The Macro-Stability of Swiss WIR-Bank Credits: Balance, Velocity and Leverage[1]

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Abstract: Since 1934 the Swiss *Wirtschaftsring/Cercle Économique* (Economic Circle), now the WIR-Bank, has issued its own currency, not backed by Swiss Francs. Turnover in WIR is countercyclical: firms use it more in a recession. A money-in-the-production-function (MIPF) model implies that this spending arises through larger WIR *Balances* for larger firms, but greater WIR *Velocity* for smaller ones. Panel data by industrial sector confirms this pattern, similar to commercial trade credits, a major source of non-bank credit. The countercyclical multiplier on WIR expenditures is highly leveraged, and its impact on the Swiss Economy greater than its turnover would suggest. Keywords: complementary or community currency, countercyclical
JEL Codes: E51, G21, P13.

I. Introduction

The Swiss *Wirtschaftsring* or "Economic Circle," founded in 1934, is nowadays called the WIR-bank. Those studying reciprocal payment mechanisms refer to it as a "social," "community," or "complementary" *currency* – terms that are broadly equivalent. The WIR is really a centralized credit system for multilateral exchange, not a physical currency *per se*.

Despite its origins in the ideas of Silvio Gesell – a monetary economist praised by Keynes (1936) – the WIR has attracted little attention from economists. Studer (1998) and Stodder (2009) provide the only formal empirical studies. Studer (1998) shows that WIR credits are positively correlated with the growth of the Swiss money supply. Stodder (2009) shows that WIR bank transactions are also highly countercyclical –more so than the official Swiss money supply itself. If a secondary currency provides added financial stability, then standard monetary policy may not be optimal.

The idea that community currency expenditures will be countercyclical has a long currency. It is accepted by Yale's Irving Fisher in his *Stamp Scrip* (1933), a short book that documents the flourishing of such currencies in the US of the Great Depression. Building on Stodder's (2009) empirical demonstration of countercyclical WIR spending, our present paper explains the different commercial motivations for large and small firms – the latter with more restricted credit access – in their use of WIR. We can thus show how these differing motivations create a credit interaction that makes WIR Turnover (or total expenditure) highly countercyclical.

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Stodder's earlier (2009) paper considers the countercyclical pattern of WIR *Turnover* (Turnover = WIR Balances *times* Velocity), but lacks data to distinguish Balances from Velocity. With a new disaggregated data set, we can now show that WIR Balances and Velocity are *both* countercyclical drivers, but for different types of businesses. Larger Non-Registered (i.e., non-member) firms – free to accept as much or as little WIR-currency as they wish – accept more WIR when other forms of money are in short supply, in a recession. For such Non-Registered firms, WIR-Balances are the countercyclical term. Smaller Registered firms, by contrast, will be shown to have countercyclical WIR-Velocities. Thus both Registered and Non-Registered firms show a countercyclical Turnover, but dominated by different terms. This pattern for WIR between large and small firms is argued to be highly analogous to Trade Credits, a major form of non-bank credit in developed economies, also countercyclical (Nilsen, 2002).

There are hundreds of community currency systems in existence today, described in a descriptive literature, largely by non-economists (Williams, 1996; Greco, 2001; Gomez, 2008). The Swiss WIR-Bank is the largest such system, with over 70,000 customers throughout the country. Formal membership and registration is restricted to Small and Medium Enterprises (SMEs) (Studer, 1998).

The Swiss WIR-Bank, is the largest and oldest surviving 'club' form of money of which we know. The finding by Stodder (2009) that WIR activity is countercyclical is based on data from 1948 to 2003. Our present study with more recent data (i) strengthens that conclusion, (ii) performs further tests for structural breaks, and (iii) shows how large and small firms interact to structure this countercyclical resilience.

The paper is organized as follows. Section II tests the countercyclical record on a long time-series of WIR data. Section III examines WIR's structure of smaller and larger clients. Section IV presents some basic theory on how firms will use secondary or 'residual' currency. Section V runs panel regressions to test this theory. ('Bootstrap' simulations are first required to build up a large sample for cointegration testing.) Section VI breaks our panel into sectors and uses Chi-Squared tests to summarize 192 separate regressions. Section VII summarizes our results and considers the implications.

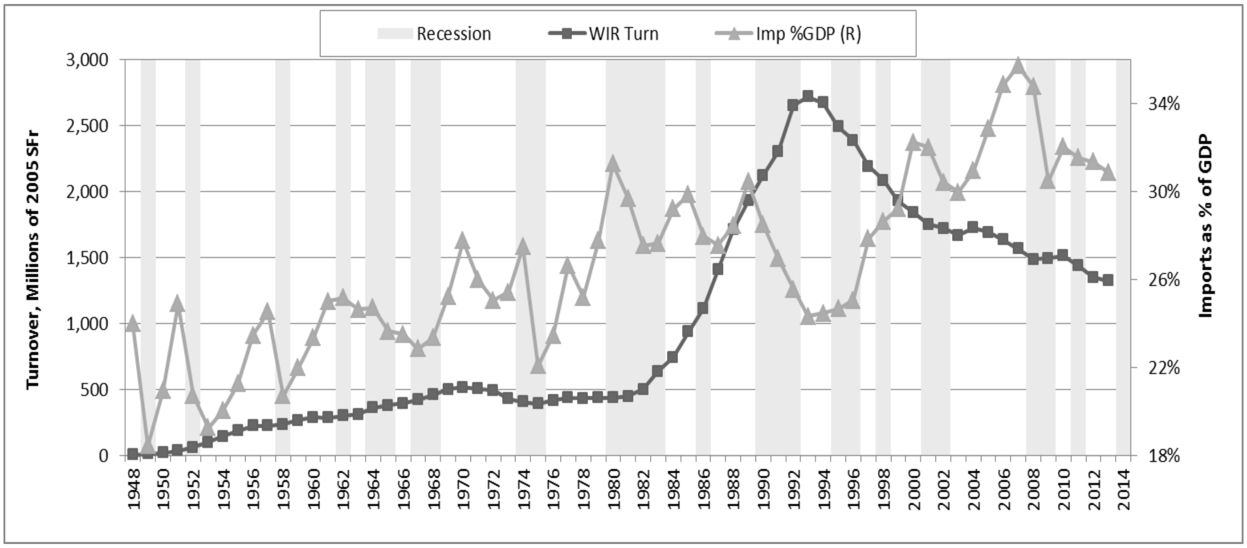
II. WIR's Countercyclical Record: Time-Series Regressions

We first turn to our basic countercyclical result. Stodder (2009) uses Vector Error Correction (VEC) models to check the stability and cyclical nature of WIR expenditures. If WIR grows with the economy, then the long-term relationship between them – shown by the coefficient on GDP in the Error Correction (EC) portion of the VEC – should be *positive*. But if WIR activity is also countercyclical, then the correlation between short-term changes in GDP on the one hand, and changes in WIR activity on the other, should be *negative* – as shown in the Vector Auto Regression (VAR) portion of the VEC. These results contrast long-term "secular" growth with short to medium-term "cyclical" deviations.

Stodder (2009) uses VEC models, so the non-stationarity of all variables is a necessary condition for cointegration. Standard Augmented Dickey-Fuller (ADF) tests show all variables to be integrated of order 1, or I(1). Integration is not tested for *breaks* in constant or trend in this earlier paper, however. The faltering trend of WIR growth post-1992 (see Figure 1) does suggest such breaks, so tests are useful. The present paper implements structural break tests and furthermore, uses ARDL models to replicate the results of VEC models when both are feasible; i.e., when all endogenous variables are I(1). Our key variable, WIR Turnover, is shown countercyclical in both types of cointegrated regression.

Figure 1 shows WIR Turnover and Swiss Imports as a percent of GDP from 1948 to 2013, with recession bars shown up to 2014. There is a sharp dip in Imports for most recessions. WIR Turnover is seen to peak in the early 1990s, at the end of a long recession and a trend of falling Imports. The steady decline in Turnover since 1992 suggests that WIR activity may be negatively correlated with the percent of Swiss GDP going to imports. This is intuitive, since WIR currency is normally accepted by Swiss firms only, and a subset of Swiss firms at that. Greater internationalization of the Swiss economy therefore works against WIR activity – and limits it even more to the Small and Medium Enterprises (SMEs), where, as will be seen, it is already in greatest use.

Figure 1: Real WIR Turnover, Imports as % of GDP (1948 to 2013)



Sources: Turnover from WIR Annual Reports, Swiss Imports, GDP, and GDP-Deflator from State Secretariat for Economic Affairs (http://www.seco.ch); Recessions 1962-2014 shown by OECD and Federal Reserve (https://research.stlouisfed.org/fred2/series/CHEREC#) as in recession for at least six months. Years were marked recessionary from 1948 to 1961 if real GDP grew by less than 1 percent.

Table 1 shows the names of variables we will use in the empirical estimates to follow.

Table 1: Notation for following Tables

1	LrTURN(-t)	Log of Real WIR **TURNOVER**, lagged -t period(s)
2	LrTURNa(-t)	Log of Real WIR **TURNOVER**, **averaged t and t-1**, lagged -t period(s)
3	LrGDP(-t)	Log of Real **GDP**, lagged -t period(s)
4	LrGDPa(-t)	Log of Real **GDP**, **averaged t and t-1**, lagged -t period(s)
5	LrIMP(-t)	Log of Real **IMPORTS**, lagged -t period(s)
6	LrIMPa(-t)	Log of Real **IMPORTS**, **averaged** t and t-1, lagged -t period(s)
7	LrVA(-t)	Log of Real **VALUE-ADDED**, lagged -t period(s)
8	LrVAa(-t)	Log of Real **VALUE-ADDED**, **averaged** t and t-1, lagged -t period(s)
9	LrBAL(-t)	Log of Real WIR **BALANCES**, lagged -t period(s)
10	LrBALa(-t)	Log of Real WIR **BALANCES**, **averaged** t and t-1, lagged -t period(s)
11	LrVEL(-t)	Log of Real WIR **VELOCITIES**, lagged -t period(s)
12	LrVELa(-t)	Log of Real WIR **VELOCITIES**, **averaged** t and t-1, lagged -t period(s)
13	CointEqRes(-1)	Residual of the Cointegrating Equation, lagged 1 period
14	D( )	First Difference of any variable

All our estimates – both ARDL (Auto-Regressive Distributed Lag) and VEC (Vector Error-Correction) regressions of WIR Turnover against GDP and Imports – face a problem of simultaneity. This arises from using both Imports and GDP as "independent" variables. Imports are highly correlated with GDP, and modeled as such in standard macroeconomic treatments. From Figure 1 it is clear that while both Imports and GDP fell in recessions, Imports fell by more, i.e., were more pro-cyclical. Yet we need to consider Imports, since they make WIR currency less useful.

GDP and Imports are likely to be exogenous for WIR-Turnover, but mutually determining for each other. This is what our regressions of Turnover on both variables show: both variables are significant in isolation, but insignificant when used together – although their Adjusted R-Square has increased. This evidence of collinearity suggests either simultaneous, or principal component methods (Johnson and Whitern, 1992). The latter is attractive since we are not so much interested in the relation between GDP and Imports as in their joint effect on Turnover. Thus in Groups 3 and 4 in Table 2 below, we replace the two collinear explanatory variables, GDP and Imports, by two principal component series, GdpImp1 and GdpImp2, that are orthogonal, but with joint information content nearly equivalent to the original series.

Table 2: Toda-Yamamoto (1995) Tests of Granger Precedence

Group (1)		Group (2)		Group (3)		Group (4)	
Lags = df = 2 Exog: 1 Lag, No Trend, No Intercept		Lags = df = 5 Exog: 1 Lag, Trend, Intercept Break		Lags = df = 2 Exog: 1 Lag, Trend, Intercept (no break)		Lags = df = 4 Exog: 1 Lag, Trend, Intercept Break	
Dependent: LrTURN		Dependent: LrTURNa		Dependent: LrTURN		Dependent: LrTURNa	
Excluded:	P-val.	Excluded	P-val.	Excluded	P-val.	Excluded	P-val.
LrGDP	0.2318	LrGDPa	0.7766	LrGdpImp1	0.0133	LrGdpImp1a	0.0097
LrIMP	0.7104	LrIMPa	0.9542	LrGdpImp2	0.0311	LrGdpImp2a	0.0260
Both	0.0431	Both	0.1495	Both	0.0063	Both	7.66E-05
Dependent: LrGDP		Dependent: LrGDPa		Dependent: LrGdpImp1		Dependent: LrGdpImp1	
Excluded:	P-val.	Excluded	P-val.	Excluded	P-val.	Excluded	P-val.
LrTURN	0.8350	LrTURNa	0.0220	LrTURN	0.4579	LrTURNa	0.0617
LrIMP	0.0021	LrIMPa	6.59E-04	LrGdpImp2	0.0325	LrGdpImp2a	0.0096
Both	0.0061	Both	1.12E-04	Both	0.1263	Both	0.0109
Dependent: LrIMP		Dependent: LrIMPa		Dependent: LrGdpImp2		Dependent: LrGdpImp2	
Excluded:	P-val.	Excluded	P-val.	Excluded	P-val.	Excluded	P-val.
LrTURN	0.3176	LrTURNa	0.0159	LrTURN	0.2331	LrTURNa	0.0272
LrGDP	0.0818	LrGDPa	0.0070	LrGdpImp1	0.1262	LrGdpImp1a	0.0131
Both	0.1918	Both	1.14E-04	Both	0.1561	Both	0.0013

We show exogeneity by tests of Granger precedence. Here we follow the terminology of Maddala and Kim (1998, p.188), who note that the Granger (1988) tests show only that variation in one variable reliably *precedes*, not 'causes' that in another. Table 2 shows Granger precedence tests for a cointegrated series, following Toda-Yamamoto (1995). This test specifies the maximal number of lags suggested by information criteria (Lütkepohl, 1991) and adds additional lags equal to the highest order of integration: here I(1). We also add exogenous trend and intercept terms, with possible breaks on the latter. Evidence for these exogenous terms will be given later, in unit root tests.

Note in Table 2 that the p-value for the null of *no* Granger precedence on the 'Both' term for GDP and Imports is usually significant. This 'Both' p-value is also usually more significant than the product of its component p-values; e.g., the value in row (c) is less than the product of (a) and (b) in all Groups but (3). This suggests a joint rather than independent effect. Note also that when GDP or Imports is the Dependent variable, the p-value on Turnover is always less significant than the remaining term; i.e. the values are always less than in row (e) than (d); and less in (h) than (g). The p-value on Turnover is always insignificant, while that on the other term is always significant. This shows GDP and Imports are exogenous to Turnover, and that they are mutually determining, as previously argued.

To carry out the regressions in Table 3 using cointegration, we must first determine the integration order of each variable. For VEC models, endogenous variables must all be I(1); for ARDL models, they may be either I(0) or I(1), but not I(2). In order to allow for *both* VEC and ARDL testing, we limit our estimates to trend, constant, and breakpoint combinations where each variable can be shown to be I(1). For the variables LrIMPa, and LrTURNa, applying ADF tests with intercept, we can reject the null hypothesis of unit root in levels at p-values of only at 0.091 and 0.501, respectively. That same null was rejected only at 0.121 and 0.239 for the fitted forms of these same variables. For LrGDPa, applying the ADF innovation breakpoint test with intercept and trend, we can reject the unit root null only at 0.905. The same null is decisively rejected, however, for first differences of all variables, with the same assumptions on intercept, trend, or breakpoint. Lag length was based on the Schwarz criterion, and breakpoints chosen by Dickey-Fuller minimum t-statistic. Thus all variables appear I(1) in this form, and we can use both ARDL and VEC models. For all the first-differenced forms, however, the unit root null was decisively rejected.

To concentrate on the independent variables of interest – the first-differenced one-lagged terms for GDP and Imports – other lags are not shown in Table 3. The number of lags for each variable is given in the column heading, however. Most of the terms not reproduced were quite insignificant.

Table 3: Changes in Turnover in the WIR Exchange Network, as Explained by Changes in GDP and Imports 1948-2013 (N=66), Moving Averages of Levels, With Up To 5 Lags
*t-statistics in [ ]; ***: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10*

Column: Regression Form (Lags):	(1a) ARDL(3,3)	(1b) VEC(5)	(2a) ARDL(3,0,2)	(2b) VEC(3)	(3a)♦ ARDL(3,0,3)	(3b)♦ VEC(5)
Cointegrating Equation:	**Dependent Variable: LrTURNa(-1)**					
LrGDPa(-1)	1.365 [1.63]	1.185 ***[2.53]	-23.44 **[-2.11]	-0.531 [-0.32]	-3.327 [-0.69]	12.030 ***[5.75]
LrIMPa(-1)			25.44 [1.39]	7.329 **[2.39]	8.749 [0.98]	-15.98 ***[-4.04]
Post_81	1.836 ***[5.15]	2.662 ***[11.77]	1.995 ***[4.11]	2.524 ***[8.40]	2.441 ***[3.42]	2.972 ***[13.67]
Trend	-0.042 **[-2.19]	-0.066 ***[-5.65]	-0.051 *[-1.93]	-0.108 ***[-6.07]	-0.069 [-1.54]	-0.103 ***[-6.80]
Constant		-7.396		-20.25	8.749	64.768
Independent Variables:	**Dependent Variable: D(LrTURNa(-1))**					
CointEqRes	-0.0573 ***[-5.16]	-0.0454 ***-2.57]	-0.0487 ***[-5.72]	-0.0366 ***[-3.18]	-0.0384 ***[-4.61]	0.0120 [0.64]
D(LrGDPa(-1))	**-0.5806 **[-2.02]**	**-1.151 ***[-4.22]**		**-0.5150 [-0.86]**	**-0.4288 ***[-3.36]**	**-0.6191 *[-1.83]**
D(LrIMPa(-1))			**-0.2738 **[-2.08]**	**-0.2461 [-0.73]**		**0.1921 [0.27]**
R-squared	0.971	0.955	0.970	0.970	0.957	0.970
Adjusted R-squared	0.967	0.937	0.966	0.961	0.950	0.961
F-statistic	***147.182	***55.199	***251.291	***115.761	***136.341	***115.761
Log likelihood	255.586	149.737	146.672	151.708	141.734	151.708
Akaike AIC	-4.490	-4.500	-4.473	-4.515	-4.257	-4.515
Schwarz SC	-4.215	-3.901	-4.199	-4.031	-4.453	-4.031
(a) Bounds Test (p) (*)	< 0.01		< 0.01		<0.05	
(b) Johansen Tests (p) (*)		0.0063		0.0259		4.649e-07
(c) Serial LM (p) (*)	0.2233	0.5196	0.2380	0.1582	0.1867	0.5355

Notes: ARDL estimates are via the Schwarz Criteria (SC). (*) P-values in rows (a-c) are for null hypotheses of: (a) no long run relationship between variables, (b) no cointegration, and (c) serial-correlation does *not* exist. The p-value in (a) is for the ARDL Bounds Test; that in (b) is for the Johansen Stability trace test; (c) is for the Lagrange Multiplier test on the number of lags shown in that column.
♦ - Fitted 2SLS forms of LrGDPa and LrIMPa used in columns 3a and 3b.

If there is no coefficient shown for a term named in Table 3, then it did not appear in the cointegrated form of the regression – D(LrGDPa(-1)) in column (2a), for example. Note that Turnover is treated here as a dependent variable. This follows from our Granger tests of Table 2, which show GDP and Imports exogenous to Turnover. Cointegration for all forms is confirmed by the Bounds and Johansen tests in rows (a) and (b), implying (but not implied by) the Granger precedence shown in Table 2. The important structural result here is that the first lags of GDP or Imports, here in bold, are generally both negative and significant – implying counter-cyclicity. The exception is in column 2a. Here simultaneity biases the result, with both GDP and Imports appearing as right-hand-side variables.

Columns (3a) and (3b) address this simultaneity problem with *fitted* forms of LrGDPa and LrIMPa, as in a Two-Stage-Least-Squares (2SLS) estimate. Our first-stage OLS regressions use Exchange Rate and Total Factor Productivity as identifying exogenous variables for LrIMPa and LrGDPa, respectively. Serial correlation and multi-collinearity are irrelevant here; all we care about is fit, and all R^2 are at 99 percent. All independent variables are significant; results available on request.

It is encouraging that we get not only high significance but the expected signs on coefficients for GDP and Imports in the cointegrating portion of (3b). These signs are consistent with Figure 1, which suggests WIR activity tends to rise with GDP, but is depressed by the portion going to Imports. Bounds and cointegration tests in rows (a) and (b) are all highly significant, and the null of *no* serial correlation cannot be rejected by any p-value in row (c).

III. WIR Trade Credits: Registered and Non-Registered Members

According to WIR-Bank statistician Stefan Winkler (2010), WIR client-companies are a large part of the Swiss total in several industrial sectors, as Table 4 shows. Previously unreleased data are for 2005, the last year for which nation-wide totals were made available by the WIR-Bank. Notice that the number of Non-Registered Clients is two or three times that of Registered Clients in all sectors but Hospitality. According to Winkler (2010), this Non-Registered group includes some very large corporations. WIR-Bank cannot list the names of these companies due to Swiss bank secrecy laws (Winkler, 2010). Large firms, for their part, *cannot* become WIR members: a 1972 by-law stated that only SMEs can be members (Stodder, 2009). Registered firms must accept WIR for at least 30 percent of the payment of their first 2,000 SFr due on a bill. Non-Registered firms are free to accept any amount – or none at all (Studer, 1998, p. 33).

Table 4: WIR-Client Enterprises, by Sector, 2005

Industry	All Swiss	All WIR	Portion WIR/Swiss	(1,000 SFr) Turnover	(1,000 SFr) Tot. Bal.	(SFr) Av. Bal.	Turn/Balance = Velocity
RETAIL, of which	62,380	14,275	22.9%	345,757	127,100	8,904	2.720
Registered		5,933	9.5%	223,822	64,958	10,949	3.446
Non-Registered		*8,342*	*13.4%*	*121,935*	*62,142*	*7,449*	*1.962*
SERVICES, of which	164,709	10,380	6.3%	213,515	88,788	8,554	2.405
Registered		3,817	2.3%	112,186	30,745	8,055	3.649
Non-Registered		*6,563*	*4.0%*	*101,329*	*58,044*	*8,844*	*1.746*
HOSPITALITY, of which	28,006	3,438	12.3%	73,021	22,416	6,520	3.257
Registered		2,099	7.5%	61,872	16,156	7,697	3.830
Non-Registered		*1,339*	*4.8%*	*11,148*	*6,261*	*4,676*	*1.781*
CONSTRUCTION, of which	57,268	21,162	37.0%	527,619	210,477	9,946	2.507
Registered		6,992	12.2%	280,169	82,462	11,794	3.398
Non-Registered		*14,170*	*24.7%*	*247,450*	*128,015*	*9,034*	*1.933*
MANUFACTURING, of which	38,421	7,310	19.0%	230,196	101,884	13,938	2.259
Registered		1,820	4.7%	87,418	26,092	14,336	3.350
Non-Registered		*5,490*	*14.3%*	*142,778*	*75,792*	*13,805*	*1.884*
WHOLESALE, of which	21,762	4,138	19.0%	223,631	73,787	17,832	3.031
Registered		1,027	4.7%	80,371	15,462	15,056	5.198
Non-Registered		*3,111*	*14.3%*	*143,260*	*58,325*	*18,748*	*2.456*
TOTALS, of which	372,546	60,703	16.3%	1,613,739	624,452	10,287	2.584
Registered		21,688	5.8%	845,838	235,874	10,876	3.586
Non-Registered		*39,015*	*10.5%*	*767,901*	*388,578*	*9,960*	*1.976*

Source: WIR-Bank Panel Data, 2010. Most of these data, not previously public, may be shared with interested researchers.

A note on household versus enterprise membership: The total of WIR Client Enterprises shown in Table 4, 60,703, is 81 percent of total for WIR members that year, 74,732, as shown in the annual *Rapport de Gestion* (2005). The remaining members are households (Winkler, 2010).

Note in Table 4 that while the Balances of Non-Registered clients are much greater than those of Registered Clients in all sectors but Retail and Hospitality, the Turnover for both sorts of clients is quite similar overall, and fairly similar within most sectors. Except for Hospitality, the ratio of high to low Turnover for Registered and Non-Registered clients is always less than 2. Note however that the Velocity, or Turnover/Balance, at which Turnover circulates, is always much higher for Registered Clients. As we will see, this dominance of Velocity for Registered firms (and of Balances for Non-Registered) is fundamental to their countercyclical activity: Registered firms respond to recessions by increasing the Velocity of WIR Turnover.

Non-Registered firms accommodate by allowing their SME customers to settle less in cash and more in WIR – thus accumulating larger WIR-Balances.

We should note that SMEs typically have less access to formal credit institutions (Terra, 2003), and rely disproportionately on self-financing (Small Business Administration, 1998) and the trade credits supplied by larger firms (Petersen and Rajan, 1997; Nilsen, 2002). Following the argument of Studer (1998) on self-financing trade, WIR-money can be seen as an extension of the trade credits widely used between firms (Greco 2001, p. 68; Stodder, 2009).

Trade credits are traditionally advanced by larger firms to smaller customers and distributors, especially during recessions (Nilsen, 2002). In the US, for example, trade credits are commonly given on terms of "2% 10, net 30," whereby a buyer gets a 2% discount by repaying within 10 days, with full settlement due in 30 days (Nilsen, 2002). The main use of demand deposit accounts for most businesses, according to Clower and Howitt (1996, pp. 26-28), is to clear such trade credits. By accepting delayed payment from a smaller firm via a trade credit, the larger firm thereby accumulates a credit in its accounts receivable – an increase in its trade credit balance.

In a Philadelphia Fed publication, Mitchel Berlin (2003) notes that there has been surprisingly little macroeconomic study of trade credits, despite the fact that they are the primary form of countercyclical credit for SMEs. Petersen and Rajan (1994, 1997) find that only 11 to 17 percent of large-firm assets in the G7 countries are dedicated to accounts payable, but 13 to 29 percent in accounts receivable. Since accounts receivable normally exceed accounts payable for large firms, this implies an extension of trade credit. This same inequality shows that *receiving* trade credits is more important than granting them for smaller firms, in their role as customers or distributors for larger ones.

Nilsen (2002) finds that use of trade credits is countercyclical for SMEs. SMEs are more likely to be credit-rationed by banks when money is tight, leaving trade credits as their only form of credit. The importance of trade credits for the macro-economy was indirectly shown by the Federal Reserve's decision to buy up "commercial paper" in the 2007-2009 financial crisis, thereby lowering short-term finance costs for large firms.

The link between commercial paper for large firms, and the trade credits they in turn provide to smaller customers, is noted by Bernanke and Gertler (1995, p. 38, ff. 15). In a recent World Bank publication, Love notes that if there is severe disruption to the commercial paper market, "there may be nothing left to redistribute through trade credit." (2011, p. 34)

In the case of WIR-credits for commercial trade, many types of goods and services are exchanged – construction, hotel stays, restaurant meals, used vehicles, legal services – with offerings posted online and in publications like WIR-Plus (2000-13). Prices are quoted in both Swiss Francs (SFr) and WIR, and often a mix of the two, and with a maximum posted for the percent of payment accepted in WIR. For ease of comparison, WIR prices are denominated in the same units as SFr. The WIR-Bank keeps account of each customer in terms of her credits or debits. This is partly to check that large sums of WIR are not being traded for cash; i.e., that there is a rough balance of credits and debits over time. 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 or "overdraft" can be run. WIR-Bank is a registered Swiss bank, and so also provides ordinary banking services in SFr.

Non-Registered clients are not subject to the organization's by-laws and thus not obliged to accept any minimum share of payment in WIR (Studer, 1989, p. 33) – as Registered clients must do. The Non-Registered are thus free to extend the privilege of WIR-settlement to most favored customers, or only when it is most needed – as during an economic downturn. This helps explain the countercyclical variability in Non-Registered accounts, a role similar to that of trade credits. If the relationship of Non-Registered to Registered firms is predominantly that of suppliers to customers/distributors, then we would expect to see countercyclical responses showing as increased Balances for the former and by increased Velocities for the latter. We will show this pattern in the econometric tests on Registered and Unregistered firms.

Yet we must also note here two crucial differences between ordinary trade credits and WIR-credits. First, unlike an ordinary trade credit payable in Swiss Francs, a payment in WIR is itself final payment. As long as the WIR-Bank exists, a firm receiving WIR for it products will never see the check "bounce." Second, like any true currency, WIR-credits support multilateral, not just bilateral exchange. That is, a WIR-creditor's value is ensured, not by her debtor's ultimate willingness to settle in cash, but by the current willingness of thousands of firms and households to accept WIR as final payment. To repeat Studer's formulation (1998, p. 32), "every franc of WIR credit automatically and immediately becomes a franc of WIR payment medium."

Since every WIR-credit is matched by an equal and opposite debit, the system as a whole must net to zero. Individual traders can have positive or negative Balances or "overdrafts." The latter is, in effect, a loan from the WIR-Bank. Short-term overdrafts are interest-free, with an overdraft limit "individually established" (Studer, 1998, p. 31) by credit history. As long as these limits are maintained, the WIR-Bank can be quite relaxed about variations in its total bank *Balances*. The system is also highly flexible: while the net value of WIR credits and debits must be zero, their absolute total is determined by current economic activity alone – there is no monetary *base* as such. This balanced flexibility of an "automatic plus-minus balance of the system as a whole" (Studer 1998, p. 31) is shown in teaching software for a system similar to WIR, as devised by Linton and Harris-Braun (2007), available at www.openmoney.org/letsplay/index.html. In this program, balances increase in the alternative currency as traders gain confidence in the system and are able to liquidate unsold inventories.

A second difference with trade credits is that WIR-exchange is totally centralized, combining the functions of the commercial bank *system* and a central bank. The WIR-Bank thus has much more detailed knowledge of credit conditions in its own currency than any ordinary commercial or central bank. Of course it can still make mistakes, extending too many overdrafts or direct loans. Such credit "inflation" has occurred in WIR's history (Stutz, 1984; Defila, 1994; Studer, 1998), but now appears contained by sensible overdraft limits.

The WIR was inspired by the ideas of an early 20th-century German-Argentine economist, Silvio Gesell (Defila 1994, Studer 1998)[2]. Gesell is given a chapter in Keynes' General Theory (1936; Chapter 23, Part VI),

2 Gesell was familiar with trade credits from his international trade experience. His use of the term *demurrage* is borrowed from international shipping, where it denotes a reduction in payment to compensate for an unscheduled delay in delivery. Similarly, Gesell applies *demurrage* to the holding of currency balances, with the aim of increasing velocity.

A form of bank-mediated trade credit 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 whom he sees as an "unduly neglected prophet," anticipating some of his own ideas on why interest rates may exceed the marginal efficiency of capital. Keynes notes (1936, p. 355) that "Professor Irving Fisher, alone amongst academic economists, has recognised [Gesell's] significance," and predicts that "the future will learn more from the spirit of Gesell than from that of Marx." Although the intellectual linkage between Keynesian and Gesellian *ideas* has received substantial attention (Klein, 1980; Darity, 1995) Gesellian *institutions* like the WIR-Bank have not.

IV. Theory: Money in the Production Function

Stodder (2009) formalizes the interaction of WIR-money and national currency *via* "money in the production function" (MIPF). This is analogous to "money in the utility function" (MIUF), and similarly derived by the implicit function theorem. Both MIPF and MIUF are justified by the transactions-cost-saving role money plays, moving the economy to its efficiency frontier. There is a substantial literature on this idea (Patinkin, 1956; Fischer, 1974, 1979; Finnerty, 1980; Rösl, 2006).

We formalize the basic result by showing a profit-maximizing firm as minimizing both its direct and transactional costs subject to the constraint of producing quantity, $\overline{Q}$, exogenously determined by the market:

$$\text{Min:} \quad c_pK_p + c_sK_s + r_pM_p + r_sM_s \qquad (1)$$

$$\text{s.t.:} \quad \overline{Q} = \overline{Q}_p + \overline{Q}_s \le f(K_p, M_p, K_s, M_s) = f_p[(K_p, \overline{K}_s), M_p] + f_s[(\overline{K}_p, K_s), M_s].$$

Here the *primary* national and *secondary* social currency, M_p and M_s, show interest rates/opportunity costs of r_p and r_s. They are used to pay the market costs, c_p and c_s, of the required capital inputs, K_p and K_s, respectively. These inputs are assumed divisible and perfect substitutes. Subscripts account only for means of purchase, since many purchases are for a mix of WIR and SFr (Studer, 1989, p. 33). The production/transaction functions $\overline{Q}_p = f_p[(K_p, \overline{K}_s), M_p]$ and $\overline{Q}_s = f_s[(\overline{K}_p, K_s), M_s]$, are assumed concave and differentiable, with the bars indicating that Output quanties $\overline{Q}_p$ and $\overline{Q}_s$ are set exogenously. The Marginal Rates of Substitution (MRS) derived from (1) show that inventories of money and physical inputs can be substitutes.

can be interpreted as extending the payment terms on bankers' acceptances from short to medium-term, and from bilateral to multilateral.

It is assumed that $r_p > r_s$ and $c_p \leq c_s$. The first inequality arises because primary currency is more useful than secondary, and so must have a higher opportunity cost. This is recognized by Studer (1998, p. 31), who states it as a basic fact about WIR commerce: "Since the WIR Bank operates in competition with conventional credit banks and a WIR loan is less universally useful than a cash loan, the cost of WIR credit must in any case be kept lower than normal interest rates." The second inequality arises from the same fact: since WIR money is less useful, items for sale are often posted at WIR prices higher than their equivalent price in SFr. (Stodder, 2009).

<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, but that of M_s is less than M_p.*

<u>Proof</u>: Using the above inequalities, first order conditions of (1) yield

$$(c_s/c_p) = (\partial f/\partial K_s)/(\partial f/\partial K_p) \geq 1 > (r_s/r_p) = (\partial f/\partial M_s)/(\partial f/\partial M_p). \qquad (2)$$

Secondary currencies are 'residual,' used when the primary currency is unusually scarce. The next Lemma shows that if Registered (R) clients face more restricted credit conditions than larger Non-Registered (NR) clients (that is, a higher interest rate on primary money, r_p), then larger holdings of M_s/M_p Balances for Registered than Non-Registered clients will result:

<u>Lemma 2</u>: *If a Registered firm (R) is more credit constrained in primary currency than a Non-Registered firm (NR), $r_p^R > r_p^{NR}$, yet their access to secondary currency is equivalent, $r_s^R = r_s^{NR}$, then R's holdings of the secondary currency must be relatively larger: $M_s^R / M_p^R > M_s^{NR} / M_p^{NR}$.*

<u>Proof</u>: The above assumptions give $r_s^R/r_p^R < r_s^{NR}/r_p^{NR}$. By Lemma 1, each ratio is equal to the ratio of marginal products of secondary to primary currency, $(\partial f/\partial M_s)/(\partial f/\partial M_p)$ for Registered and Non-Registered firms, respectively: $(\partial f/\partial M_s^R)/(\partial f/\partial M_p^R) < (\partial f/\partial M_s^{NR})/(\partial f/\partial M_p^{NR})$ Since the production/ transaction function f( ) is assumed concave and the same for each firm, R must therefore hold a larger ratio of secondary to primary currency than NR.

Table 4 showed that Registered firms hold larger average WIR Balances than Non-Registered firms. If the average SFr holdings for Registered firms are also smaller than for Non-Registered firms (Winkler, 2010), then *a fortiori*, they must have larger *relative* Balances of WIR to SFr., as in Lemma 2.

Smaller Registered clients may be quite limited in their access to credit in the primary currency (Winter-Ebmer and Zweimüller, 1999). In a recession, SMEs may lose such credit altogether (Wan *et. al.*, 2011). As with the greater use of supplier-provided trade credits by SMEs during a recession (Nilsen, 2002), so a greater portion of WIR currency is often accepted by larger Non-Registered firms in a recession, thus helping their Registered SME customers to conserve cash.

Note that Table 4 shows Non-Registered firms with WIR Turnover levels comparable to those of the smaller Registered firms. This suggests that large Non-Registered firms limited WIR activity almost exclusively to their smaller Registered customers, Registered firms playing a reciprocal role. This rough parity of Turnover can be shown to hold for the 15 years of our sample.

Given this pattern, let us assume for modeling purposes, not too unrealistically, that secondary currency trade between Registered and Non-Registered firms is "mirror-imaged" in the sense that Turnover is equal for both types, but Balances for each type show opposite cyclical effects. Countercyclical activity is structured by such reciprocity, as we show in Lemma 3:

Lemma 3*: Consider the elasticity of secondary currency expenditures with respect to Output. Let*

(i) Turnover Elasticity for both Registered (R) and Non-Registered (NR) firms be of counter-cyclial (negative) sign, and

(ii) NR firms allow R firms to settle a greater proportion of bills outstanding in secondary currency in a recession, but wait to spend most of this currency until the recession is over.

It follows that:

(1) For an R firm, its countercyclical Turnover is dominated by a ***countercyclical Velocity.*** *That is, although both are negative, the Velocity Elasticity of Output is greater in absolute value than the Turnover Elasticity of Output.*

(2) For an NR firm, its countercyclical Turnover is dominated by a ***countercyclical Balance.*** *That is, although both are negative, the Balance Elasticity of its Output is greater in absolute value than the Turnover Elasticity of its Output.*

Proof: By (ii) we have countercyclical NR Balances, and pro-cyclical R Balances. Thus we can write $B_Q^{NR} < 0 < B_Q^R$; i.e., the Balance (*B*) Elasticity of Output (*Q*) is countercyclical for NR, but pro-cyclical for R firms. Since (i) Turnover is countercyclical, this gives our first result:

$$T_Q^R = \underset{(-)}{V_Q^R} + \underset{(+)}{B_Q^R} < 0, \qquad (3.1)$$

or the countercyclical Turnover of an R firm is dominated by its countercyclical Velocity. Again by (ii), R Velocity is countercyclical, and that of NR is pro-cyclical: $V_Q^R < 0 < V_Q^{NR}$. Again, countercyclical Turnover (i) gives our second result:

$$T_Q^{NR} = \underset{(+)}{V_Q^{NR}} + \underset{(-)}{B_Q^{NR}} < 0, \qquad (3.2)$$

or the countercyclical Turnover of an NR firm is dominated by its countercyclical Balance.

V. Panel Econometric Tests

V.1 A Bootstrap Simulation to Test Cointegration

Instead of regressing overall WIR activity against Swiss GDP, as in Table 3 above, more disaggregated data allow us to regress WIR activity against changes in GDP *by sector*. Our six WIR sectors were shown in Table 4; we now regress them against GDP Value-Added by sector. Our sectoral time series is short, 15 years only, so we are not so concerned with the "long-term" relationship between imports and WIR, or with the EC portion of the VEC. As long as the EC equation is cointegrated, we can concentrate on the coefficients of the *lagged, first-differenced* terms – the VAR part of the model, where any countercyclical effects would show.

Fisher tests on moving average terms overwhelmingly fail to reject the null hypothesis of individual unit roots. The 5 percent rejection level was achieved for the null of a *common* unit root across the panel – by the Levin, Lin, and Chu, or LLC test – for two series: the moving average log of real WIR Velocities and Turnover for Non-Registered firms. The null of *individual* unit roots across the panel, however – using the Im-Pesaran-

Shin (IPS), Augmented Dickey Fuller, and Phillips-Perron tests – could not be rejected at 5 percent. These latter two tests are versions of the Fisher test. Maddala and Wu (1996) report that in the presence of correlation between sectors, as we have here, Fisher tests have greater power to reject the null than either the LLC common or the IPS individual test. We undertook 14 Fisher-type tests – 2 each for the moving averages of Turnover, Velocity, and Balances on both Registered and Non-Registered firms, plus 2 for the moving average of Output, or 2 x 3 x 2 + 2 = 14. Only one test on Registered Balances and one on Non-Registered Turnover could reject the null of a unit root at 10 percent; no others could reject even at 15 percent. With strong evidence of unit roots, cointegration tests are legitimate.

Panel cointegration, however, is problematic with our small data set, with only 15 years and 6 sectors, since there will generally have poor size characteristics when correlation between panel sectors exists (Banerjee and Carrion-i-Silvestre, 2006) – as can easily be shown to be the case here. A common resort is to extend the time dimension through bootstrapping. We have done this here with a Residual-Based Stationary Bootstrap (RSB) method for cointegration testing by Di Iorio and Fachin (2011).

We begin by residual-based cointegration through successive residuals, ε_t and ε_{t-1}, taken from a cointegrating equation, $y_t = \mu_t + \beta x_t + \varepsilon_t$, where y_t and x_t have unit roots. We then form an AR(1) relation on the residuals, $\hat{\varepsilon}_t = \rho\hat{\varepsilon}_{t-1} + v_t$. The estimated residuals, $\widehat{v_t}$, are then "re-shuffled" in chained blocks of random length, at random locations. Replacing these estimated residuals, $\widehat{v_t}$, with their reshuffled pseudo-residuals, v_t^*, there is a low probability that $\widehat{v_t} = v_t^*$. We use the v_t^* term to replace our estimated AR residuals, $\hat{\varepsilon}_t$, with a new set of *AR-pseudo-residuals*, $\varepsilon_t^* = \rho\varepsilon_{t-1}^* + v_t^*$, based on the null hypothesis of no-cointegration; i.e., $\rho = 1$, where $\varepsilon_t^* \equiv v_t^*$ for the first element of the series. The Data Generating Process (DGP) in bootstrapping should mimic the null hypothesis (Maddala and Kim, 1998, p. 317; Van Giersbergen and Kiviet, 1994). The panel cointegration tests used here are appropriate by this criterion, since they are based on the null of no cointegration.

Armed with these AR-pseudo-residuals, we simulate new values of our dependent variable, $y_t^* = \hat{\mu} + \hat{\beta}x_t + \varepsilon_t^*$, and where $\hat{\mu}$ and $\hat{\beta}$ are the estimates from our original cointegrating equation. This process is repeated B-1 times, until the time dimension of our pseudo-data is not T but BT. (In the simulations below, B = 13.) Note that the dependent variable, y_t – not the original independent variable, x_t – is simulated by this bootstrap. If we want to reverse the role of y_t and x_t in cointegration, we must perform a new bootstrap.

Using this simulation method, a full battery of Pedroni cointegration tests was implemented. A lag length of 1 was used, consistent with cointegrating equations to follow. An example of a Pedroni test is seen in Table 5. Here *LrTURNa_NR(i,t)* = the log of real WIR Turnover averaged over 2 years for Non-Registered Clients for i = 1, 2, .., 6 industrial sectors, and *LrVAa(i,t)*, the log of averaged Real Output (Value-Added, in Swiss Francs), again for each sector. The original t = 1, 2, .., 15 periods were expanded by 12 simulated sequences of 15, yielding a total of 13x15 =195 periods, with 6 sectors for 15x13x6 =1170 observations. (A few dozen observations are missing because there were no 1994 observations on Balances or Velocity. These lacunae are magnified by the simulation's re-shuffling.)

Note that the null hypothesis of No Cointegration is more decisively rejected (i.e., lower p-Values) in simulations where the alternative hypothesis was for "Group" cointegration; i.e., AR residuals for *each* sector i, formed by separate coefficient values $|\rho_i| < 1$. This is as compared to an alternative hypothesis of "Panel" cointegration, with a common value $|\rho| < 1$ across *all* sectors. Pedroni (2001) refers to these as the "between" and "within" dimension, respectively.

Table 5. Pedroni Residual Cointegration Tests: LrTURNa_NR(i,t) = α + β*LrVAa + ε(i,t); Bootstrapped data, DOLS Regression for Non-Registered WIR Clients.
(*Null Hypothesis: No cointegration*.)

Alternative hypothesis: *common AR coefficients, (within-dimension)*	**Weighted Statistic**	**P-Value**
Panel v-Statistic	32.2372	0.00E+00
Panel rho-Statistic	-59.6962	0.00E+00
Panel PP-Statistic	-24.4248	4.66E-132
Panel ADF-Statistic	-4.6886	1.38E-06
Alternative hypothesis: *individual AR coefficients, (between-dimension)*	**Statistic**	**P-Value**
Group rho-Statistic	-57.6423	0.00E+00
Group PP-Statistic	-29.3090	3.98E-189
Group ADF-Statistic	-4.6491	1.67E-06

Data: 195 periods = 15x13, 6 Cross-sections => 15x13x6 =1170 Observations, some omitted by re-shuffling. In Pedroni tests, no deterministic trend, Lag length = 1. Newey-West bandwidth selection and Bartlett kernel.

Despite somewhat lower P-values for this Group or "between" case – a consistent finding – we focus here on the Panel or "within" case for the following reasons. First, WIR clients trade with other sectors, not just their own. Second and more importantly, our interest is not just in the intra-sectoral circulation of WIR, but its broad countercyclical effectiveness. It would be natural for firms to respond first to business conditions within their own sector, but myopic for them to look only there.

Following the example of Table 5, cointegration tests were carried out in 24 simulations: 2 types of clients, Registered and Non-Registered, 2 cointegration forms, FMOLS and DOLS, 3 possible pairings of 3 variables, and 2 options as to which is dependent and which the independent variable in each pairing. A summary of these 2 x 2 x 3 x 2 = 24 possible relations is shown in Table 6.

For the cointegration tests carried out for Table 6 we used 1 lag, consistent with the VEC regression models to follow. Also for consistency with these VEC regressions, with 3 lags in their VAR portion, we use 4 lags for the Granger tests of Table 6. This is based on the Toda-Yamamoto (1995) criteria of the number of VAT lags one for each possible cointegrating relationship.

In Table 6, the *highest* P-value for the Weighted Panel statistics is used for the sake of conservatism. For example, the ADF Statistic in Table 5 shows a value of 1.38E-06. This is the first DOLS p-value shown in section 4, column 2 of Table 6.

Table 6 is divided into white and grey cells to emphasize the pattern of cointegration within the white, but not the grey cells. Note that cointegration P-values in grey cells are all above the 5 percent level. P-values significant at 5 percent are written here in scientific notation.

Sections 1-3 show the cointegration and Granger P-values for R firms, while Sections 4-6 are for NR firms. For Section 1, recall that our earlier time-series estimates in Table 3 showed WIR-Turnover as both cointegrated and countercyclical with GDP. Table 6 shows sectoral Value-added; i.e., the sectoral *contribution* to GDP. Thus we expect these entries to show significant cointegration and Granger precedence – as they do.

Table 6. Highest P-Value of 4 Pedroni Panel Cointegration Tests; *P-values in Bold Italics*; Null of No Cointegration. P-values on Granger Precedence; (Reverse Precedence in Parentheses); Null of No Granger Precedence.

Section #	Dependent Variable in Simulation	FMOLS	DOLS	FMOLS	DOLS	Dependent Variable in Simulation
(1)	**Registered: LrVAa => LrTURNa**	***2.33E-02***	***3.15E-02***	***1.79E-10***	***0.1882***	**Registered: LrVAa <= LrTURNa**
		6.79E-02	0.1107	0.7589	0.2793	
		(0.5472)	(0.4092)	(2.39E-06)	(1.64E-04)	
(2)	**Registered: LrVAa => LrVELa**	***7.19E-05***	***2.47E-14***	***0.00E+00***	***3.52E-10***	**Registered: LrVAa <= LrVELa**
		3.87E-06	2.68E-09	3.97E-02	0.6226	
		(0.2210)	(0.2760)	(0.9637)	(7.98E-02)	
(3)	**Registered: LrVAa => LrBALa**	***0.6180***	***0.9644***	***8.17E-09***	***2.17E-11***	**Registered: LrVAa <= LrBALa**
		4.80E-03	0.1063	4.72E-02	5.00E-02	
		(4.05E-03)	(2.01E-02)	(0.5758)	(6.97E-06)	
(4)	**Non-Registered: LrVAa => LrTURNa**	***2.05E-02***	***1.38E-06***	***3.47E-20***	***1.87E-11***	**Non-Registered: LrVAa <= LrTURNa**
		0.00E+00	9.33E-265	0.1582	0.4011	
		(1.75E-36)	(9.73E-35)	(4.68E-06)	(6.94E-06)	
(5)	**Non-Registered: LrVAa => LrVELa**	***0.4782***	***0.9871***	***3.89E-08***	***3.34E-11***	**Non-Registered: LrVAa <= LrVELa**
		5.49E-09	9.14E-07	0.1022	4.73E-03	
		(0.3950)	(0.0932)	(1.72E-03)	(6.44E-02)	
(6)	**Non-Registered: LrVAa => LrBALa**	***3.07E-03***	***2.96E-06***	***8.65E-07***	***1.62E-11***	**Non-Registered: LrVAa <= LrBALa**
		2.24E-11	0.00E+00	2.00E-04	1.25E-05	
		(0.1432)	(3.59E-13)	(7.00E-07)	(1.86E-05)	

Data: Bootstrap simulation of panel data: 15 periods simulated more 12 times, 6 Cross-sections =>15x13x6 = 1170 observations; some omitted by simulation re-shuffling. P-values < 5 percent are given in scientific notation. Lags of 1 used for Cointegration tests, and lags of 4 for the Toda-Yamamoto Granger tests, as explained in text. Greyed-out area show Cointegration test p-values > 5 percent.

It is somewhat surprising that cointegration and Granger relations are seen also in the opposite direction, in the right-side columns of Section 1, where Value-added is now a dependent variable. Note here that Granger precedence appears to run from Value-added to WIR-Turnover, but not in the opposite direction. This is unsurprising, given the size of WIR Turnover relative to Swiss GDP.

Compere this pattern for Registered in Section 1 with Turnover for Non-Registered firms in Section 4. The first two column entries in both Sections show the expected cointegration relations, consistent with our time series estimates in Table 3. In the opposite direction, in the right-hand columns, there is again cointegration and Granger precedence. But as with the Registered firms, note that WIR Turnover does not appear to Granger precede Value-added.

For Sections 2 and 6 in the left-hand columns, recall that Lemma 3 predicted countercyclical Velocities for R firms, and countercyclical Balances for NR firms. These relationships may be reflected in the strong evidence for cointegration. When we move to the right-hand columns, we find that R firms show Granger precedence from Value-added to WIR-Velocity, but evidence for the reverse precedence is mixed. NR firms, however, now show cointegration and Granger precedence *in both directions* between WIR-Balances and Value-added. This probably reflects the larger scale of the NR firms, restricted from direct WIR membership (but not client relations) by WIR-Bank bylaws.

Finally, for the greyed-out Sections 3 and 5, recall that Lemma 3 predicted that Velocity for NR firms and Balances for R firms will be pro-, not countercyclical. Thus we expected (although it is not strictly implied) that these variables would *not* show cointegration with Value-added – and instead show a looser 'residual' relationship. Very high p-values are indeed shown for all cointegration entries in these greyed-out areas. In the right-side columns of the same Sections 3 and 5, however, while there is again strong evidence of cointegration, the direction of Granger precedence is ambiguous. The only unambiguous evidence of direct macro-economic impact from WIR activity appears in the last two columns of Section 6: the WIR Balances of Non-Registered firms appear to Granger precede changes in Value-added.

In summary, the leading countercyclical role sketched for NR Balances and R Velocities is strengthened by these cointegration and Granger results. In the case of the larger NR firms, there is also some evidence for 'reverse causality' – WIR Balances for NR firms may be large enough to have a direct macro-economic impact on the larger Swiss economy. This is a theme to which we will return.

V.2 Vector Error Correction (VEC) Estimates

V.2.1 VECs for Registered Firms

In Table 7, for Registered WIR-Clients, the cointegrating equations shown here are from the actual data, not the bootstrap results shown in Table 6. From the Pedroni cointegration and Granger tests from Table 6, however, reproduced here for convenience, cointegration modeling is clearly valid.

Results in Table 7 are encouraging: the coefficients on the first-differenced Value-Added terms in columns (1a) and (1b) are of the right countercyclical sign, though not highly significant. Note that the significant countercyclical effects in columns (2a) and (2b), are of the opposite sign, as they must be for stability, but only on the second lag.

In columns (1a) and (1b) of Table 7, the Wooldridge (2002) null hypothesis of *no* first-order serial-correlation cannot be rejected; thus serial correlation is not a likely problem. In columns (2a) and (2b), however, this null of no first-order auto-regression is strongly rejected. This is not quite as bad as it seems, however. In Table 7 and the panel regressions that follow, we use White (1980) period estimators, robust to within-cross-section serial correlation (Arellano, 1987). This means our coefficient estimates are unbiased but not efficient; i.e., their standard errors are not as small as possible. So despite our serial correlation result, significance levels are conservative and we can be fairly confident about signs of these coefficients. It is therefore credible that the coefficients – here in bold – on the second-lagged, first-differenced Turnover in columns (2a) and (2b) show positive and highly significant effects on Value-added. From Table 6, however, we know that although there is cointegration, there is no evidence of Granger precedence *in this direction* – from Turnover to Value-added.

Table 7: REGISTERED WIR Clients: 2 Year Moving Averages of Log of Real WIR Turnover (LrTURNa), regressed on Log of Real Value-Added (LrVAa), by Sector

t-statistics in [ ]; *******: p-val ≤ 0.01, ****** : p-val ≤ 0.05, *****: p-val ≤ 0.10

Method: Vector Error Correction Model, Panel Data, Fixed Effects White Period Covariance (no degrees of freedom correction)				
	Sample (adjusted): 1999-2008 Periods: 10, Cross-sections: 6		Sample (adjusted): 1999-2008 Periods: 10, Cross-sections: 6	
COINTEGRATING EQUATION (METHOD)	**(1a) Depend. Variable: LrTURNa(-1) (FMOLS)**	**(1b) Depend. Variable: LrTURNa(-1) (DOLS)**	**(2a) Depend. Variable: LrVAa(-1) (FMOLS)**	**(2b) Depend. Variable: LrVAa(-1) (DOLS)**
Constant	12.27	9.670	12.24	8.453
LrVAa(-1)	0.0820 [0.33]	0.3877 [1.03]		
LrTURNa(-1)			*-0.1641 [-0.53]*	*0.1781 [0.28]*
Independent Variables:	**Depend. Variable: D(LrTURNa)**	**Depend. Variable: D(LrTURNa)**	**Depend. Variable: D(LrVAa)**	**Depend. Variable: D(LrVAa)**
CointegEqRES	-0.1241 [-1.57]	-0.0452 [-1.22]	-0.0542 [-0.72]	0.0609 [3.70]***
D(Dependent Var. (-1))	0.6747 [6.60]***	0.5755 [10.01]***	1.1834 [5.97]***	1.0393 [5.87]***
D(Dependent Var. (-2))	-0.5485 [-18.91]***	-0.5704 [-29.92]***	-0.8079 [-3.87]***	-0.7856 [-3.83]***
D(Dependent Var. (-3))	0.3374 [3.37]***	0.2661 [3.97]***	0.3716 [2.57]**	0.2327 [1.98]*
D(LrVAa(-1))	**-0.7861 [-1.81]***	**-0.5249 [-1.56]**		
D(LrTURNa(-1))			*-0.0280 [-0.70]*	*-0.0251 [-0.97]*
D(LrVAa(-2))	0.2867 [0.82]	0.2233 [0.55]		
D(LrTURNa(-2))			***0.0676 [3.21]******	***0.0568 [3.12]*****
D(LrVAa(-3))	0.3095 [1.01]	0.4802 [1.534]		
D(LrTURNa(-3))			*0.0071 [0.230]*	*0.0103 [0.51]*
Constant	-0.1771 [-1.79]*	-0.1023 [-1.54]	0.0060 [2.20]**	0.0254 [4.34]***
R-squared	0.687	0.669	0.706	0.717
Adjusted R-squared	0.607	0.585	0.631	0.645
Log likelihood	112.6	111.0	189.5	190.7
F-statistic	8.579	7.930	9.414	9.931
Akaike info criterion	-3.321	-3.268	-5.884	-5.922
Schwarz criterion	-2.867	-2.814	-5.430	-5.468
a) Pedroni Tests:	2.33E-02	3.15E-02	1.79E-10	0.1882
b) Wooldridge AR1:	0.4765	0.3740	0.0000	0.0000
c) Granger Precedence:	6.79E-02 (0.5472)	9.33E-265 (9.73E-35)	0.7589 (2.39E-06)	0.2793 (1.64E-04)

Notes: *P-values in a)-c) are based on null hypotheses of: a) No panel cointegration, from estimates of Tables 6; b) No first-order serial-correlation (Wooldridge AR test); and c) No Granger Precedence. For c), the first p-value tests if the independent variable does not Granger precede the dependent variable. (The p-value in parentheses is for the reverse precedence.)*

Table 8: <u>REGISTERED</u> WIR Clients: 2 Year Moving Averages of Log of Real WIR <u>Velocity</u> (LrWirVelAv2), regressed on Log of Real <u>Value-Added</u> (LrVaAv2), by Sector

*t-statistics in [ ]; ***: p-val ≤ 0.01, ** : p-val ≤ 0.05, *: p-val ≤ 0.10*

Method: Vector Error Correction Model, Panel Data, Fixed Effects White Period Covariance (no degrees of freedom correction)				
	Sample (adjusted): 1999-2007 Periods: 9, Cross-sections: 6		Sample (adjusted): 1999-2008 Periods: 10, Cross-sections: 6	
COINTEGRATING EQUATION (METHOD)	**(1a) Depend. Variable: <u>LrVelAv2(-1)</u> (FMOLS)**	**(1b) Depend. Variable: <u>LrVelAv2(-1)</u> (DOLS)**	**(2a) Depend. Variable: <u>LrVaAv2(-1)</u> (FMOLS)**	**(2b) Depend. Variable: <u>LrVaAv2(-1)</u> (DOLS)**
Constant	10.86	14.10	12.24	11.22
LrVaAv2(-1)	-0.3963 [-3.71]***	-1.137 [-2.52]**		
LrVelAv2(-1)			*-0.1641 [-0.53]*	*-0.6328 [-6.37]****
Independent Variables:	**Depend. Variable: D(LrWirVelAv2)**	**Depend. Variable: D(LrWirVelAv2)**	**Depend. Variable: D(LrVaAv2)**	**Depend. Variable: D(LrVaAv2)**
CointegEqRES	-0.697 [-9.63]***	-0.220 [-2.82]***	1.1610 [8.26]***	-0.014 [-0.37]
D(Dependent Var. (-1))	0.638 [5.13]***	0.358 [2.56]**	-0.7004 [-12.11]***	1.1158 [9.79]***
D(Dependent Var. (-2))	-0.152 [-1.41]	-0.396 [-6.45]***	0.3170 [6.75]***	-0.7007 [-9.87]***
D(Dependent Var. (-3))	0.334 [3.58]***	0.217 [2.91]***	1.1610 [8.26]***	0.2881 [7.18]***
D(LrVaAv2(-1))	**-0.856 [-4.74]*****	**-1.871 [-3.63]*****		
D(LrWirVelAv2(-1))			*0.0146 [0.51]*	*0.0030 [0.15]*
D(LrVaAv2(-2))	0.821 [1.55]	1.472 [1.52]		
D(LrVelAv2(-2))			*0.0182 [0.76]*	*0.0094 [0.47]*
D(LrVaAv2(-3))	-0.683 [-2.17]**	-0.175 [-0.22]		
D(LrVelAv2(-3))			***0.0747 [2.64]*****	***0.0681 [2.74]******
Constant	-0.106 [-12.42]***	-0.234 [-3.09]***	*0.006 [2.13]***	*0.007 [2.29]***
R-squared	0.728	0.471	0.772	0.765
Adjusted R-squared	0.649	0.316	0.714	0.704
Log likelihood	90.78	72.79	197.1	196.2
F-statistic	9.161	3.042	13.26	12.72
Akaike info criterion	-2.880	-2.214	-6.138	-6.105
Schwarz criterion	-2.402	-1.735	-5.684	-5.652
a) Pedroni Tests:	2.47E-14	7.19E-05	0.981	0.858
b) Wooldridge AR1:	0.000	0.024	0.000	0.000
c) Granger Precedence	1.89E-4 (2.23E-10)		0.552 (3.06E-03)	

Notes: *P-values in a)-c) are based on null hypotheses of: a) No panel cointegration, from estimates of Tables 6; b) No first-order serial-correlation (Wooldridge AR test); and c) No Granger Precedence. For c), the first p-value tests if the independent variable does not Granger precede the dependent variable. (The p-value in parentheses is for the reverse precedence.)*

Turning to Table 8, we regress Velocity against Value-Added, and we can compare the countercyclical coefficients to Table 7. As predicted by Lemma 3, the countercyclical coefficients on Velocity in Table 8 are greater than those on Turnover in Table 7. We will shortly undertake formal tests of these differences. As in Table 7, we can accept the sign and significance of these variables, despite the rejection of no serial correlation by the Wooldridge tests. Also as in Table 7 when WIR activity is the independent variable in columns (2a) and (2b), the significant coefficients are at later lags, and evidence for Granger precedence is ambiguous.

V.2.2 VECs for Non-Registered Firms

Let us turn now to Table 9, which shows the relation between sectoral WIR Turnover and sectoral Value-Added for Non-Registered WIR clients. In the left-hand columns, we see that the coefficient on the first lagged Value-Added term – in bold – is of countercyclical sign and highly significant. In the right-hand columns significant coefficients on Turnover are shown only on the second or third lag – similar to the pattern in Table 7. Note also that row c) shows Granger precedence, but not in both directions. Granger precedence runs from Value-added to WIR-Turnover for Non-Registered firms, but not the opposite way.

Turning to Table 10, we find that the first and second lagged Value-Added terms – in bold – are *not* significant in (1a) and (1b), whereas the WIR-Balance coefficients in (2a) and (2b) show significance only at a later lag – repeating the pattern shown in Tables 7-9. Unlike these previous results, however, now there is now strong evidence of Granger precedence in *both* directions. The implication is that the WIR-activity of Non-Registered firms, probably because of their larger scale, has a direct countercyclical impact on GDP, and is not just a reflection of broader macro-economic trends.

Table 9: NON-REGISTERED WIR Clients: 2 Year Moving Averages of the Log of Real WIR Turnover (LrTurnAv2), regressed on Log of Real Value-Added (LrVaAv2), by Industrial Sector
*t-statistics in [ ]; ***: p-val ≤ 0.01, ** : p-val ≤ 0.05, *: p-val ≤ 0.10*

Method: Vector Error Correction Model, Panel Data, Fixed Effects White Period Covariance (no degrees of freedom correction)				
	Sample (adjusted): 1999-2008 Periods: 10, Cross-sections: 6		Sample (adjusted): 1999-2008 Periods: 10, Cross-sections: 6	
COINTEGRATING EQUATION (METHOD)	**(1a) Depend. Variable: LrTurnAv2(-1) (FMOLS)**	**(1b) Depend. Variable: LrTurnAv2(-1) (DOLS)**	**(2a) Depend. Variable: LrVaAv2(-1) (FMOLS)**	**(2b) Depend. Variable: LrVaAv2(-1) (DOLS)**
Constant	18.32	16.60	13.59	14.67
LrVaAv2(-1)	-0.5240 [-1.71]*	-0.3106 [-1.33]		
LrTurnAv2(-1)			*-0.2725 [-4.36]****	*-0.3613 [-7.08]****
Independent Variables:	**Depend. Variable: D(LrTurnAv2)**	**Depend. Variable: D(LrTurnAv2)**	**Depend. Variable: D(LrVaAv2)**	**Depend. Variable: D(LrVaAv2)**
CointegEqRES	-0.1143 [-4.92]***	-0.0479 [-3.13]***	-0.1651 [-2.58]***	-0.1165 [-2.19]**
D(Dependent Var. (-1))	0.2232 [1.73]*	0.2143 [1.54]	0.0263 [1.08]	0.9910 [8.11]***
D(Dependent Var. (-2))	-0.0453 [-0.47]	-0.0950 [-1.05]	0.1292 [3.39]***	-0.6131 [-4.68]***
D(Dependent Var. (-3))	0.2175 [4.04]***	0.1935 [3.07]***	0.0357 [7.41]***	0.1965 [2.12]**
D(LrVaAv2(-1))	**-0.6702 [-4.34]*****	**-0.5192 [-3.58]*****		
D(LrTurnAv2(-1))			*0.0263 [1.08]*	*0.0317 [1.52]*
D(LrVaAv2(-2))	**0.4359 [2.06]****	**0.4664 [1.78]***		
D(LrTurnAv2(-2))			***0.1292 [3.39]******	***0.0757 [1.51]***
D(LrVaAv2(-3))	-0.0577 [-0.256]	-0.0103 [-0.04]		
D(LrTurnAv2(-3))			***0.0357 [7.41]******	***0.0303 [2.82]******
Constant	-0.1778 [-5.59]***	-0.1138 [-3.83]***	-0.0125 [-1.20]	-0.0112 [-1.12]
R-squared	0.518	0.477	0.7301	0.7136
Adjusted R-squared	0.395	0.343	0.6612	0.6404
Log likelihood	127.2	124.7	192.1	190.3
F-statistic	4.207	3.569	10.59	9.759
Akaike info criterion	-3.806	-3.725	-5.969	-5.909
Schwarz criterion	-3.353	-3.271	-5.515	-5.456
a) Pedroni Tests:	4.66E-132	3.78E-02	3.47E-20	1.87E-11
b) Wooldridge AR1:	0.0006	0.0010	0.0007	0.0002
c) Granger Precedence	0.00E+00 (1.75E-36)	9.33E-265 (9.73E-35)	0.1582 (4.68E-06)	0.4011 (6.94E-06)

Notes: *P-values in a)-c) are based on null hypotheses of: a) No panel cointegration, from estimates of Tables 6; b) No first-order serial-correlation (Wooldridge AR test); and c) No Granger Precedence. For c), the first p-value tests if the independent variable does not Granger precede the dependent variable. (The p-value in parentheses is for the reverse precedence.)*

Table 10: NON-REGISTERED WIR Clients: 2 Year Moving Averages of the Log of Real WIR Balance (LrBALav2), regressed on Log of Real Value-Added (LrVAav2), by Industrial Sector
*t-statistics in [ ]; ***: p-val ≤ 0.01, ** : p-val ≤ 0.05, *: p-val ≤ 0.10*

Method: Vector Error Correction Model, Panel Data, Fixed Effects White Period Covariance (no degrees of freedom correction)				
	Sample (adjusted): 1999-2007 Periods: 9, Cross-sections: 6		Sample (adjusted): 1999-2007 Periods: 9, Cross-sections: 6	
COINTEGRATING EQUATION (METHOD)	**(1a) Depend. Variable: LrBALAv2(-1) (FMOLS)**	**(1b) Depend. Variable: LrBALav2(-1) (DOLS)**	**(2a) Depend. Variable: LrVaAv2(-1) (FMOLS)**	**(2b) Depend. Variable: LrVaAv2(-1) (DOLS)**
Constant	13.24	16.14	12.71	14.32
LrVaAv2(-1) / *LrBALAv2(-1)*	-0.1892 [-0.75]	-0.4242 [-1.74]*	*-0.2141 [-3.08]****	*-0.3534 [-6.21]****
Independent Variables:	**Depend. Variable: D(LrBALa)**	**Depend. Variable: D(LrBALa)**	**Depend. Variable: D(LrVAa)**	**Depend. Variable: D(LrVAa)**
CointegEqRES	-0.4731 [-2.78]***	-0.2535 [-1.43]	0.0093 [0.20]	-0.0081 [-0.21]
D(Dependent Var. (-1))	0.4678 [3.83]***	0.2801 [1.70]	1.0739 [9.44]***	1.0850 [10.46]***
D(Dependent Var. (-2))	0.3732 [1.97]*	0.2815 [1.28]	-0.6404 [-6.96]***	-0.641 [-7.04]***
D(Dependent Var. (-3))	0.1612 [0.88]	0.0124 [0.04]	0.2004 [4.85]***	0.2168 [3.74]***
D(LrVaAv2(-1)) / ***D(LrBALAv2(-1))***	**-1.1036 [-1.14]**	**-0.7791 [-0.78]**	***0.0272 [1.59]***	***0.0267 [1.39]***
D(LrVaAv2(-2)) / ***D(LrBALAv2(-2))***	**0.5667 [0.53]**	**0.6190 [0.53]**	***-0.0436 [-4.05]******	***-0.0412 [-2.55]*****
D(LrVaAv2(-3)) / *D(LrBALAv2(-3))*	-0.5275 [-0.77]	-0.2011 [-0.24]	*-0.0136 [-1.20]*	*-0.0081 [-0.59]*
Constant	-0.2261 [-2.84]***	-0.2559 [-1.48]	0.0081 [1.30]	0.0051 [0.57]
R-squared	0.278	0.214	0.660	0.660
Adjusted R-squared	0.067	-0.016	0.573	0.573
Log likelihood	83.63	81.34	185.1	185.1
F-statistic	1.314	0.929	7.607	7.607
Akaike info criterion	-2.616	-2.531	*-5.738*	-5.738
Schwarz criterion	-2.137	-2.052	*-5.285*	-5.285
a) Pedroni Tests:	3.07E-03	2.96E-06	8.65E-07	1.62E-11
b) Wooldridge AR1:	0.0005	0.0030	0.0000	0.0000
c) Granger Prec. 4, (2) lags:	2.24E-11 (0.1432)	0.00E+00 (3.59E-13)	2.00E-04 (7.00E-07)	1.25E-05 (1.86E-05)

Notes: *P-values in a)-c) are based on null hypotheses of: a) No panel cointegration, from estimates of Tables 6; b) No first-order serial-correlation (Wooldridge AR test); and c) No Granger Precedence. For c), the first p-value tests if the independent variable does not Granger precede the dependent variable. (The p-value in parentheses is for the reverse precedence.)*

We now collect, in Table 11, evidence from these regressions on the dominance of Velocity and Balance Elasticities for Registered and Non-Registered firms, respectively. From Lemma 3, Velocity – and not Balance – elasticities dominate the countercyclical response of WIR Turnover for *Registered* firms: Since $V_Q^R + B_Q^R = T_Q^R < 0$ and $0 < B_Q^R$, it follows that $V_Q^R - T_Q^R < 0$. Thus our null hypothesis is $V_Q^R - T_Q^R = 0$. Since the alternative hypothesis is an inequality, it is evaluated by the one-tailed p-value. For these elasticities we can take, say, the coefficients on Turnover, -0.525, in Table 7 (1b), and on Velocity, -1.871, in Table 8 (1b), respectively. The Wald test on the null can now be rejected at p-values of 1.13E-04 and 6.31E-03, respectively.

For Non-Registered firms, by contrast, Balances should dominate the countercyclical elasticity of Turnover: $B_Q^{NR} - T_Q^{NR} < 0$, with the null hypothesis that this difference should be zero. For these elasticities we take the coefficients on first lagged term of Turnover, -0.519, from Table 9(1b), and that of Balances, -0.779, from Table 10 (1b), respectively. The Wald test on this null can be rejected at p-values of 0.0399 or 0.3979. This gives added support for our Lemma 3.

Table 11: P-Values: Wald Tests of Elasticity Dominance of Velocity and Balances over Turnover on Value-Added Elasticities, Registered and Non-Registered WIR Clients

Registered Null Hypothesis: $V_Q^R - T_Q^R = 0$, Alternative Hypothesis: $V_Q^R - T_Q^R < 0$		**Non-Registered** Null Hypothesis: $B_Q^{NR} - T_Q^{NR} = 0$, Alternative Hypothesis: $B_Q^{NR} - T_Q^{NR} < 0$	
FMOLS Estimates	**DOLS Estimates**	**FMOLS Estimates**	**DOLS Estimates**
7(1a): $T_Q^R =$ -0.7861, 8(1a): $V_Q^R =$ -0.8557.	7(1b): $T_Q^R =$ -0.5249, 8(1b): $V_Q^R =$ -1.8710.	9(1a): $T_Q^{NR} =$ -0.6702, 10(1a): $B_Q^{NR} =$ -1.1036.	9(1b): $T_Q^{NR} =$ -0.5192, 10(1b): $B_Q^{NR} =$ -0.7791.
p-values: 7(1a): ***0.4366***, 8(1a): ***0.3509***	p-values: 7(1b): 1.13E-04, 8(1b): 6.31E-03	p-values: 9(1a): 3.64E-03, 10(1a): ***0.3279***	p-values: 9(1b): 3.99E-02, 10(1b): ***0.3979***

By examining Table 11, we can confirm that the countercyclical dominance of R Velocity or NR Balance predicted by Lemma 3 (here, the Alternative Hypothesis) does indeed hold in all cases. It is only statistically significant, however, in 4 of the 8 Wald tests. Note also that significance was achieved 3 out of 4 times when the Wald test was calibrated on a Turnover regression, in Tables 7 and 9 – but only once when based on a Velocity or Balance regression, in Tables 8 and 10.

VI. **Estimates within Industrial Sectors**
VI.1 Construction Sector

Table 12: Registered and Non-Registered Clients, CONSTRUCTION Sector: Log of Real WIR Turnover, Velocity and Balances in CONSTRUCTION (LrTURN_Cons, LrVEL_Cons, LrBAL_Cons) Regressed on Log of Real Value-Added in CONSTRUCTION, (LrVA_Cons)

*t-statistics in ( ); ***: p-val < 0.01, ** : p-val < 0.05, *: p-val <0.10*

Method: Vector Error Correction Model				
	Sample (adjusted): 1997 2008, Periods: 12		Sample (adjusted): 1997 2007, Periods: 11	
COINTEGRATING EQUATION	**(1a) Registered Depend. Variable: LrTURN_Cons(-1)**	**(1b) Non-Registered Depend. Variable: LrTURN_Cons(-1)**	**(2a) Registered Depend. Variable: LrVEL_Cons(-1)**	**(2b) Non-Registered Depend. Variable: LrBAL_Cons(-1)**
Variable	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
Constant	18.409	20.190	31.570	15.938
LrVA_Cons	-0.585 [-2.35]**	-0.771 [-4.88]***	-3.010 [-9.94]***	-0.425 [-2.59]***
VECTOR ERROR-CORECTION EQUATION	**Depend. Variable: D(LrTURN_Cons)**	**Depend. Variable: D(LrTURN_Cons)**	**Depend. Variable: D(LrVEL_Cons)**	**Depend. Variable: D(LrBAL_Cons)**
Variable	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
Cointeg_Equa_RES(-1)	-0.543 [-2.84]**	-0.571 [-2.86]**	-0.120 [-0.39]	-2.754 [-1.67]
D(Dependent Var. (-1))	0.387 [1.76]	0.202 [0.69]	-0.052 [-0.09]	1.180 [0.79]
D(Dependent Var. (-2))	0.380 [1.45]	0.306 [1.04]	-0.037 [-0.09]	-1.171 [-0.58]
D(LrVA_Cons (-1))	**-1.052 [-3.14]*** **	**-0.760 [-1.85]**	**-1.181 [-1.83]**	**-2.981 [-1.55]**
D(LrVA_Cons (-2))	0.538 [2.11]*	0.206 [0.62]	0.310 [0.31]	0.393 [0.24]
Constant	0.001 [0.10]	-0.014 [-0.81]	-0.030 [-0.91]	0.051 [0.42]
R-squared	0.777	0.718	0.562	0.826
Adj. R-squared	0.590	0.484	0.124	0.651
Sum sq. resids	0.005	0.007	0.021	0.113
S.E. equation	0.028	0.034	0.064	0.150
F-statistic	4.166	3.060	1.282	4.734
Log likelihood	29.867	27.757	18.923	9.592
Akaike AIC	-3.978	-3.626	-2.350	-0.653
Schwarz SC	-3.735	-3.384	-2.133	-0.436
a) Johansen-Fisher:	0.032	0.001	0.001	0.005
b) Lagrangian AR:	0.342	0.996	0.010	0.991
c) Granger Precedence:	0.027 (0.805)	0.002 (0.211)	0.109 (0.394)	0.407 (0.097)

Notes: *P-values in a)-c) are based on null hypotheses of: a) No panel cointegration, from estimates of Tables 6; b) No serial-correlation with the lag-structure shown in this column; and c) No Granger Precedence. For c), the first p-value is on the null that the independent variable does not Granger precede the dependent variable. (The p-value in parentheses is for the reverse precedence.)*

We will now explore the countercyclical patterns *within* industrial sectors. Comparing the elasticities of Balances vs. Velocities between Registered and Non-Registered firms within a sector is of uncertain value here, since there is no reason to believe that most WIR trade is intra-industry. A Registered manufacturing firm seems at least as likely to trade with a Non-Registered services provider as it would with a Non-Registered manufacturing firm, and so on. Nonetheless, substantial intra-industry trade may in fact exist, since we find a similar pattern within most sectors.

Consider Construction, in Table 12 above. From Table 4, this is the sector with both the greatest Turnover – almost a third of the Swiss total – and the most widespread acceptance: 37 percent of Swiss construction firms accept WIR credits. It is possible that, due to the common practice of subcontracting, more intra-industry trade takes place in Construction than in other sectors.

In Table 12 we are using annual Value-added, rather than its moving average as in Tables 3 and 7-10. The significance of Table 12 suggests that Construction may be quicker to respond to cyclical trends than other sectors. Most of the statistical tests here are similar to those earlier Tables, with the exception of that for Autoregressive errors. Tables 7-10 are panel data, whereas Tables 3 and 12 are simple time series. Thus we can use a Lagrange Multiplier test for serial-correlation. Here we *cannot* reject the null hypothesis of no serial-correlation – giving us substantial confidence in the results.

Similarly to the panel results in Tables 7 through 10, we see in Table 12 that the first lagged Value-Added term on Construction – in bold – has the countercyclical negative sign. Also similar to our panel results, we see that for Registered firms, this Value-Added elasticity of Velocity in (2a) dominates the elasticity of Turnover in (1a), in the sense of having greater absolute value. Balances (2b) similarly dominate Turnover (1b) for Non-Registered firms. This Registered/Non-Registered pattern was shown in Table 11 to hold across all our panel results. In what follows, we will refer to this as the *standard countercyclical pattern.*

In columns (1a) and (1b), note that Granger precedence flows from Construction Value-Added to WIR-Turnover, but not in the opposite direction. In (2b), however, there is some evidence of precedence running in the opposite direction, from WIR-Balances to Construction Value-added for Non-Registered firms. Again, this may reflect the large size of some NR Construction firms (Winkler, 2010).

V1.2 Summary of Within-Sector Results: Contingency Tables

Sector-by-sector VEC regressions as shown above for Construction in Table 12 illustrate the 'standard countercyclical pattern.' This pattern was not always replicated by each sectoral regression; it varies by functional specification. Rather than choosing a 'best' specification for each sector, Table 13 summarizes results for the following 4 regression forms:

i) One and two year lags of first-differenced variables in that sector;
ii) One and two year lags of first-differenced *2-year Moving Average* of variables in that sector;
iii) As in a), but with a trend in the cointegrating equation; and
iv) As in b), but with a trend in the cointegrating equation.

Table 13 is a summary of contingency tables showing how often the following conditions were met: a) the elasticity of WIR Turnover has the expected negative countercyclical sign and is significant, and b) *either* the elasticity of Velocity dominates, *or* the elasticity of Balances dominates, as predicted by Lemma 3. We count whenever these conditions are met for both Registered and Non-Registered firms. Note that there are 4 functional specifications for each relationship, and two lag structures for each independent variable. Thus there could be as many as 8 instances for each of the 4 cells for the 6 sectors in Table 13, summarizing 8x4x6 = 192 regressions. But only the first or second lag is likely to be both of correct countercyclical sign *and* statistically significant, so we should expect to see a maximum of 4 or 5 in most cells. This is so for all but the cell SUM, which adds up all the other outcomes.

Note that we give the count for each of the 6 industrial sectors, plus the **Unified** merging all 6 sectors into one, and finally the **Sum** counting up of All Effects separately. Our predicted 'standard countercyclical pattern' is shown in a grey checker-board pattern of Velocity dominance for Registered and Balance dominance for Non-Registered firms. This is so within the Construction, Services, Wholesale, and the Sum sections. Of the sectors with enough observations to do a contingency test, only Manufacturing reverses this pattern of countercyclical dominance.

Manufacturing shows countercyclical Velocity dominance among its Non-Registered, not its Registered firms. We conjecture that the pattern of intra-sectoral purchases in this sector is likely to be the *reverse* of all others. Rather than larger firms supplying output to – and accepting WIR currency from – the smaller ones, as in most sectors, within Manufacturing it is common for smaller Registered firms to supply components for – and accept WIR currency from – their larger Non-Registered counterparts. If this conjecture is correct, then this reversal of our standard countercyclical pattern would be an ‘exception that proves the rule’ – because it highlights the same structural logic.

Table 13: Countercyclical Dominance of WIR Balances (B) or Velocity (V), Registered and Non-Registered Firms, Several Functional Specifications

	Yates	Pearson		Reg	Non-Reg
SUM, All Effects	0.0856	0.0441	Count_B=	6	11
			Count_V=	15	7
CONST	0.6650	0.0833	Count_B=	0	1
			Count_V=	2	0
RETAIL	NA	NA	Count_B=	0	0
			Count_V=	2	1
HOSP	NA	NA	Count_B=	1	0
			Count_V=	0	0
SERV	0.2357	0.0578	Count_B=	2	3
			Count_V=	4	0
MANUF	0.2059	0.0350	Count_B=	2	0
			Count_V=	1	5
WHOL	0.0528	0.0098	Count_B=	0	4
			Count_V=	5	1

The p-values on the Pearson Chi-Squared two-tailed tests are given for each contingency table, along with the Yates correction for continuity. Chi-Squares could not be calculated for the Retail or Hospitality sector, since they had a zero row or column sum; these tables are greyed out. All of the Pearson tests are significant at the 10% level. Given our small sample size, however Yates p-values may be more appropriate here. These statistical results are therefore suggestive but not dispositive. Along with the regressions of Tables

7 through 12, however, they provide consistent evidence for the standard countercyclical pattern, as predicated by Lemma 3.

VI. Conclusions

Previous work (Stodder, 2009) and updated regressions in Tables 2 and 3 show that WIR activity has been highly countercyclical for 65 years in Switzerland. Tables 7-12 allow us to examine this countercyclical trend over a shorter period, but *within* major industrial sectors. Regressions and Granger tests give evidence of the 'standard countercyclical pattern' of WIR-exchange predicted by Lemma 3: Non-Registered firms supply both product and credit to smaller Registered firms. Velocities of Registered firms, and Balances of the Non-Registered firms play the leading countercyclical roles.

It is clear from Table 4 that WIR is a big part of the credit picture for SMEs, and also for some large Non-Registered companies in Switzerland. But is the WIR-Bank an "only in Switzerland" case? Paradoxically, the best evidence for the broader viability of WIR may be its very Swiss nature. WIR is spread across ethno-linguistic regions, unlike other community-based cooperatives (Ostrom, 1990). German, French, and Italian-speaking memberships are in rough proportion to their Swiss populations (WIR *Rapport de Gestion*, 2000-2013). This suggests similar institutions could work elsewhere.

What about WIR's inflationary potential? There is a broad literature (Mankiw, 1993; Mankiw and Summers, 1986; Bernanke and Gertler, 1995; Gavin and Kydland, 1999) showing money supply is pro-cyclical. Even less controversial is the finding that Velocity is pro-cyclical (Tobin, 1970; Goldberg and Thurston, 1977; Leão 2005). By contrast, WIR Turnover is countercyclical, and our earlier VEC models (Stodder, 2009) show that WIR Turnover and Swiss money supply are negatively correlated.

If WIR Turnover is countercyclical while that of national currency is pro-cyclical, then increases in the former should be less inflationary than increases in the latter. Our estimates show that WIR is most used when ordinary money is in shortest supply – during recessions, and where it is most needed – by SMEs. So WIR Turnover is greatest when and where its inflationary potential is the least.

In addition to this non-inflationary bias, WIR activity may also ‘leverage’ far more economic activity than suggested by its small size relative to Swiss money supply. Data for 2007, the most recent available to us, show total WIR Balances of 612 million in SFr, only one-quarter of one percent of the basic Swiss money supply, M1 (IMF, 2009). Consider, however:

- The penetration of WIR into many sectors; e.g., 37 percent of all Swiss construction firms in Table 4.
- Nearly twice as many Non-Registered as Registered firms in Table 4, including, as WIR statistician Winkler (2010) notes, some that are quite well-known. The WIR activity of these large Non-Registered firms may itself not be widely-known, however, due to its non-advertised nature.
- Large Non-Registered firms show overall Turnover very close to that of smaller Registered firms in Table 4. Lemma 3 and our regressions detail a structured reciprocity between large and small firms that is fundamental to the countercyclical resiliency of WIR.
- Large Non-Registered firms have smaller average WIR balances than Registered SMEs in Table 4. This implies a higher ‘leveraging’ of Non-Registered SFr activity by WIR, as predicted in Lemma 2. Without knowing the Swiss Franc expenditures of WIR clients, precluded by Swiss bank secrecy, we cannot estimate the countercyclical ‘multiplier’ on WIR expenditures. The tiny ratio of WIR to M1, however, suggests that it is likely be far higher than conventional multiplier estimates.

Lietaer et.al. (2009) argue that complementary currencies like WIR optimize a tradeoff between efficiency and resiliency, mimicking a stable ecosystem. This contrasts with the impressive efficiency but worrisome brittleness of our overall financial system. WIR resiliency is natural in the sense that the supply of WIR-credits grows endogenously from trade, a trade that is itself countercyclical. As with a keystone species within a stable ecosystem, the systemic resiliency gained by WIR’s leverage may be greater than is suggested by its small “footprint.”

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