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Measuring the Value Added by Money in Trade

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Abstract: The paper tests the proposition that money generates value in trade. It examines the data for 5,746 Russian companies for 1997 and finds that money accounts for 24.6 percent of their value-added. The functional form of the return on money in trade is determined to be positive and marginally declining.

The paper imputes that Russian GDP lost 8.1 percent in 1997 because of diminished use of money in trade. It hypothesizes that the severity of the Great Depression in the USA of 1930s could have been significantly reduced if the proposed barter networks were implemented at the time.

JEL code: E4, N10, P34

Keywords: Money, Value-added, Empirical econometrics

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1. Introduction

The statement that the institute of money provides important services to economic agents is broadly accepted within the profession. Undergraduate textbooks on money and banking present vivid pictures of the world without money emphasizing how the need to satisfy the "double coincidence of wants" condition increases transaction costs.[1] As traders spend more time and other resources searching for customers, the volume of trade falls and cost grows. Thus the use of monetary as compared with non-monetary trade is viewed as a positive development that increases economic welfare.

General agreement that money is useful should not preclude us from attempting to measure the degree of its usefulness. A quantitative evaluation of the role played by money in trade is a necessary input that monetary authorities can take into account while contemplating the tightening of money supply.[2] Such knowledge may also be relevant to the branch of monetary theory that seeks to understand how and why money is such an important part of market transactions. Finally, economic historians may find it useful to reconsider how non-monetary trade contributed to the severity of the Great Depression in the USA of 1930s and transition economies in 1990s.[3]

This paper estimates how the use of monetary trade by firms affects the creation of value by examining cross-sectional data on 5,746 publicly traded Russian companies for 1997. The choice of the country and year is not accidental. Russia as a number of other transition economies witnessed a surge in non-monetary trade prior to the default of 1998.[4] This unique situation set a natural experiment for the investigation of properties that money exhibits in trade. Further, the use of monetary trade in Russia was lowest in 1997 implying that the variation in the use of money in trade across firms was highest. This makes econometric analysis less sensitive to other, unobserved factors.[5] The firm-

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[1] See, for example, p. 22 in Mishkin, Frederic S. (1993). *The Economics of Money, Banking and Financial Institutions*, 3rd Edition, HarperCollins Publishers, New York.

[2] Kashyap et al (1993) present evidence that tight monetary policy affects the composition of corporate finances. In a closely related paper, Oliner and Rudebusch (1996) extend this line of research showing that small firms keep less money balances and large firms – switch to non-banking sources of finance.

[3] Sam Lubelsky (New York Times, March 12, 1933) reported that up to a million of Americans were employed in fully barter-operating establishments at that time. See Keehn (1982).

[4] See Seabright (2000).

[5] By monthly data, the fraction of non-monetary in total trade was highest in August 1998. However, the default of the same month might introduce disturbances that affect firms unevenly. To make the identification problem less challenging a "calmer" year 1997 was chosen.

level data indicate that monetary trade adds value to the firm's output at a positive but declining rate.

This study does not have close predecessors. In style, it is related to the empirical research on the demand for money by firms, e.g. Mulligan (1997). In substance, the paper can be broadly associated with literature that explores the credit channel of monetary policy, e.g. Bernanke (1983). This work differs from other papers in two aspects. Unlike Mulligan (1997), it focuses on the relationship between the mode of trade and the value-added and not on the link between money holdings and output. Compared with Bernanke (1983), the paper explores a non-monetary financial phenomenon that belongs to the same group of credit-affecting factors but is not suggested in the previous work.

2. An Empirical Model of the Value-added Generated by Monetary Trade

Since the topic of this paper is of general economic interest, it is necessary to keep the number of identifying restrictions low. This stress on generality warns against building a detailed behavioral model of the choice between monetary and non-monetary trade extending, for example, the model developed in Kiyotaki and Wright (1993). The behavioral approach is definitely worth pursuing because it can shed light on other important issues, e.g. in corporate finance.[6] Yet, it does not generate additional insight for the purposes of this paper while diverts attention from the main question.

Let the value-added relative to the output produced by firm *j* (V_j) be a function of the fraction of monetary to total trade that it uses (M_j) – that we measure in percentage points $M_j \in [0,100]$ – and other firm-specific factors (Z_j)

$$V_j = f(M_j, Z_j) \qquad [1]$$

It is uncontroversial to say that a higher value of M_j results in a continuous and monotone increase in the value-added V_j on the whole interval $[0,100]$. Then, it is reasonable to assume that V_j is differentiable in M_j on the same interval. Economic theory is less certain about the relationship between M_j and Z_j. Firms take into consideration diverse factors such as their individual production technology, optimal scale of operations, or

[6] One interesting question to ask is to investigate if a higher use of non-monetary trade is compatible with the trade-off versus pecking order models of corporate finance; see Myers (1977) and Myers and Majluf (1984) respectively. Another promising venue is to study how the costs of non-monetary trade are distributed among different claimants on the value-added – owners, workers, and government.

geographic location when they choose how much money to use in trade.[7] Let us assume that M_j is related to Z_j with a continuous and monotone function $g'(M_j)$. Denoting the inverse function of $g'(M_j)$ as $g(M_j)$, equation [1] can be rewritten as

$$V = f(M, g(M)) \qquad [2]$$

where subscript j is dropped for expositional purposes. Using Taylor's formula equation [2] can be approximated as

$$V(M, g(M)) = V(0) + \frac{(V_{M_0} + g_{M_0})}{1!}M + \frac{(V_{M_0M_0} + 2V_{M_0}g_{M_0} + g_{M_0M_0})}{2!}M^2 + ... + R \quad [3]$$

where M_0 is normalized to 0. An econometric analogue of equation [3] is

$$V = \alpha + \beta_1 M + \beta_2 M^2 + ... + \varepsilon \qquad [4]$$

where error term ε can be correlated with explanatory parameters.[8]

Note that when the effect of factors Z_j on M_j and V_j is accounted for, the impact of M_j on V_j is independent from firm-specific characteristics. Therefore, as the sample size increases, the statistical estimates of the terms of *f ()* in [3] converge to their true values. Estimating and testing β's for significance is the primary exercise that this paper conducts.

3. Firm-Level Data

The firm-level data for this study were mostly obtained from the website of the Federal Committee for Security Markets of the Russian Federation.[9] In accordance with the regulations, certain Russian publicly traded companies are obliged to disclosure its extended balance sheet (forms 1 and 5), financial statement (form 2), and statement on money flows (form 4), which the author has used to build a database that eventually has comprised 5,746 companies. The choice of companies was based on the availability of data that were necessary to calculate the present value of the firm's value-added and the fraction of monetary in total trade.[10]

[7] For example, firms locked in long-term contracts – like coal mines and power plants, gas producers and distributors – are more likely to engage in mutual clearance of debts by non-monetary means.

[8] The error term ε includes the cross-products of G_M and G_{MM} with M, and M^2 that may be statistically different from 0.

[9] The website address is http://disclosure.fcsm.ru

[10] Not all companies complied with the regulations. Reports for many firms, including some largest ones, were unavailable. This fact suggests that the obtained reports were not deliberately falsified; see the

Given that Russian statistics is commonly suspected to be flawed if not deliberately distorted, a significant effort has been extorted in insuring the consistency of data. To this end, the author has checked that sums in forms 1, 2, and 4 correspond to their components (14, 4, and 2 checks respectively), entries on money holdings are identical for forms 1 and 4 (2 checks), and entries on total costs coincide for forms 2 and 5(6). Significant amount of errors have been discovered. Up to a third of firms in the total sample presented reports with typing errors. Most commonly, a person responsible for the report omitted or added a digit to an entry, which led to the wrong summation of the entries. Sometimes, the typist attempted to balance books *ad hoc* being obviously unaware of the error. Such inconsistencies were uncovered and corrected. The other crosscheck of documents has revealed about 60 reports that combined forms 1 and 4 prepared for different years. These firms have been deleted from the sample. A deliberate misrepresentation of results was found in few separate instances.[11] They were not considered in this study. The most troubling was the finding that 129 firms received more cash in payment for goods and services, entry 4(30), than they reportedly sold, entry 2(10). A closer look on industrial affiliation of this group has revealed that it consisted of enterprises in sectors commonly suspected of participating in informal activities such as distilleries and traders. These enterprises were left in the sample but to avoid the problems created by outliers, the author imposed low and upper bounds on the parameters of interest.[12] It is worth noting that most of errors and misrepresentations could be corrected or, at least, flagged. This conclusion indicates that a massive and consistent distortion of actual accounting information was challenging undertaking for the great majority of enterprises present in the sample.[13]

Two variables of interest have been constructed using primary accounting information. The present value of the value-added $PV(V_j)$ at producer prices has been

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discussion below. Dishonest managers could always choose not to report than to get engaged in expensive matching of false statements in a consistent way.

[11] For example, an identical report was submitted for 5 different companies registered on two addresses in Moscow.

[12] The value-added as a percentage fraction of revenue has been limited to the interval [-100,100] and the fraction of monetary to total trade – [0,100].

[13] The easiest way to conceal actual information from outsiders like the author would be to ignore the requirement to disclose information. This is what many companies did in 1997. Consequently, they were not included in the sample.

found as the percentage difference between the present value of total revenue $PV(Y_j)$ and the present value of the costs of intermediate inputs $PV(C_j^m)$ and normalized by $PV(Y_j)$

$$\frac{PV(V_j)}{PV(Y_j)} = (1 - \frac{PV(C_j^m)}{PV(Y_j)}) \times 100 = (1 - \sum_{t=1}^{12} \left(\frac{C_j^m(t)}{p_j^m(t+\nu_j)} \right) / \sum_{t=1}^{12} \left(\frac{Y_j(t)}{p_j(t+\tau_j)} \right) \times 100 \qquad [5]$$

where $Y_j(t)$ and $C_j^m(t)$ are imputed revenue and intermediate costs for month t, $p_j(t)$ and $p^m{}_j(t)$ are changes in prices of output and intermediate costs for month t, and τ_j and ν_j are the average duration of the grace period in months granted to consumers and received from suppliers if any.[14]

The percentage fraction of monetary to total trade cannot be determined on the basis of accounting information unless two simplifying assumptions are made. It has been assumed in the paper that the dynamics of payments and deliveries did not change in two adjacent years. The problem is that monetary receipts or advance payments are reported on historical basis. As such the amount of money received in 1997 includes payment for deliveries that took place in 1996 and exclude payments for deliveries of 1997 that were received in 1998. Similarly, advance payments made in 1996 for deliveries of 1997 are not reported in the statement on money flow for 1997. The assumption of unchanged dynamics allows approximating the value of payment made in 1998 for deliveries of 1997 with the value of payment made in 1997 for deliveries of 1996. The same argument applies to the value of advance payments. Then, the value of monetary receipts for deliveries made in 1997 becomes equal to the sum of advance payments and payments for goods and services received in the same year. Their percentage fraction in total sales is the value of monetary receipts for 1997 divided by the total revenue of 1997 and multiplied by factor 100

$$M_j = \frac{AdvancePayment_j + MonetaryPayment_j}{Revenue_j} \times 100 \qquad [6]$$

A scatter plot of both parameters is presented on Figure 1.

[14] If prepayment was required τ and ν become negative. Complete formulas for transformation of original data are presented in Appendix A.
The use of present values instead of values at current prices is explained by large variations across firms in their stocks of receivables or payables. Stocks accumulated exactly because firms' customers or firms did not have money to complete transactions promptly. This loss in value because of waiting is relevant to the question that we study, namely what is the value that money generates in trade.

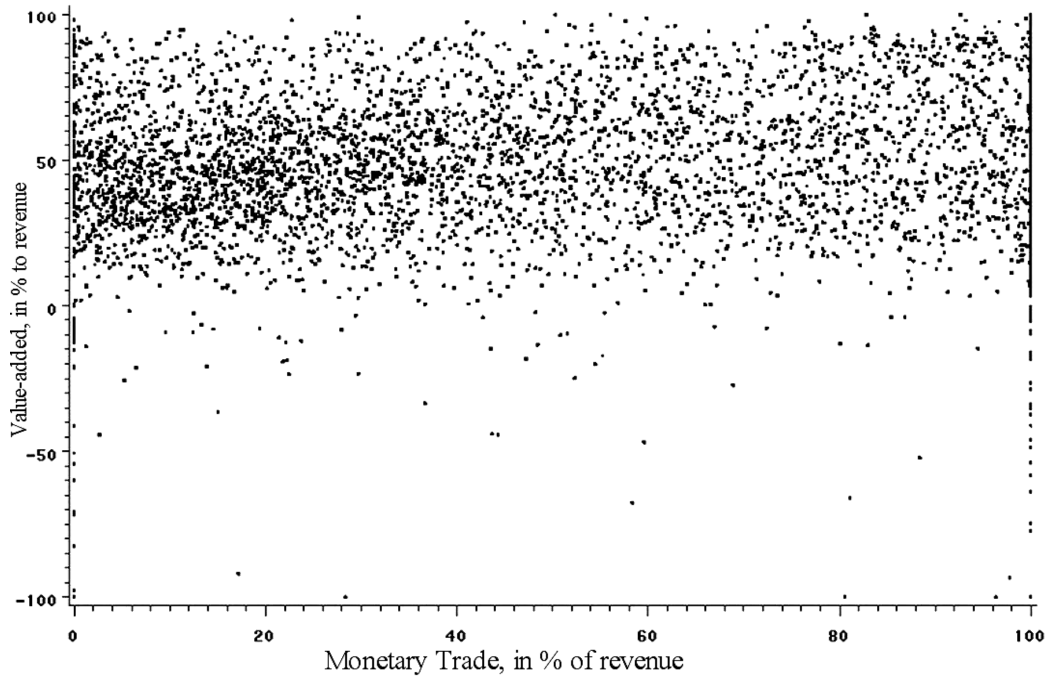

Figure 1: Scatter plot of the value-added and the fraction of monetary to total trade, in percent. Sources: Author's dataset

4. Estimates of the Value Added by Money in Trade

The empirical part focuses on the estimation of the functional relationship between the value-added and the fraction of monetary to total trade; see equation [4]. We begin with ordinary least squares (OLS) estimates under the assumption that the polynomial form of [4] is unknown. Column 2 of Table 1 presents the obtained results that we discuss next.

First, the regression suggests the quadratic form of the polynomial function $f()$. The inclusion of explanatory variables of a higher power than two generates statistically insignificant coefficients. This result makes sense from the theoretic point of view. It is generally accepted that the return on inputs in the production function is positive and diminishes as the relative consumption of the input increases. There is no rationale to expect that the use of money in transactions does not exhibit a similar pattern.

Second, tests for heteroskedasticity strongly reject the hypothesis of homoskedastic errors. This result is not unexpected given our previous note of a potential correlation between explanatory variable M_j and the vector of omitted firm-specific parameters Z_j.[15] To correct for heteroskedasticity, we employ weighed least squares (WLS) regression, the results of which are reported in column 3 of Table 1.[16]

	OLS	WLS
Intercept	**41.032**	**41.895**
MT	**0.268**	**0.237**
t-stat	(6.03)	(5.16)
MT2	**-0.0013**	*-0.00103*
t-stat	(-3.21)	(-2.55)
R^2	0.0326	0.0295
N	5,746	5,746
White statistics	172.4	6.67
Breusch-Pagan statistics [a]	78.44	1.81

Table 1: Regression of quadratic form of equation [4]. Results significant at 1% are in bold, at 5% - in italics. Sources: Author's calculations using SAS software

[a] With intercept, MT, and MT2 as explanatory variables.

The correction for heteroskedastic errors does not change our previous analysis in important ways. The WLS regression results indicate that the likeliest functional form of *f ()* is still quadratic.[17] The magnitude and the sign of coefficients stay the same. The tests of their statistical significance strongly reject the hypothesis that they are equal to zero.

Finally, we construct confidence intervals for the estimates obtained by WLS regression using nonparametric method of local maximum likelihood (LOESS).[18]

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[15] See the derivation of equation [2].

[16] The author has used the WLS regression technique as explained in Greene (1990, p. 405-6). The main problem in WLS is to find appropriate weights. This is done by regressing squared residuals obtained by OLS regression on explanatory variables. In this case, the weights were obtained by regressing residuals on MT of up to 4^{th} power. The reason for inclusion of additional terms is that the distribution of observations is bimodal and cannot be replicated by a quadratic function; see Figure 3 below.

[17] That is the estimates of coefficients of higher power are insignificant.

[18] The author has used procedure LOESS of SAS software, which stands for 'local regression'. The main task in the procedure is to find a suitable smoothing parameter that determines the limits of localities, which are included in local regression. The author has relied on Akaike Information Criterion choosing the value of smoothing parameter 1.3. Unfortunately, LOESS requires building and manipulating with a covariance matrix, of size 5747×5747 in our case, to construct the confidence interval, which is impractical

Nonparametric methods are preferable in this case because no assumptions about the parametric form of the regression can be made *a priori*. Figure 2 plots the estimates that are obtained with WLS and LOESS regressions and shows the 95% confidence interval.

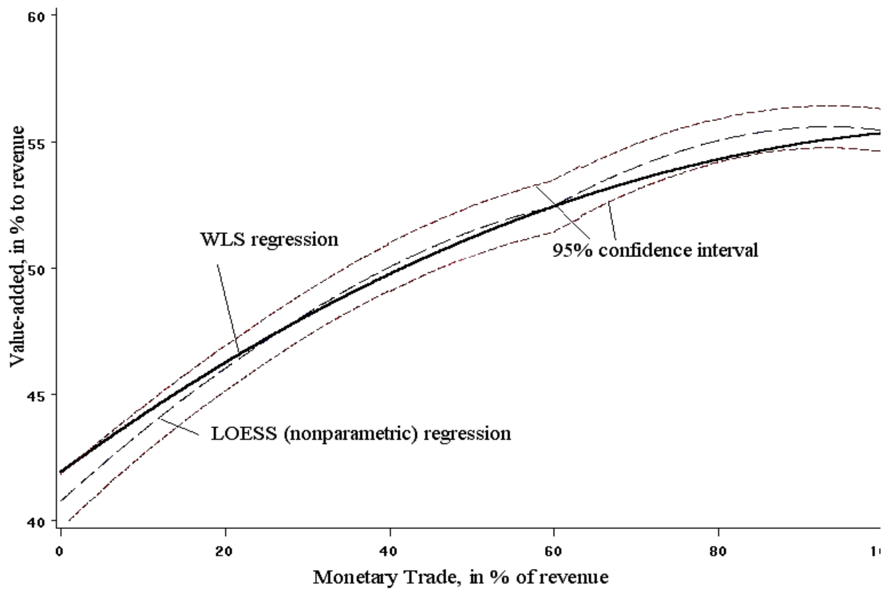

Figure 2: Estimates of the quadratic form of equation [4]. Sources: Author's calculations using SAS software

Nonparametric estimation shows that WLS estimate of the quadratic form of equation [4] lies within 95% confidence bounds. This result supports our previous conclusion that the use of money in trade exhibits positive and diminishing return in terms of adding value.

5. Testing for Stability of the Coefficients

In section 4 we have derived and tested for stability the functional form of equation [4]. Here we estimate how omitted parameters, such as the firm's industrial affiliation, its geographic location, and size can affect the impact that the use of money in trade makes on the value-added. It may be significant because firms presented in the

at the moment. The author has followed Yatchew (1998, Fig. 7) constructing the confidence interval asymptotically. An accessible introduction to LOESS is available at http://www.ats.ucla.edu/stat/sas/library/loesssugi.pdf.

sample compose at least two distinct groups in the use of money in trade as the graph of their joint probability density function shows; see Figure 3.[19]

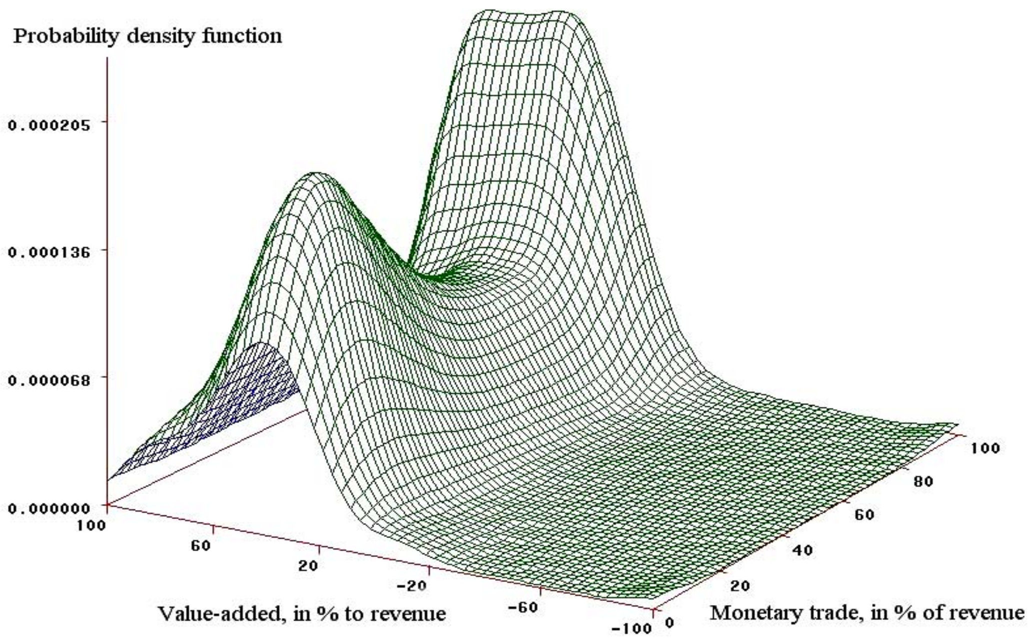

Figure 3: Estimated joint probability density function of (*M, V*) found using kernel density estimate with the bandwidth $M = 1.4$, $V = 1.4$. Sources: Author's calculations using SAS software.

To this end we run WLS regression for sub-samples of firms that possess similar characteristics.[20] The obtained results are presented in Table 2.

The findings presented in Table 2 lead to several conclusions. First, we see that the sampling size matters, which is unsurprising. Money plays a secondary role in generating value and as the sample is subdivided into groups the relationship between money and the value-added becomes obscured. This observation warns against mechanic extrapolation of the obtained results. Our estimates of the effects that non-monetary trade made on GDP historically – see the next section – should be treated with reservation. Yet,

[19] Values for figure 3 have been obtained using KDE, which stands for 'kernel density estimator', procedure of SAS software. The bandwidth parameter is 1.4 that was the smallest parameter that generated smooth surface. Figure 3 is drawn with procedure G3d. An accessible introduction to KDE and G3d can be found at www.cpcug.org/user/sigstat/PowerPointSlides/kde.ppt

		OLS or WLS	Average MT, %	MT	(t-stat)	MT2	(t-stat)	R^2	Sample size
	Industrial affiliation								
1	Machine building	WLS	46.144	**0.354**	(4.06)	**-0.003**	(-3.19)	0.025	1,039
2	Food processing	OLS	70.976	-0.053	(-0.62)	0.001	(1.65)	0.036	667
3	Other manufacturing and mining	WLS	44.516	**0.185**	(2.76)	-0.001	(-1.64)	0.019	1,452
4	Agriculture	OLS	55.844	-0.267	(-0.97)	0.002	(0.94)	0.004	246
5	Transportation and communication	WLS	73.247	**0.617**	(3.26)	*-0.004*	(-2.68)	0.041	477
6	Construction	WLS	53.429	*0.294*	(2.49)	-0.001	(-0.76)	0.090	617
7	Trade and business services	WLS	74.621	*0.431*	(2.36)	-0.002	(-1.72)	0.014	920
8	Science and earth exploration	WLS	73.008	0.181	(0.77)	-0.001	(-0.82)	0.002	328
	Geographic location								
9	Moscow and region	WLS	79.374	*0.395*	(2.10)	-0.002	(-1.24)	0.026	986
10	Saint Petersburg and region	WLS	73.761	0.029	(0.11)	0.000	(0.21)	0.010	313
11	North and Center	WLS	54.307	0.098	(0.72)	0.000	(0.15)	0.031	550
12	'Black Earth' regions	WLS	56.479	0.236	(1.94)	-0.001	(-0.92)	0.032	862
13	Central Volga	WLS	47.205	**0.254**	(2.78)	-0.001	(-1.68)	0.023	1,016
14	South	WLS	59.551	0.117	(0.78)	0.000	(0.23)	0.046	511
15	Ural	OLS	45.635	0.132	(0.91)	-0.000	(-0.21)	0.029	328
16	Western Siberia	WLS	46.710	*0.302*	(2.27)	-0.002	(-1.36)	0.030	599
17	Central Siberia and Pacific	WLS	56.660	**0.470**	(3.31)	*-0.003*	(-2.48)	0.037	581
	Scale of operation (revenue)								
18	Large (> 60,000 mil Ruble)	WLS	51.905	*0.131*	(2.25)	-0.000	(-0.51)	0.030	1,838
19	Medium (10,000-59,999 mil Ruble)	WLS	57.943	0.054	(0.86)	0.000	(0.45)	0.017	2,096
20	Small (< 10,000 mil Ruble)	WLS	64.741	**0.481**	(4.30)	**-0.003**	(-3.23)	0.024	1,812

Table 2: OLS or WLS if tests reject the hypothesis of homoskedastic errors regressions for sub-samples. Results significant at 1% are in bold, at 5% - in italics.

Sources: Author's calculations using SAS software. Appendix B contains descriptors of the aggregates for industrial affiliation and geographic location

the estimates built on smaller samples generally preserve the upward slope of the regression line implying that the finding that money generates value in trade is robust. Second, the grouping of significant results shows that the industrial affiliation is one of

[20] We use the same econometric techniques as described above to obtain the results of Table 2.

the main omitted factors that affect the relationship between money and value-added. This finding is uncontroversial. Industries vary in relative capital and labor intensity and the effectiveness of the use of money may be unevenly correlated with each of them: e.g. owners receive the return on capital in form of shares and other non-monetary means more often than workers do. Third, the use of money in trade is more valuable in situations where the maintenance of trust is costly or, reinterpreting Williamson (1989), where money saves on transactions costs when contracts are incomplete or not fully enforceable. As an example, the sector of machine building requires a larger degree of cooperation, or coordination along the technological chain, than the sector of food processing where the problem of opportunistic behavior is less severe because intermediate products are easier to convert for alternative use. Thus, if enterprises in the former sector employ money in trade more effectively, they see a larger increase in total productivity that food producers do. This argument is supported by the finding that money is the most valuable in trade for small firms. Small firms usually have few customers or suppliers and they are most vulnerable to their opportunistic behavior. In this respect the present work is consistent with finding by Kashyap et al (1993) and Oliner and Rudebusch (1996) who report that small firms contract more in time of tight monetary policy than large companies do.[21]

6. The Role Played and Not Played by Money in Two Great Depressions: Russia of 1990s and the USA of 1930s

The preceding analysis enables us to address the question of how detrimental or useful non-monetary trade can be for GDP. The situation in which Russia found itself in 1990s is particularly relevant. According to GKS (2000, Table 2.19) Russian GDP of 1997 amounted to 63.7% of GDP in 1991. At the same time the fraction of monetary trade for industrial establishments fell from 92% in February 1992 to 53% in December

[21] Non-linearity of responses to the use of money in trade that firms of different size exhibit is an interesting finding. The result that the largest firms receive more value from the use of money than medium companies do is consistent with the proposition advanced independently by two researchers. Humphrey (2000) notes that large Russian companies serve as clearing houses for their smaller clients. As such they receive a return on monetary credit extended to cash-constrained customers. Kashyap and Stein (1994) suggest that an increase in the fraction of commercial papers in total external finance in the USA flags the shift of external financing from banks to large producers who increase the volume of trade credit extended

1997.[22] Can it be that the growth of less efficient non-monetary trade is partially responsible for decline in GDP?

To answer this question we impute losses associated with non-monetary trade for 23 economic sectors that appear in the input-output table for 1997.[23] Since almost every sector of the table is represented in our sample – government being a notable exemption – the function of the value-added with the fraction of monetary trade as its argument can be estimated using WLS regression for equation [4] for each of them. The obtained formulas are used to forecast the amount of the value-added that the sectors would generate if they traded only with money. These forecasts are compared with the average of the value-added found for sub-samples and their ratio is applied to the sectoral value-added as reported in the input-output table to arrive at the imputed estimates of the value-added when all trade is monetary. Mathematically, we calculate the forecasted value-added for each sector, including the low and upper bounds, as

$$\widetilde{V}_{L,U} = \frac{\hat{V} \pm t_{\lambda/2} se(\hat{V})}{\overline{V}} \times GDP \qquad [7]$$

where $\widetilde{V}_{L,U}$ is the forecast confidence interval for V; $\hat{V}$ is the predicted amount of the value-added if all trade is monetary ($M = 100$) and $se(\hat{V})$ is its standard error; $\overline{V}$ is the average value-added for the sub-sample, $t_{\lambda/2}$ is t-statistics with λ determining the power of the test, and *GDP* is the amount of the sectoral value-added taken from the input-output table. The results of calculations are presented in Table 3.

Comparing the sums of columns 2 and 3 of Table 3 we see that if Russian companies traded only with money in 1997, the expected increase in GDP, at producer prices, would amount to 8.1 percent. This finding indicates that the decline in monetary trade significantly contributed to the severity of the Russian depression of 1990s. This conclusion partially explains why the economy rebounded so quickly after the default of August 1998. As monetary trade became more widespread, it brought about gains that were caught and reported in general statistics.

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to their customers. In both cases a higher return on money that the largest companies receive is explained by their financial activity, which is unrelated to production.

[22] According to the monthly survey conducted by the Russian Economic Barometer, which is available at http://www.imemo.ru/eng/barom/survey.htm, Table 18.

[23] See Ivanenko (2001) for the derivation of the table.

		GDP: I/O table	Imputed value-added (average $\widetilde{V}_{L,U}$)	$\widetilde{V}_L$: 95% confidence interval	$\widetilde{V}_U$: 95% confidence interval
1	Electricity	102,471	148,316	127,955	168,678
2	Oil and gas extraction and processing	146,487	159,130	137,574	180,686
3	Coal and other fuels mining	20,658	21,997	17,696	26,299
4	Iron and steel	32,474	34,793	28,944	40,642
5	Non-ferrous metallurgy	43,123	45,812	34,180	57,444
6	Chemical and petrochemical	26,925	30,541	27,694	33,388
7	Machine building and metal processing	124,254	129,200	122,843	135,556
8	Wood and paper	21,018	20,171	17,994	22,349
9	Construction materials	28,695	31,610	29,342	33,878
10	Textile, apparel, and footwear	12,399	13,617	12,669	14,564
11	Food processing	83,103	90,495	83,728	97,262
12	Other manufacturing	17,781	18,338	16,072	20,604
13	Construction	179,200	204,887	195,589	214,184
14	Agriculture and forestry	149,269	153,088	123,888	182,288
15	Transportation services	233,421	236,720	221,987	251,453
16	Communications	44,213	45,731	31,118	60,343
17	Trade, intermediation, and food services	494,837	504,066	449,402	558,730
18	Other activities related to production of goods and services	19,667	18,912	14,762	23,063
19	Residential, communal, and household services	133,620	172,789	133,241	212,337
20	Health, education, and culture	191,707	186,723	120,970	252,477
21	Science, geology, and meteorology	28,543	29,745	27,468	32,021
22	Finance, credit, and insurance	16,493	17,182	14,439	19,925
23	State and business management and NGO	157,858	181,071	175,586	186,556
	Memo: Total (in billion of Rubles)	**2,308,216**	**2,494,933**	**2,165,138**	**2,824,728**

Table 3: Actual and imputed value-added at producer prices under the condition of all monetary trade, in billion of Rubles. Sources: column 2 is from the input-output table for 1997, see Ivanenko (2001); column 3 – the predicted amount of the value-added (V hat); columns 4 and 5 – low and upper bounds ($V_{L,\,U}$ *tilde*), author's calculations

While the application of the obtained results to the Russian situation of 1990s is straightforward, the relevance of the suggested relationship between money and the value-added to other historical instances is questionable. Certainly, the Russian depression of 1990s differs in significant ways from the Great Depression of 1930s. One important and unobserved parameter is the state of financial technology. We have estimated that trading without money reduces the value-added by 24.3 percent; see column 3 of Table 1. This number is dependent on financial innovations. For example, an introduction of a new system of mutual debt clearance reduces the demand for money to serve the same number of transactions, as the operation of inter-banking clearance centers show.[24] Another parameter that has obviously changed in time is the average size of the firm. We have found that small firms are more dependent on money in trade than large companies; see the last three rows in Table 2. Though Berle and Means noticed the growth of large American corporations in 1930s,[25] the average size of Russian companies was larger in 1990s compared with the size of Americans firms in 1930s.

With these warnings in mind, let us hypothesize how the use of non-monetary trade would affect the American GDP in 1933 if it was widely practiced. This proposition would not sound strange to America of 1930s.[26] Barter exchanges operated in a number of states and were at least contemplated nationwide. New York Times reported on March 12, 1933 that up to a million of Americans learned how to live without money. A Democratic Party nominee for Governor of California in 1934 and famous novelist Upton Sinclair based his unsuccessful election platform, End Poverty in California, on the premises that trade without money should be publicly promoted. Federal Emergency Relief Act of 1933 contained a provision that authorized the making of federal aid grants to ‘self-help associations for the barter of goods and services’.

[24] In limit, as the tracking of trade deals becomes all-embracing, money services become worthless as the work by Kocherlakota (1998) shows. Yet, with respect to financial innovations, Russian financial system was rather similar to the American system of 1930s. Its inter-banking clearance centers operated manually and severe delays in the processing of checks in 1992-4 were the reason for numerous complaints.

[25] See Berle, Adolf A. Jr. and Gardiner C. Means. *The Modern Corporation and Private Property*, The Macmillan company, New York, 1933

[26] The information related to American experience with barter or, more generally, non-monetary trade that is presented further has been taken from Keehn (1982).

Yet, trade without money did not take roots during that time. Assuming that 2 percent of the labor force – which is what one million barter users meant in 1933 – is representative of the scale of non-monetary operations in the USA in1933, our estimates show that it accounted for mere 1.5 percent share in total GDP.[27] This amount is insignificant in comparison with 45.9 percent drop in GDP that took place between 1929 ad 1933.[28] The miniscule share of barter in total sales apparently explains why economic historians ignored this phenomenon. However, if the proposition to sponsor non-monetary trade by the state that was advocated by Upton Sinclair would be implemented it resulted in quite substantial economic gains.

Let us consider what would happen if 24.9 percent of the labor force reported to be unemployed in 1933 started to work on public script or other form of compensation unrelated to money. Assuming that their idleness was responsible for total decline in GDP, their work in the non-monetary sector would restore up to 34.8 percent of GDP. This would reduce the scale of the Great Depression to 11.3 percent.[29] Thus, in the retrospect, Upton Sinclair and his followers might not be communist conspirators as many their contemporaries believed but thinkers whose time was yet to come.[30]

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[27] From column 3 of Table 1: $\Delta V = 2 \times \frac{41.895}{(41.895 + 0.237 \times 100 - 0.00103 \times 10000)} \approx 1.515\,\%$

[28] GDP is taken from Table 1.1 of the Bureau of Economic Analysis, available at http://www.bea.gov/bea/dn/nipaweb/TableViewFixed.asp#Mid

[29] From column 3 of Table 1: $\Delta V = 45.9 \times \frac{41.895}{(41.895 + 0.237 \times 100 - 0.00103 \times 10000)} \approx 34.777\,\%$

[30] Certainly, the above calculations merely highlight potential magnitude of the effect that non-monetary trade would make on American GDP of 1930s but cannot serve as a basis for judgment of particular policies that were implemented during that period.

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Appendix A: Deriving the Estimates of the Value-added and the Fraction of Monetary Trade

The following original data have been used in derivation of the value-added. The annual costs of intermediate inputs $C^{m}{}_{j}\,(t)$ have been found as the fraction of material costs reported in form 5, entry 610 – referred to as 5(610) in what follows – plus 0.1 times the fraction of other costs 5(650) divided by total costs 5(660) and multiplied by total operational costs 2(20+30+40). The item “other costs” includes payments for outside business services such as communication and information technologies, which should be added to the costs of intermediate inputs. Unfortunately, they also comprise the value of several taxes levied on businesses, such as property tax, which is a part of the value-added. The choice of factor 0.1 is somewhat arbitrary representing the author’s judgement of what the fraction of the costs of business services compared with other costs is. The use of operational costs reported in form 2 instead of total costs reported in 5(660) is justified on the grounds that form 2 reports costs related to present sales whereas form 5 reports historical costs. To arrive at monthly costs, annual costs were divided in 12 equal parts, which amounts to the assumption of linear consumption of intermediate products. Monthly revenue $Y_j\,(t)$ comes from 2(10) divided by 12.

The present value of the both parameters is found by discounting their imputed monthly values with price level $p\,(t)$. $Y_j\,(t)$ has been discounted using normalized (January index is equal to 1) price indices $p_j\,(t)$ reported for a number of industries. In total 20 monthly price series have been used: 18 PPI series for manufacturing sectors, agriculture, construction, transportation, and communication; and 2 CPI series for trade and residential services. The series for 1997 have been taken from the database constructed by Russian Economic Trends.[31] They are series 362, 367, 369, 372-4, 377, 380, 384, 386-96. Cost prices have been averaged using the multiplication of the transposed matrix of intermediate costs **A** from the input-output table for 1997, reported in Ivanenko (2001), by the vector of price indices for corresponding entries **p (t)** for month *t*

$$\mathbf{p^m(t)} = \mathbf{A}^T \circ \mathbf{p(t)} \qquad \text{[A1]}$$

[31] The database is available at http://www.recep.org/ret/retdb.htm

The grace period for receivables τ_j has been found as the difference between the averaged stocks of receivables 1(231-3 and 241-3) and advance payments 1(627) at the beginning and end of the year divided by total revenue 2(10) times 12. The grace period for payables ν_j is the difference between the averaged stocks of payables 1(621-3) and advance payments 1(234 and 245) divided by annual costs of intermediate inputs $C^m{}_j\,(t)$, defined above, times 12.

The percentage fraction of monetary to total trade is the sum of advance payments 4(50) and payments for goods and services 4(30) divided by total value of deliveries 2(10) and multiplied by factor 100. One adjustment has been made when the assumption of unchanged dynamics of receivables is violated. Some firms report growth or fall in receivables that cannot be extrapolated in 1996 or 1998 without moving into negative territory. To impose the non-negativity constraint, the sum of receivables for adjacent years has been approximated by the sum of receivables at the beginning or the end of the year respectively. Then, the fraction of imputed present or future monetary revenue paid for former or present deliveries has been increased or decreased by a corresponding amount. This adjustment has amounted to the modification of the assumption of permanent dynamics in receivables by introducing bounds on their values.

Appendix B: Notation to Table 2

Russia uses the Soviet industrial classification system OKONKh that is not fully compatible with American SIC or NAICS. OKONKh combines manufacturing with mining into industrial group, which is the main difference. Table 2 considers the following groups:

- machine building and metal processing outside of foundries (groups 14000-999);
- food and grain processing (groups 18000-300 and 19200-20);
- other industries including electric generation and transmission (groups 11000-13999, 15100-17999, 19110-30, and 19310-19790);
- agriculture and forest maintenance (groups 21100-32000);
- transportation and communication (groups 51000-52300);
- construction (groups 61000-69000);

- trade, business, and residential services (groups 71000-81200, 83000-84500, 90100-310, and 96000-97950);
- science, earth exploration, health, education, and culture (groups 82000, 85000-87900, 91500-95400);

The division along geographic lines has been chosen without an external reference. The sample has been divided as to roughly equate the size of sub-samples. The exact geographic location of national republics, *krai* and *oblast* are as following

- **Moscow** and Moscow *oblast*;
- **Saint Petersburg** and Leningradskaya *oblast*;
- **North and Center**: Republics of Kareliya and Komi, Arkhangel'skaya, Bryanskaya, Vladimirskaya, Vologodskaya, Murmanskaya, Novgorodskaya, Pskovskaya, Tverskaya, and Yaroslavskaya *oblast*;
- **'Black Earth'**: Republic of Kalmykya, Astrakhanskaya, Belgorodskaya, Volgogradskaya, Voronezhskaya, Kaluzhskaya, Kurskaya, Lipetskaya, Orlovskaya, Penzenskaya, Ryazanskaya, Samarskaya, Saratovskaya, Tambovskaya, Tul'skaya, and Ulyanovskaya *oblast*;
- **Central Volga**: Republics of Bashkortostan, Mari El, Mordoviya, Tatarstan, Udmurtiya, and Chuvashiya, Ivanovskaya, Kirovskaya, Kostromskaya, and Nizhegorodskaya *oblast*;
- **Ural**: Orenburgskaya, Permskaya, Sverdlovskaya, and Chelyabinskaya *oblast*;
- South: Republics of Adygeiya, Dagestan, Kabardino-Balkariya, Karachaevo-Cherkessiya, Krasnodarskii and Stavropol'skii *krai*, and Rostovskaya *oblast*;
- **Western Siberia**: Altaiskii *krai*, Kemerovskaya, Kurganskaya, Novosibirskaya, Omskaya, Tomskaya, and Tyumenskaya *oblast*;
- **Central Siberia and Pacific**: Republics of Buryatiya, Khakassiya, and Yakutiya, Krasnoyarskii, Primorskii and Khabarovskii *krai*, Amurskaya, Evreiskaya, Irkutskaya, Kamchatskaya, Magadanskaya, Sakhalinskaya, and Chitinskaya *oblast*.

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