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Business Cycle in Czechoslovakia Under Central Planning: Were Credit Shocks Causing It?

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Abstract

This paper examines credit origins of the business cycle in the former Czechoslovakia. Industrial production is found to be cointegrated with various measures of bank credit during 1976-90 and it is shown that noninvestment credits are Granger-causing industrial production and that a feedback relation exists between investment credits and industrial production. Although the potency of credit supply shocks to industrial production has been changing, production decline (growth) seems to follow credit tightening (loosening). However, the paper confirms that credit shocks were only a minor part of the output decline in 1989-90.

JEL Classification Numbers:
P21, E52

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Contents

Summary

This paper examines the effect of credit policies on industrial output fluctuations in the former Czechoslovakia. To justify the existence of the so-called credit view of the business cycle, assumptions of credit endogeneity and neutrality under central planning are revisited. Even prior to the economic reform launched in 1990-91, the Czechoslovak Monobank was able to regulate the credit supply and its credit policy changes were neither fully nor automatically offset by fiscal transfers, changes in prices, arrears, and the like.

Using quarterly data for 1976-90, the paper employs cointegration and vector autoregression techniques to establish long-term relationships and directions of Granger causality between various measures of monobank credits and industrial output.

The results confirm the contribution of credit shocks to the business cycle, especially during 1985-90. Different measures of credit to the economy and industrial production are cointegrated; moreover, noninvestment credits are weakly exogenous with respect to industrial output. It is found that noninvestment and total credits are Granger-causing industrial production and that industrial production is Granger-causing investment credits. However, the impact of credit shocks is short-lived.

Even though the potency of credit supply effects changed over time, the paper's results support the hypothesis that the initial squeeze in (real) credit supply in 1990 (and perhaps beyond 1990) might have contributed to the decline in (real) industrial output. In 1989-90, however, the total impact of the credit shock was relatively small. The paper concludes, based on the past credit-output responses, that the production decline in 1990-92 was likely generated and propagated through some other, noncredit, mechanisms.

I. Introduction

This paper attempts to provide some new evidence on the issue of the credit origins of the business cycle and, ultimately, production decline in the former Czechoslovakia. In the late 1970s and in the 1980s the Czechoslovak Monobank was able to regulate the credit supply and its credit policy changes were not fully or automatically offset by fiscal transfers, changes in prices, arrears, and the like. The evidence shows that different measures of credit to the economy and industrial production are cointegrated.

A relatively strong Granger causality is found to exist between bank credits and industrial production. It is shown that noninvestment and total credits are Granger-causing industrial production and that a feedback relation exists between investment credits and industrial production. In other words, credit shocks were generating a business cycle. Although the potency of credit supply effects changed over the period of 1976-90, production decline (growth) seems to follow credit tightening (loosening). Our results support the hypothesis that the initial squeeze in real credit supply in 1990 (and perhaps beyond 1990) might have contributed to the decline in industrial production. However, the total impact was relatively small and the production decline was likely generated and propagated through other mechanisms and hence we refrain from estimating an explicit credit-based production function.

The paper is organized as follows. First, the economic institutions of the former Czechoslovakia are reviewed and links between the real and the monetary economy are outlined. Second, cointegration between bank credits and industrial production is tested. Third, the tests of Granger causality and exogeneity for bank credits and industrial production in bivariate vector autoregressions (VAR) are presented. Finally, conclusions are drawn.

II. A Note on the Credit View

1. Two preconditions of the credit view

The role of credits in the production decline at the outset of economic transition has been actively debated. 1/ Most notably, Calvo and Coricelli (1993) and Calvo and Kumar (1994) noted that if the supply of credits is cut too abruptly, severe output losses may result. 2/ The essence of this hypothesis is that bank lending does not have perfect substitutes and that firms face cash-in-advance constraints to pay for labor

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1/ It should be noted, however, that in the former Czechoslovakia the production decline (or, at least, a deceleration of the rate of growth) began long before the demise of the socialist system in November 1989. The output decline in 1990-93 was most likely overestimated in a fashion similar to the other former socialist countries; see Gavrilenkov and Koen (1995).

2/ For a review of the so-called credit view, see Bernanke and Blinder (1988), Bernanke (1993), and Alexander and Caramazza (1994); for the relation between the financial structure and aggregate economic activity, see Gertler (1988).

and other intermediate inputs. The underlying production function, which we will be implicitly using, is that of Calvo and Kumar (1994).

In order to accept the credit view for a socialist economy, one has to revisit two traditional presumptions concerning command systems: first, credits were endogenous, meaning that the Monobank was unable to manipulate the supply of credits, which was production driven; and second, the fiscal system and the direct allocation of inputs fully insulated individual firms from monetary shocks, that is, the assumption of a "credit superneutrality." These presumptions effectively exclude credit shocks as a propagation mechanism of the business cycle under central planning. 1/

While in Bulíř (1995) we show that in the late 1970s and 1980s the Czechoslovak Monobank was able to regulate the overall credit supply, 2/ in this paper we revisit the presumption of credit superneutrality. In the period under consideration, and especially from the early 1980s, credit policy changes could not be easily reversed because of fundamental changes in macroeconomic policy design. 3/ Although some of the design changes were policymakers' choices, some of them represented the Monobank's newly acquired awareness about the inflationary consequences of its actions.

2. The role of credit in Czechoslovakia

Credit changes are certainly one of the lesser known mechanisms generating business cycles under central planning. While the main reason for the output collapse in the early stages of the transition can likely be found in the real economy, 4/ the credit squeeze might have further aggravated the collapse. Credit tightening in 1987-88 and the imposition of strict ceilings on total commercial bank lending in 1990 5/ led to a vacuum in the credit markets that could not be filled immediately by non-bank institutions and trade credits, given the lack of information, legal framework, and institutions needed for a private financial market to exist.

1/ On the issue of a business cycle under central planning, see Kýn, Schrettl, and Sláma (1978) or Ickes (1990).

2/ However, its control over certain types of credits, mostly investment ones, was more limited. See Instructions ... (1981), which details the process of monetary planning in the former Czechoslovakia.

3/ We do not rule out, however, credit neutrality in the period preceding the 1980s or in the period preceding our sample.

4/ The literature highlighted the following real shocks: the simultaneous collapse of the Council for Mutual Economic Assistance (CMEA) and of the Warsaw Pact military procurement, redirecting the use of capital from its value-subtracting planning targets to market utilization, and major changes in consumer demand, most notably from domestically produced goods to imports. See Aghevli, Borensztein, and van der Willigen (1992), Borensztein, Demekas, and Ostry (1993), Banerjee (1995), and Fischer, Sahay, and Végh (1996) for empirical analyses.

5/ The State Bank of Czechoslovakia (SBCS) was split in January 1990 into several state-owned commercial banks and the central bank.

Even in the pre-reform period, credit had almost no substitutes. In contrast to market economies, reinvestment of profits was practically non-existent, owing to insignificant after-tax profits: profit taxes were levied at ad hoc rates varying between 70 percent and 95 percent. Furthermore, enterprise deposits were largely insensitive to developments in the supply of credits. During 1981-83, when credit growth declined sharply, those deposits actually increased as a percentage both of credits and of the net material product (NMP). During the second period of credit tightening, in 1987-88, deposits initially decreased, but bounced back in the second year. Moreover, state subsidies to enterprises were cut in the 1980s as well and payment arrears were only imperfect substitutes for bank credits. 1/ Assuming that the productivity of most enterprises could not improve immediately after the collapse of the old system, that is, before the full-scale restructuring and privatization--then the sharp decline of real credit might have hampered output.

Credit policies in the former Czechoslovakia were far from the textbook command economy where "money does not matter," (see Grossman 1990). 2/ While construction and financing of major fixed capital ventures--such as CMEA investment projects, nuclear power plants, and the like--were still decided by the Planning Authority, short-term industrial growth prospects depended on the inflow of new noninvestment and investment capital into the industrial sector. The Monobank was subject to quantitative targets on noninvestment credits and decisions about the allocation of those credits were left increasingly in the Monobank's hands. However, the allocation of investment credits, or more generally of investment financing, remained mostly in the hands of the Planning Authority.

Noninvestment credits were used for financing inventories, wages, intermediate production, and the like, for which markets were in place. In other words, those credits were mainly servicing short-term needs of the supply side of the economy. From the early 1980s, the granting of noninvestment credits was at the discretion of the Monobank, it ceased to be automatic or tied to material flows, and it usually required some bargaining on the side of firms to obtain the demanded volume of credits. However, there was no, or very limited, rationing by interest rates even though the effective interest rates rose steadily.

Investment credits were used only for procurement of fixed capital and were basically at the discretion of the Planning Authority, that is, the portion of the investment contained in the Plan was more or less automatically financed by the Monobank. To be precise, the Monobank usually

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1/ As in other planned economies, interenterprise arrears were widespread, especially in the 1980s, and served as a sort of trade credit. However, the evidence suggests that arrears entailed nonnegligible costs for both "creditors" and "debtors" and that arrears were not perfect substitutes for bank credits (Bulíř 1995).

2/ The economy tended to resemble the late-Soviet society analyzed by Olson (1995).

financed the gap after firms' own resources and capital expenditures by the state budget had been apportioned. However, from the early 1980s industrial firms also gained some freedom in determining their volume of fixed capital investment. 1/

3. Credit targeting

In the 1980s, a simple rule was sought for a monetary policy that would shield the Monobank from firms' demands for additional credits. The so-called basic monetary target, or BMT (základní monetární kritérium), was defined as a relationship between the growth rate of credit lent to the enterprise sector and the growth rate of the net material product. 2/ Although the BMT was not defined in any law, it was stipulated annually between the Monobank and the Planning Authority, and eventually decreed in the Economic Memorandum of the Government. In principle, the Monobank could have been held accountable for any overruns.

One can rewrite this as:

$$U^*_{t+1} = U_t(1 + r^*) ,$$

where U^*_{t+1} is the targeted stock of noninvestment credits on December 31 in year $t+1$; U_t is the actual stock of noninvestment credits on December 31 in year t; and r^* is discretionary growth coefficient based on an implicit feedback function embodying the state of the economy. 3/

If the credit view is to be a valid explanation of the business cycle in the pre-reform Czechoslovakia, one would expect that changes in noninvestment credits would precede changes in industrial production, while industrial production expansion would drive investment credits. Moreover, one would expect possible feedback relationships between investment credits and output, capturing the capital-intensive character of the economic growth in the socialist economies. 4/ Those hypotheses are examined in the next

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1/ For example, investment projects totaling Kčs 3 million and eventually Kčs 10 million (about $0.3 million and $1 million at the official exchange rate) were not subject to planners' approval. Those "small" investment ventures were usually more efficient than the mammoth projects supervised by the Planning Authority.

2/ The BMT was later augmented by several microeconomic criteria, the so-called criteria of credit efficiency. See Kroupar (1987).

3/ For example, the former Chairman of the SBCS praised the Monobank that "[in 1981-1985] the credit growth was lower than that of the nominal NMP," see Stejskal (1986), pp.75. Next year he specified: "... This year we want the growth rate of credits to be lower by 1.3 percentage points than the growth rate of the net material product," see Stejskal (1987), p.77. The political economy of the feedback function is discussed in depth in Bulíř (1995).

4/ See, for example, Easterly and Fischer (1994).

section by the so-called Granger causality tests.

Although Granger causality tests cannot prove a functional relationship, the existence of a third variable driving credits and industrial production simultaneously would be hard to justify. 1/ Why would the Planning Authority change the flow of credits first and only subsequently influence the real economy through its direct instruments (planning orders, allocation of labor and raw materials, or sector-oriented fiscal subsidies), given that those instruments were easier to administer than credits and carried shorter gestation periods as well? It is notable that most of the inputs were available without significant queues and little rationing was enforced--in contrast to other socialist economies, the input markets were not in a state of global shortage, albeit local disequilibria occasionally developed, see Dlouhý (1988), Klaus and Tříska (1989), and Klaus (1990).

III. Is There a Long-Term Relationship Between Credits and Production?

1. Data and time series properties

a. Data sources

Noninvestment and investment credits and industrial production at quarterly frequencies are utilized in this study. 2/ The sample periods are the first quarter of 1976 to the fourth quarter of 1990, as dictated by the availability of the original data taken from the SBCS's database and from *Statistické obzory*, a monthly publication of the Federal Statistical Office.

Total credit data consist of two time series. About two thirds of total credits to the economy were noninvestment credits and one third were investment credits. Firms could neither borrow abroad nor outside the Monobank. The latter condition was, however, occasionally violated by the existence of interenterprise arrears.

Industrial production data were collected for all centrally planned enterprises, which constituted more than 95 percent of the industrial base. The original time series were published as percentage change over the same period of the previous year and we recovered the nominal values from the

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1/ There is an extensive literature using VAR models for testing the money versus income causality in developed countries. Beside the pioneering paper by Sims (1972) see, for example, Friedman and Kuttner (1992), and Becketti and Morris (1992).

2/ Unfortunately, appropriate quarterly data for other variables affecting the business cycle, say, fiscal subsidies and taxation, foreign loans, terms of trade, or labor force, are not available. Hence, a multivariate VAR, which would gauge the relative contribution of credit shocks, could not have been performed.

absolute industrial production data for 1989, published in 1991.

b. Time series properties

It is easy to observe that all variables are nonstationary in levels; see Chart 1. Table 1 presents unit root test results using the Dickey-Fuller and the augmented Dickey-Fuller tests. However, after taking successively seasonal differences and first differences, all time series begin to exhibit mean-reverting properties, which confirms that the original series were seasonally integrated of the order one, SI(1).

Empirical analyses around points of structural or institutional breaks, such as those in the mid-1980s and the early 1990s, beg the question of analytical consistency. We are convinced, however, that the 1990 economy is not significantly different from, say, the 1986 economy: prices were liberalized only in January 1991, privatization started only in 1992, and so on. Of course, the same claim would be harder to justify for 1991 or even 1992. Primarily for this reason, our analysis ends in 1990.

2. Cointegration

Various measures of credit and industrial production moved together during the sample periods. Table 2 provides Johansen's tests (JJ) of the cointegrating relationship between industrial production and various definitions of credit variables. 1/ The null hypothesis of no cointegrating vectors can be rejected in favor of the existence of two cointegrating vectors for all equations. As supplemental evidence, we also performed the Engle-Granger (EG) test of cointegration with somewhat mixed results: the Durbin-Watson tests (DW) imply cointegration, but the Augmented Dickey-Fuller tests suggest otherwise--with the exception of the regression of investment credits on industrial production (Table 3). 2/

Even though credit inflows had obviously no "multiplicative" effects on production, the estimated elasticities clearly reject the hypothesis of credit neutrality (see Table 3). 3/ Noninvestment and total credit elasticities of industrial production are in the range 0.4-1.0; industrial production elasticity of investment credit is estimated to be between 1.0

1/ The relevant references for the cointegration techniques are Johansen and Juselius (1990), Engle and Granger (1987), and Urbain (1992). The long-run matrix π in the JJ procedure can be written as $\alpha\beta'$, where α and β are kx1 vectors. We normalize the long-run coefficients β' as $(1,-\delta')$ and partition the adjustment matrix as $\alpha'=(\alpha_1,\alpha_2)$.

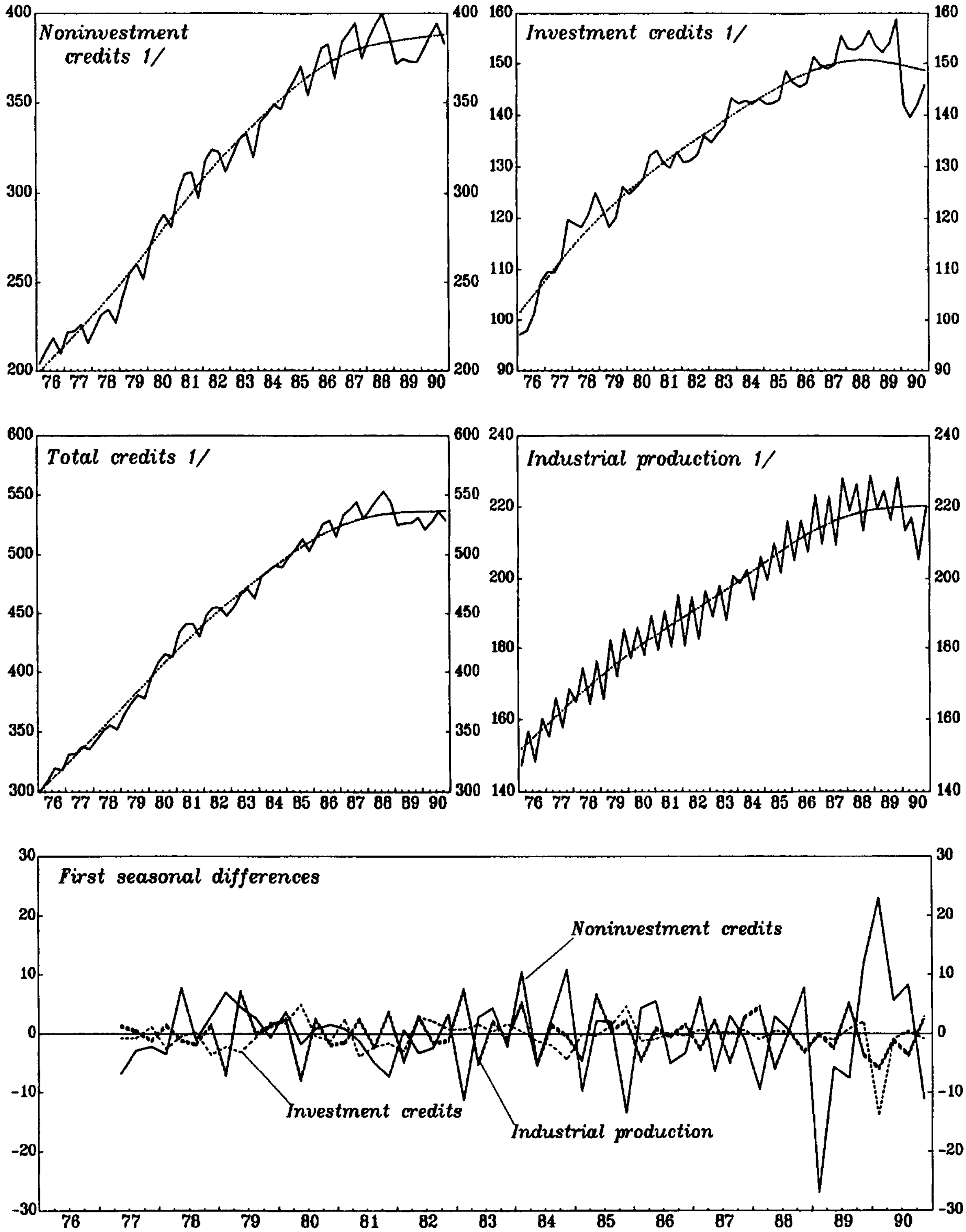
2/ The latter result can be attributed, however, to the generally low power of the E-G test rather than to the lack of cointegration: multiplicity of cointegrating vectors in the JJ test generally signals a non-robustness of the EG test.

3/ They were obtained in two ways: by normalizing the β-vectors in the JJ procedure and by an OLS regression of industrial production on credits (the EG procedure).

CHART 1

Credits and Industrial Production

(In billions of current Kcs)



Source: State Bank of Czechoslovakia, Federal Statistical Office.

1/ Seasonally unadjusted series and Hodrick-Prescott filter.

Table 1. Dickey-Fuller and Augmented Dickey-Fuller Tests for the Presence of a Unit Root, 1976:I-1990:IV

Variable 1/		DF 2/	ADF(1) 3/	ADF(2)	ADF(3)	ADF(4)
Credits						
Noninvestment	4/	-1.594	-1.051	-0.321	0.480	-0.954
	5/	-7.356	-4.932	-3.929	-5.356	-3.574
Investment	4/	-3.364	-2.959	-2.541	-1.433	-1.171
	5/	-9.168	-6.842	-4.254	-5.737	-5.510
Total	4/	-0.982	-0.414	0.264	1.008	0.399
	5/	-10.738	-6.407	-3.630	-3.552	-3.017
Industrial production	4/	-7.967	0.090	-0.755	1.036	0.736
	5/	-13.074	-7.205	-4.824	-5.690	-4.160
Critical values 6/	4/	-3.486	-3.488	-3.489	-3.490	-3.492
	5/	-3.494	-3.495	-3.497	-3.499	-3.501

1/ All variables are in natural logarithms.
2/ DF is the Dickey-Fuller Statistics. The regression equation contains a constant and a trend.
3/ ADF(k) is the Augmented Dickey-Fuller Statistics with lag k. The regression equation contains a constant and linear trend.
4/ Levels.
5/ First seasonal differences.
6/ At the 95 percent confidence interval.

Table 2. Johansen Test Statistics for Cointegration, 1976:I-1990:IV (vector autoregression with two lags) 1/

	Maximum Eigenvalue Test Statistics	
Hypothesis: 2/		
Null	$r = 0$	$r \leq 1$
Alternative	$r = 1$	$r = 2$
Industrial production and		
Noninvestment credits	17.24	9.32
Investment credits	22.53	9.91
Total credits	19.92	6.35
Critical values: 3/	14.07	3.76

	Trace Test Statistics	
Hypothesis: 2/		
Null	$r = 0$	$r \leq 1$
Alternative	$r = 1$	$r = 2$
Industrial production and		
Noninvestment credits	26.56	9.32
Investment credits	32.45	9.91
Total credits	26.27	6.34
Critical values: 3/	15.41	3.76

1/ The lag structure selection was based on three tests: an iterative application of restrictions on a higher order VAR [Holden and Perman (1994)], the Akaike information criterion, and the adjusted coefficient of determination.
2/ A "r" is the number of cointegrating vectors.
3/ At the 95 percent confidence interval.

Table 3. Cointegrating Vectors from the Johansen and Engle-Granger Procedures

Variables 1/	Johansen estimation		Engle-Granger estimation			
	β_{JJ} 2/		β_{EG} 3/	R^2	DW	ADF(1) 4/
	first vector	second vector				
Noninvestment credits	0.384	0.636	0.521	0.87	2.56	-2.73
Investment credits	1.052	0.436	0.943	0.90	1.96	-3.44
Total credits	0.351	0.677	0.622	0.90	2.79	-2.41
Industrial production 5/	0.951	2.296	0.956	0.90	1.82	-4.37

1/ Right-hand side variable in regression of industrial production on credit variables. For the sake of simplicity, only those cointegrating relationships are presented for which a Granger causality was later identified.

2/ Normalized parameters of the long-term relationships from the Johansen procedure (JJ).

3/ A parameter of the long-term relationships from the Engle-Granger regressions (EG).

4/ Critical value at the 95 percent confidence interval is -3.44.

5/ Industrial production regressed on investment credits.

and 2.3. Moreover, those estimates are generally invariable across different estimation techniques. 1/

IV. Granger Causality Results

1. Directions of Granger causality

The results support the hypothesis that noninvestment credits led industrial production during 1985-90 and that investment credits had a feedback relation with production during the same period. Assuming that productivity of most Czechoslovak enterprises could not improve immediately after 1989, that is, before the full-scale restructuring and privatization, then lower credit supply (growth) in 1989-90 might have adversely affected output (growth) at the outset of the reform.

How stable was the Granger causality over time? Earlier we discussed literature suggesting that the partially independent position of the Czechoslovak Monobank developed over time as its intermediation powers were increasing. Mechanical tests of statistical significance placed the structural break either in 1984 or 1985 and, hence, we estimated our equations for three periods: the full sample (1976:I-1990:IV), the "pre-independence" period (1976:I-1984:IV), and the "independence" period (1985:I-1990:IV).

The regression estimates reveal directions of Granger causality conforming with the assumptions outlined earlier (see Table 4 for a summary and Table 5 and 6 for the respective marginal significance levels of the likelihood ratio tests). 2/ First, the VAR(2) models show that total credits and noninvestment credits were Granger-causing industrial production in 1985-90. Therefore, new credits financing inputs (mainly labor and inventories) were preceding changes in industrial output. However, noninvestment and total credits do not appear to be Granger-causing industrial output in 1976-84. Hence, as expected, credits may have been "neutral" in the period prior

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1/ The usual way to proceed after establishing a cointegration relationship would be to estimate an error correction model (ECM). Indeed, the first rows of the adjustment matrices (α_1) in the JJ procedure are negative, which is consistent with the hypothesis of an error correction mechanism. On the one hand, the ECM performs reasonably well for most of the sample until 1989. On the other hand, its predictive failure in 1990 can be viewed as a confirmation of the earlier mentioned noncredit generation and propagation mechanisms of the industrial production decline. Hence, to estimate a meaningful production function one would have to include other variables.

2/ Note that we employed two complementary definitions of Granger causality tests, each with two differently transformed time series (see Appendix). As the tests of Granger causality have generally low power in small samples, it does not come as a surprise that usually one out of four tests is a substantial outlier. As a result, we consider the 25 percent significance level a reasonable benchmark for our purposes.

Table 4. Directions of Granger Causality 1/

Variable	1976-84	1985-90	1976-90	Variable
Noninvestment credits	--	→	→	Industrial production
Investment credits	←	←,↔	←,↔	Industrial production
Total credits	--	→	→	Industrial production

Source: Tables 5 and 6.

1/ A "--" signals that no Granger causality was detected. A "→" ("←") signals that the left-hand (right-hand) side variable is Granger-causing the right-hand (left-hand) side variable. A "↔" signals a feedback relationship between the left-hand and right-hand side variables.

Table 5. Significance Levels of Granger Causality Tests: Production "Causes" Credits 1/

1. Granger approach

(i) Deterministic trend and seasonal dummies

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	29	1	36
1976:1 - 1990:4	66	1	99
1985:1 - 1990:4	80	3	96

(ii) Without deterministic variables

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	86	1	71
1976:1 - 1990:4	86	59	68
1985:1 - 1990:4	84	39	19

2. Sims approach

(i) Deterministic trend and seasonal dummies

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	69	1	18
1976:1 - 1990:4	32	1	53
1985:1 - 1990:4	47	0	11

(ii) Without deterministic variables

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	49	4	54
1976:1 - 1990:4	79	21	95
1985:1 - 1990:4	90	3	49

1/ The numbers in each column are marginal significance levels for the likelihood ratio test of the joint hypothesis that all of the estimated coefficients of industrial production are equal to zero. For example, the "29" in the first row and column indicates that those coefficients are statistically different from zero at the 29 percent significance level.

Table 6. Significance Levels of Granger Causality Tests: Credits "Cause" Production 1/

1. Granger approach

(i) Deterministic trend and seasonal dummies

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	89	18	94
1976:1 - 1990:4	8	14	2
1985:1 - 1990:4	21	4	5

(ii) Without deterministic variables

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	38	27	82
1976:1 - 1990:4	59	23	69
1985:1 - 1990:4	22	31	21

2. Sims approach

(i) Deterministic trend and seasonal dummies

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	72	59	83
1976:1 - 1990:4	29	3	18
1985:1 - 1990:4	11	1	12

(ii) Without deterministic variables

	Noninvestment credits	Investment credits	Total credits
1976:1 - 1984:4	19	75	28
1976:1 - 1990:4	97	32	68
1985:1 - 1990:4	22	39	59

1/ The numbers in each column are marginal significance levels for the Likelihood ratio test of the joint hypothesis that all of the estimated coefficients of credit variables are equal to zero. For example, the "89" in the first row and column indicates that those coefficients are statistically different from zero at the 89 percent significance level.

to the mid-1980s. Industrial production appears to be Granger-causing neither noninvestment nor total credits in any period.

Second, industrial production was Granger-causing investment credits in both periods. Moreover, the tests also suggest a possibility of investment credits Granger-causing industrial production and, hence, a feedback relation between investment credits and industrial production in the second period. While the former finding conforms with the usual notion of a capital-intensive growth under central planning (industrial production growth generated its own demand for investment credits, which would finance further expansion of fixed capital), the latter finding hints at the credit view.

2. Exogeneity tests

Even though we have established Granger causality, can we be sure that credit supply was set independently from output developments? Hence, as a supplementary test to the Granger causality, we tested for weak exogeneity. 1/ Those results reinforce our Granger causality findings: noninvestment and total credits are found to be weakly exogenous with respect to industrial production (the likelihood ratio tests yield 0.274 and 3.088, respectively) and industrial production is found to be weakly exogenous with respect to investment credits (0.462). 2/ Production, however, fails the weak exogeneity test with respect to noninvestment and total credits (7.856 and 10.064, respectively) as do investment credits with respect to industrial production (8.045).

3. Contribution of credit shocks to the business cycle

The VAR estimates also allow us to construct impulse-response functions, which measure the quantitative impact of a unitary change in credit variables on industrial production and of a unitary change in industrial production on investment credits (Chart 2). The values of the estimated impulse response functions are relatively large (the six-quarter cumulative impact of one-time permanent increase in total and noninvestment credits by 1 percent increases industrial production by 0.9-1.1 percent) and cumulated in the first two quarters. This finding is consistent both with our earlier estimates of the long-run credit elasticities of industrial production and with the credit view, which assumes that credit shocks affecting the working capital should be strong but short-lived.

Although the VAR estimations reported above seem to be reasonably robust

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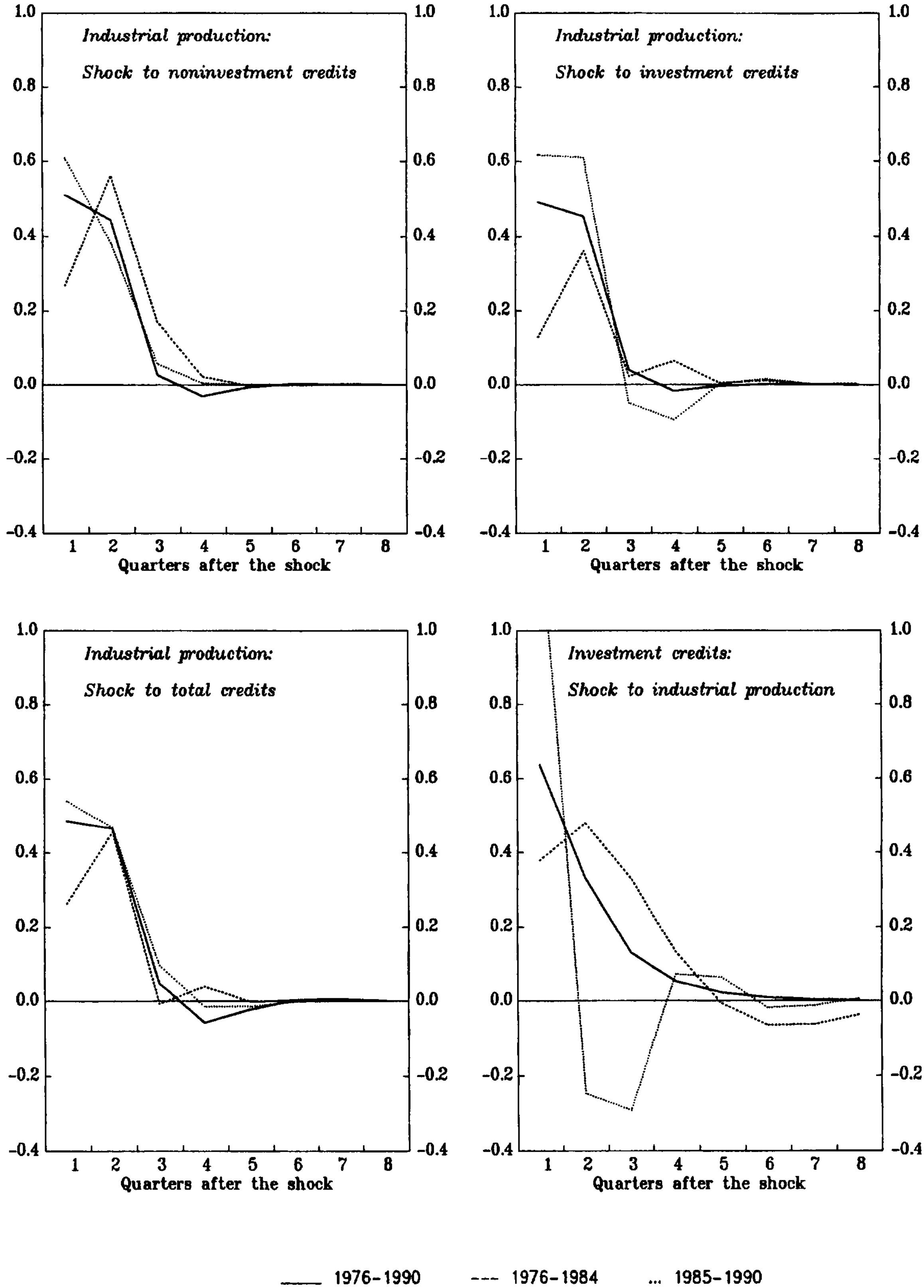
1/ In econometric jargon, weak exogeneity means that a variable x contains all information needed to estimate a variable y. If the second rows of the adjustment matrix in the JJ procedure contain zeros ($\alpha_2=0$), then the variable in question is said to be weakly exogenous with respect to the long-run parameters.

2/ The likelihood ratio test for this hypothesis is distributed $\chi^2(1)$ under the null hypothesis with a critical value of 3.841 at the 5 percent significance level.

CHART 2

Impulse Response Functions



Source: Author's computations.

and stable, their predictive power declines for the period of the late 1980s. Most notably, the VAR models underestimate the production slowdown in 1988-89 and its fall in 1990 in both one-step ahead and multistep forecasts. This can be attributed to three features of the simple bivariate VAR models. First, the reduced form models omit shocks to several relevant variables (fiscal policy, labor inputs, exchange rate, changes in the export-import regime, etc.), for which reliable data are not available and which clearly had an impact on industrial production. 1/ Second, one would suspect that the sensitivity of output to credit supply changes increased toward the end of the sample period, as confirmed by the gradually increasing size of the recursive coefficients of credit variables in the Engle-Granger cointegrating equations. 2/ Third, the negative credit shock was simply too small to account for all (or most) of the industrial production decline.

V. Concluding Remarks

This paper has quantitatively evaluated the hypothesis that a credit squeeze might have contributed to output decline in the former Czechoslovakia. The institutional setup of the Czechoslovak economy in the 1970s and 1980s hints at the Monobank's ability to regulate the overall supply of credits, even though its control over investment credits was limited. The results from the cointegration tests suggest existence of a long-run relationship between the real and monetary sectors of a planned economy.

Credit shocks apparently explain a part of the business cycle in the former Czechoslovakia. Three main inferences stand out. First, industrial production Granger-causes investment credits, but industrial production does not Granger-cause noninvestment or total credits. Second, noninvestment and total credits Granger-cause industrial output during the period 1985-90, but not before. Third, a feedback function might exist between production and investment credits during the period 1985-90. Moreover, Granger causality tests are supported by tests of weak exogeneity.

The results seem to support the hypothesis that the credit squeeze at the outset of the Czechoslovak reform in 1990 (and perhaps beyond 1990) contributed to the decline in industrial production, even though credit shocks were far from being the most important shock. The estimated impulse response functions suggest that the fall in industrial output would follow quickly after the credit squeeze with a lag of two quarters at maximum. Assuming unchanged productivity of enterprises, the lower supply of real credits might have led to lower output.

1/ The very fact of two cointegrating vectors might suggest that the endogenous versus exogenous division of variables is imperfect and that the "true" production function should consist of not one but two or more equations (see Charemza and Deadman, 1992).

2/ As expected, the recursive coefficient from the Engle-Granger equation of industrial production on investment credits declined.

APPENDIX

Tests of Granger Causality

The following two tests were used in the analysis above. It should be noted that the so-called Granger and Sims tests are not considered to be substitutes but rather complements; see Charemza and Deadman (1992). In other words, there is no trade-off between those two sets of results and the rule of thumb must used to evaluate them. In both cases we are testing whether x is Granger-causing y using VAR(2) models

1. Granger approach. Estimate:

$$y_t = A_0 D_t + \sum_{j=1}^{2} \alpha_j y_{t-j} + \sum_{j=1}^{2} \beta_j x_{t-j} + \epsilon_t \quad ;$$

if $\beta_1 = \beta_2 = 0$, then x does not Granger-cause y. If the null hypothesis is rejected then x Granger-causes y. This is clearly a straightforward test of variable deletion.

2. Sims approach. Estimate:

$$x_t = A_0 D_t + \sum_{j=1}^{2} \gamma_j x_{t-j} + \sum_{j=-2}^{2} \delta_j y_{t-j} + v_t \quad ;$$

if $\delta_{-1} = \delta_{-2} = 0$, then x does not Granger-cause y. 1/ If the null hypothesis is rejected then y does not cause x, that is, x Granger-causes y. This type of test is less straightforward: one is assuming that the future cannot cause the present and, hence, future ys cannot cause the current xs. Indeed, a logical conclusion of finding nonzero coefficients on leading y terms is that x is a Granger-cause for y.

We estimate two sets of equations, both based on the above VAR models:
1. With a deterministic time trend and a deterministic seasonal factor. All variables are in levels and the equations include the following deterministic variables: an intercept, linear time trend, and three seasonal dummies. The introduction of time trend and seasonal dummies is expected to alleviate the problem of nonstationarity in variables expressed in levels;

2. Without time trend and deseasonalized. The equations include only one deterministic explanatory variable, an intercept. All variables are in first seasonal differences ($\Delta x_t = x_t - x_{t-4}$), which were subsequently subject to first difference ($d\Delta x_t = \Delta x_t - \Delta x_{t-1}$). The twice-differenced variables are stationary, as demonstrated by the Augmented Dickey-Fuller tests, Table 1.

1/ Note that $\delta_{-1}, \ldots, \delta_{-2}$ are parameters of lead variables.

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