirTurn(-3))	-0.330	-0.347	-0.188	-3.41e-02
	[-1.12]	[-0.95]	[-0.77]	[-0.16]
D(LnWirTurn(-4))	0.012	0.257	0.249	5.49e-02
	[0.08]	[1.35]	[1.30]	[0.40]
D(LnM2(-1))	-0.551	-0.904	-6.54e-02	-0.988
	[-1.14]	[-1.57]^o	[-0.43]	[-3.60]***
D(LnM2(-2))	-0.437	-0.428	-0.281	-1.129
	[-0.81]	[-0.63]	[-1.80]*	[-4.21]***
D(LnM2(-3))	-0.849	-1.188	-3.14e-02	-0.711
	[-1.74]	[-1.81]*	[-0.19]	[-2.90]**
D(LnM2(-4))	-0.106	-0.752	0.239	-3.33e-01
	[-0.33]	[-1.78]^o	[1.02]	[-1.24]
Constant	0.269	0.366	2.30e-03	0.194
	[2.97]**	[2.53]**	[0.09]	[3.40]***
R-squared	0.8353	0.7687	0.8527	0.8949
Adj. R-squared	0.6500	0.5085	0.7896	0.8499
F-statistic	4.5082	2.9546	13.5084	19.8727
Log likelihood	38.8269	35.7714	56.0004	61.2350
Akaike AIC	-3.2030	-2.8635	-2.9678	-3.3055
Schwarz SC	-2.7083	-2.3688	-2.5052	-2.8429
(a) Johansen P-Values	{0.0160}	{0.0052}	{0.2798}	{0.0024}
(b) Serial LM P-Value	{0.7617}	{0.4349}	{0.1252}	{0.8106}
(c) Granger Causality	{0.0935}	{0.0394}	{0.1480}	{0.0000}

(**) Note: See Table 2

V. Conclusions and Discussion

This linkage between WIR and M2 begs the question – 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, 1993; 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 actually

WIR-money times Velocity, so the counter-cyclical trend of WIR Turnover (pre-1973) is doubly impressive.[16]

Our estimates suggest that WIR-Bank's creation of purchasing power could become an instrument of macro-economic policy. According to our model, furthermore, this result is not highly scale-dependent. (Recall that by our latest data, in 2003 WIR-Turnover/M2 = 0.35%.) Rather, it is a result of the automatic net-zero balance system like WIR (Studer, p. 31).

There is substantial evidence for the general form of our hypothesis, that centralized reciprocal exchange of WIR is counter-cyclical with GDP, and even more so with the Number of Unemployed. These results 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 apply, and that either 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 clearly supports the monetary side, focusing on "wrong" levels of M2 – which can be smoothed over by variations in WIR Turnover.

Reflecting the macroeconomic consensus, most commentary on e-commerce has stressed its improved price flexibility.[17] However, telecommunications networks show increasing returns to scale (Romer 1997, Howitt and Phillipe 1998, Arthur 1996), and this may fuel *pro-cyclical* instability. This is 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.

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

[17] 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 often advertised and always 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? A preliminary observation is that at current scale, it is unlikely to have any measurable effect. More theoretically interesting points 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 *net* Credit limits are stable, the automatic net balancing of WIR Turnover, with new credits matched by new debits, allows short-term fluctuations in real output to be matched by velocity. This is potentially consistent with price neutrality. In terms of the quantity equation (for the WIR system itself), Turnover = MV = PY. If M (money) is unchanged, and if any change in V (velocity) is matched by a change in Y (real goods and services), then the change in P (price) must be zero: If $\Delta M = 0$ and $\Delta V = \Delta Y$, then $\Delta P = 0$. This "practically unlimited potential" (Studer, p. 31) for self-balancing credit creation would only be strictly true for a closed WIR-type system, however.

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. This should focus the transactional effectiveness of WIR – to be greatest precisely 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. The effect of increased WIR Turnover on prices would not be inflationary, but more precisely, *anti-deflationary*.

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