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Real or Nominal Shock – Which One Does More to Destabilize Developing Economies? The Case of Money Velocity in Kazakhstan

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Real or nominal shock – which one does more to destabilize developing economies?
The case of money velocity in Kazakhstan

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Abstract

Volatility in money velocity destabilizes spending and output, generating business cycles. This note develops a gauge of this volatility, based on the quantity equation of exchange. In contrast to ad hoc regression, the gauge measures the impacts on volatility of the three determinants of velocity – money supply, output, and the price level. The algorithm allows covariances among these variables. An application to a fast-growing transition economy, Kazakhstan, finds that at the margin, price shocks affect volatility more than do real shocks, by several orders of magnitude. An oil exporter, Kazakhstan may be vulnerable to the gyrating price of crude.

JEL Classifications: E47, E52

Keywords: real shocks, monetary shocks, monetary policy, simulations, forecasting in transitional economies

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1. Introduction

To steady an economy, policymakers must know the relative impacts of real and nominal shocks on the stability of spending. This stability is reflected in the turnover rate of a unit of money. If velocity fluctuates, so does spending – and, consequently, output, since this equals the product of real money balances and velocity.

In theory, only supply shocks can affect output in the long run, since prices eventually adjust in a way that returns the economy to full employment. But in shorter periods either supply or demand shocks may have real effects. Vector autoregression (VAR) can compute the effects, but one would like to supplement these atheoretic estimates with structural ones. This paper treats velocity as a function of three random variables (output, the price level, and money supply), as in a stochastic version of the quantity equation of exchange. Since the equation is a tautology, rooting a model of velocity in it may have some advantages over an ad hoc function of such variables as real income, the real interest rate and expected inflation; and, similarly, over a structural VAR (SVAR) model with a priori restrictions.

In the equation-of-exchange model, one can compute the relative contributions of the variances of output, prices and money supply to the variance of velocity. The decomposition is of interest because these three variables determine velocity and thus the rate of spending. If, for example, the variance of money supply dominates that of velocity, then targeting money may stabilize spending and output.

This note applies the algorithm to Kazakhstan since we know less about shocks to developing economies than about those to developed ones. Indeed, a fast-growing transition economy may be more prone to fluctuations in velocity than are more established economies.

As a side benefit, the equation-of-exchange approach may improve central bank forecasts of the effects of monetary policy. When data are scarce and institutions are changing sharply – as occurred early in the transition of post-Soviet economies to markets – velocity can be hard to estimate (Citrin, 1995). A gauge of possible errors in estimates of velocity would improve forecasts. While a Monte Carlo simulation may accomplish this, we would learn more by relating the variations of velocity to those of its determinants.

Here's a road map to the paper. Section 2 surveys the literature. Modern studies concede that velocity is not constant, but they disagree over its determinants. Section 3 discusses velocity in Kazakhstan. It varies in the short run as well as in the long, but in general it has been falling since 2001, possibly because of monetization. Section 4 models the variance of velocity as a function of the variances and covariances of the three other variables in the equation of exchange. Taking derivatives and estimating their values suggest that at the margin, the variance of velocity in Kazakhstan has been dominated by the variance of the price level. Section 5 concludes and reflects. As an oil exporter, Kazakhstan is vulnerable to fluctuations in global prices of crude.

2. Literature review

We begin with the familiar equation $MV = PQ$, where M is money supply, V velocity, P the price level, and Q output. Given V and Q, a change in M induces a proportional change in P, which simplifies forecasting. When the economy produces at full capacity, Q may be constant, but a constant V is harder to justify. Marshall (1923) suggested that velocity may be slow to change because habit determines the share of income that people spend. In contrast, modern theories of velocity tend to explain why it changes. The institutional approach focuses on monetization, innovation and economic stability (Bordo and Jonung, 1981). At first, monetization increases the ratio of money supply to spending, so velocity declines. Over time, financial innovations accumulate and the economy settles down, increasing the efficiency of spending and consequently velocity. One computational approach attributes the instability of velocity to the household's smoothing of consumption over time (Cao-Alvira, 2012).

Velocity is variable in the short run as well as in the long. For the velocity of Kazakhstani tenge, the ratio of the standard deviation to the mean, both expressed in annual terms, ranged from .044 in 2005 to .213 in 2009 (Table 1).[3] Volatile velocity goes hand in hand with economic instability. The coefficient of variation for velocity was more than twice as high in the period 2009-2011 (.197) – which began with an economic slowdown and a 25% devaluation of the tenge – as in the period 2000-2008 (.076). But velocity also responds to long-run trends, as the institutional approach suggests. From 2001 to 2011, M1 velocity halved.

Modeling velocity is hard partly because its link to lagged money volatility is unclear. Friedman (1984) argued, in effect, that velocity would fall when economic uncertainty increased, since people would hold more money as a precaution.[4] Uncertainty may cause, or result from,

[3] Research into the tenge supply often uses M2 or M3. But M1 is more typical than these measures are of research into the variance of velocity.

[4] For broad perspectives, see Friedman (1970, pp. 227-9) – and Mascaro and Meltzer (1983), which "develops a general equilibrium model in which variability or risk affects the choice of portfolios" (p. 488). From this point of

money volatility. Hall and Noble (1987) tested for Granger causality in United States data and concluded that M1 velocity was "caused" partly by its own lags and by lags of the volatility of money growth. Other studies indicate that these results might vary with the period studied, due to such factors as regulation and inflation (Brocato and Smith, 1989; Mehra, 1987 and 1989). The results in Mehra's 1989 article were also sensitive to specification of the equation – e.g., variables in levels or in first differences. In addition, Granger-causality estimates often depend on the lengths of the lags specified, concluded Thornton and Batten (1985). Thornton (1995) turned up evidence supporting Friedman's hypothesis for three of nine industrial countries studied, but only in certain time periods. "The Friedman hypothesis would appear to have little general applicability" (p. 290).

We may obtain additional rigor and insight by deriving estimates of the variance of velocity directly from the quantity theory of exchange.

3. Velocity in Kazakhstan

An overview of velocity in Kazakhstan will help motivate the analysis that follows of the marginal impacts of determinants on velocity. From 2001 through 2011 in Kazakhstan, M1 velocity fell roughly from 16 to 8, despite output growth for most of this period (the average annual rate was 15.6%) and a fairly steady rate of inflation of 7% or 8% (7.3%), according to data from the central bank, the National Bank of Kazakhstan. Curiously, the rate of decline in velocity in the recession of 2008-9 was no higher than in previous years of recovery. The evident reason for the long-run fall in velocity was the sustained rise in M1 (as the institutional approach suggests). The average annual rate of M1 growth over the 11-year period was 33.1%, outstripping the corresponding rate for nominal income (24.0%). In contrast, the average growth rate of M0 was 26.6%, although it followed the same patterns as did M1; the simple correlation coefficient for the two measures of money, over quarters, was .98 (Figure 2).

The sustained rise in M1 may have stemmed from accommodative monetary policy. The most remarkable peak of M1 growth occurred in 2003, when the M1 rate of increase rose from 12.6% in 2002 to 54.4%; the M0 growth rate doubled, from 21.0% to 42.0%. The National Bank

view, the increased volatility of the tenge in the period of 2009-11 may have reflected uncertainty about the optimal amount of money to hold following the global financial crisis of 2008.

may have been reacting to an apparent slowdown in 2002, when the output growth rate fell to 9.0%, from 15.3% in 2001. This rate did recover in 2003, to 12.9%.

The National Bank may have reacted to inflation as drastically as it did to output slowdown. In 2008, when output rose 15.3%, the M1 growth rate fell to 13.3%, from 44.4% in 2007; the M0 rate fell from 42.4% to 5.9%. In 2009, when output fell by .3 of a percent, the M1 rate was 35.9%. The M0 rate fell to 3.4%. These trends raise the possibility that the National Bank over-reacted to inflation in 2007-08, when consumer prices were rising nearly 9% per year, then swung almost as drastically in the other direction when facing stagnation. Such oscillations may destabilize velocity.

In short, the Kazakhstani experience suggests that monetary policy is a determinant of velocity. This is a special case of the equation-of-exchange approach developed here.

4. Analysis

4.1 Deriving the variance of velocity

From the equation of exchange,[5]

$$V = {PQ}/{M}. \tag{1}$$

P, *Q* and *M* may be random variables. A Taylor series and a well-known property of variance give a first-order approximation of the variance of V (Appendix):[6]

$$\begin{aligned}\operatorname{var}(V) \approx\ & {Q^2}/{M^2}\operatorname{var}(P) + {P^2}/{M^2}\operatorname{var}(Q) + {P^2Q^2}/{M^4}\operatorname{var}(M). + 2\,{QP}/{M^2}\operatorname{cov}(P,Q) \\ & - 2\,{PQ^2}/{M^3}\operatorname{cov}(P,M) - 2\,{P^2Q}/{M^3}\operatorname{cov}(M,Q).\end{aligned} \tag{2}$$

Given the long-run variances and covariances of *P, Q* and *M,* Equation 2 can forecast the variance of velocity.

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[5] The velocity of money increases in nominal income (*PQ*), since people will spend a given money supply faster when they can afford more purchases; and velocity falls with an increase in money, since there are more tenge now to finance aggregate purchases of a given size.

[6] Statisticians refer to a linear Taylor approximation as the “delta method” (Greene 2008, pp. 1055-6). In a useful illustration, Larsen and Marx (2006, p. 238) apply the method in order to interpret dental X-rays.

In short-run cases, *P*, *Q* and *M* may be independent of one another – each subject to random factors, such as measurement error, which need not affect the other two variables. In these cases, the three variables have zero covariances, which would eliminate the last three terms in Equation 2. This paper, however, also considers longer periods and so will account for covariances.

4.2 Marginal impacts of the variances of the determinants

Since the price level, output and money supply increase over time in Kazakhstan, their marginal impacts on velocity may indicate future trends. Table 3 reports the marginal effects of the variances of P, Q, and M1 on the variance of velocity, taking covariances into account.[7] The estimates use the average annual levels for these four variables for the period from 2000 through 2011. The price level makes the largest impact on the variance of velocity, by several orders of magnitude. In fact, its effect easily exceeds the sum of the impacts of the other two determinants of the variance of velocity. The estimates suggest that nominal causes of volatility in spending are becoming increasingly important relative to real causes.

In the context of the Blanchard and Quah (1989) model, nominal causes are demand disturbances. In their SVAR studies of United States quarterly data for 1948 through 1987, Blanchard and Quah conclude that "demand disturbances make a substantial contribution to output fluctuations at short- and medium-term horizons…" (p. 668).

4.3 Forecasting

At times, Equation 1 may mis-calculate velocity (*V*) because of ambiguous estimates for the three right-hand variables. For an idea of how large the mistakes might be, let's measure velocity's volatility.

Suppose that the National Bank of Kazakhstan considers an increase in the money supply equal to the forecasted annual rate of growth in *Q*, 7.5%. The Bank assumes that *P* will not change. In addition to the levels of *P*, *Q,* and M1, assume for these variables their average annual variances for the period 2000-2011 (Table 2). By Equation 1, the predicted value of M1 velocity is 7.7. By Equation 2, the predicted standard deviation is 1.39, or .18 of the mean. This coefficient of variation is 70% higher than was average for 2000-2011, so the Bank may wish to

[7] Section VII.3 of the appendix derives the marginal estimators.

act on its scenario forecast with caution. If velocity follows a normal distribution, then its 95% confidence interval is (4.9, 10.5).

Covariances among *M, P* and *Q* may affect forecasts. Keynesian policy assumes that the short-run correlation between prices and money is low enough to permit an infusion of money to affect real GDP rather than the price level. But in Kazakhstan, using annual data for 2000 through 2011, the simple correlations of the Consumer Price Index, the money supply (M0 or M1), and output in Kazakhstan all exceed .97. For monthly data, the correlation between the CPI and M1 also exceeds .97. A Keynesian expansion of money supply may raise prices more rapidly than output, destabilizing recovery. Monetary policymakers may benefit from an interval estimate of the variance of velocity.

5. Conclusions and reflections

Equation 2, which decomposes the sources of the volatility of velocity, applies to any economy, since it is derived from an identity, the quantity equation of exchange. We will consider applications to Kazakhstan.

Keynesian theory emphasizes shifts in aggregate demand as causes of the business cycle; real business cycle theory emphasizes shifts in aggregate supply. This paper finds that at the margin, price shocks dominate the volatility of spending in Kazakhstan, which jibes with Keynesian theory for output near full employment. With adjustments for correlations among prices, output and money supply, the Keynesian approach may be apt for developing economies because their agents know less about them than real business cycle theory assumes.

The dominance of price shocks at the margin has two practical implications for Kazakhstan. First, prices can destabilize spending even when money supply is held constant. Targeting money supply may not eliminate business cycles. Second, oil prices may have pernicious effects on the stability of the Kazakhstani economy, since oil exports account for roughly a fourth of gross domestic product. Oil prices are unusually mercurial: From 2000 through 2011, the coefficient of variation for the annual Brent spot price was .491, according to data from the United States Energy Information Administration (2012). Thus gyrations in oil prices may destabilize spending and real GDP. This may be bad news for monetary policymakers in Kazakhstan since they cannot control global oil prices and may not even be able to anticipate them. In principle, the central bank could stabilize output by offsetting the change in velocity with an inverse change in real money balances, but it may lack the necessary finesse. The government may have to either manage the effects of instability or rely on such stabilizers as unemployment compensation.

This note also has implications for monetary forecasting. As a function of random variables, velocity is subject to uncertainty that clouds forecasts. The note's algorithm measures the randomness. In that respect, it may be most valuable when applied to short-run monetary relationships. True, recent work challenges the conventional view that the short-run demand for money is hard to explain. In the United States, the return to savings accounts and money market mutual funds may help explain M1 demand in a volatile period, 1959 through 1993 (Ball, 2012). But money markets may be less developed in transition economies. In Kazakhstan, a model of M2 demand based on an output proxy, on the interest rate, and on foreign exchange rates, has the expected coefficient signs in the long run but not in the short (Yilmaz, Oskenbayev and Kanat, 2010).[8]

[8] We thank Shahnoza Seidmedova for capable assistance with research, as well as participants in a department seminar at KIMEP University – especially Gerald Pech, who corrected an error.

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7. Appendix

7.1 The case of independent random variables

In a Taylor series, a first-order expansion approximates a function g around some point ($\mu_1, \mu_2, \ldots, \mu_n$):

$$g(W_1, W_2, \ldots, W_n) \approx g(\mu_1, \mu_2, \ldots, \mu_n) + \sum_{i=1}^{n} \partial g \big/ \partial W_i \,(W_i - \mu_i). \tag{3}$$

where the derivatives are evaluated at the point ($\mu_1, \mu_2, \ldots, \mu_n$). For velocity, such a Taylor series would be

$$V(M, P, Q) \approx V(\mu_m, \mu_p, \mu_q) + \partial V \big/ \partial M\,(M - \mu_m) + \partial V \big/ \partial P\,(P - \mu_p) + \partial V \big/ \partial Q\,(Q - \mu_q), \tag{4}$$

where μ_m, μ_p and μ_q are arbitrary constants. $V(\mu_m, \mu_p, \mu_q)$ is also a constant. A basic result concerning the variance of a linear sum of independent random variables W_i with finite means is that

$$Var\left(\sum_{i=1}^{n} a_i W_i\right) = \sum_{i=1}^{n} a_i^2 Var(W_i) \tag{5}$$

where a_i is a constant. Applying Equation 5 to Equation 4 gives us

$$\begin{aligned} Var(V) &\approx Var\left(\frac{\partial V}{\partial M}(M - \mu_m) + \frac{\partial V}{\partial P}(P - \mu_p) + \frac{\partial V}{\partial Q}(Q - \mu_q)\right) \\ &= \left(\frac{\partial V}{\partial M}\right)^2 Var(M - \mu_m) + \left(\frac{\partial V}{\partial P}\right)^2 Var(P - \mu_p) + \left(\frac{\partial V}{\partial Q}\right)^2 Var(Q - \mu_q) \\ &= \left(\frac{\partial V}{\partial M}\right)^2 Var(M) + \left(\frac{\partial V}{\partial P}\right)^2 Var(P) + \left(\frac{\partial V}{\partial Q}\right)^2 Var(Q), \end{aligned} \tag{6}$$

where the last line uses Equation 5 again:

$$Var(X - \mu) = Var(X) + Var(\mu) = Var(X), \tag{7}$$

since μ is a constant.

7.2 The general case

When covariances are not zero, the general version of Equation 5 is

$$Var(\sum_{i=1}^{n} a_i W_i) = \sum_{i=1}^{n} a_i^2 Var(W_i) + 2\sum_{j<k} a_j a_k Cov(W_j, W_k), \tag{8}$$

where we have used the result

$$\begin{aligned} &Cov(a_i W_i, a_j W_j) = E(a_i W_i a_j W_j) - E(a_i W_i)E(a_j W_j) = a_i a_j E(W_i W_j) - a_i E(W_i) a_j E(W_j) \\ &= a_i a_j \left[E(W_i W_j) - E(W_i)E(W_j)\right] = a_i a_j Cov(W_i, W_j). \end{aligned} \tag{9}$$

Equation 5 specifies Equation 4.

7.3 Deriving estimators of the marginal impacts of real and nominal shocks on the volatility of velocity

From Equation 2,

$$\begin{aligned} &\partial Var(V) \big/ \partial Var(P) = Q^2 \big/ M^2 + 2\, QP \big/ M^2 \; \partial Cov(P,Q) \big/ \partial Var(P) - 2\, PQ^2 \big/ M^3 \; \partial Cov(P,M) \big/ \partial Var(P), \\ &\partial Var(V) \big/ \partial Var(Q) = P^2 \big/ M^2 + 2\, PQ \big/ M^2 \; \partial Cov(P,Q) \big/ \partial Var(Q) - 2\, P^2 Q \big/ M^3 \; \partial Cov(M,Q) \big/ \partial Var(Q), \\ &\partial Var(V) \big/ \partial Var(M) = P^2 Q^2 \big/ M^4 - 2\, PQ^2 \big/ M^3 \; \partial Cov(P,M) \big/ \partial Var(M) \\ &- 2\, P^2 Q \big/ M^3 \; \partial Cov(M,Q) \big/ \partial Var(M). \end{aligned} \tag{10}$$

One can rewrite Equation 4 as

$$Cov(W_1, W_2) = \frac{Var(aW_1 + bW_2) - a^2 Var(W_1) - b^2 Var(W_2)}{2ab}. \tag{11}$$

This formula yields derivatives of the covariance with respect to a variance. Applying these derivatives to Equation 4 and simplifying yields

$$\begin{aligned} &\partial Var(V) \big/ \partial Var(P) = Q^2 \big/ M^2, \\ &\partial Var(V) \big/ \partial Var(Q) = P^2 \big/ M^2, \\ &\partial Var(V) \big/ \partial Var(M) = 3\, P^2 Q^2 \big/ M^4. \end{aligned} \tag{12}$$

Table 1: M1 velocity statistics for the tenge

Year	Standard Deviation	Velocity mean	Ratio
2000	0.267	3.985	0.067
2001	0.408	3.993	0.102
2002	0.359	4.134	0.087
2003	0.227	3.290	0.069
2004	0.212	2.822	0.075
2005	0.113	2.585	0.044
2006	0.139	2.422	0.057
2007	0.270	2.112	0.128
2008	0.129	2.321	0.056
2009	0.385	1.805	0.213
2010	0.362	1.890	0.192
2011	0.356	1.911	0.186

Notes: Column 2 gives the standard deviation of velocity, calculated for each year from the quarterly estimates of velocity; Column 3, the mean of velocity, calculated as the annual average of quarterly estimates; and Column 4, the ratio of the standard deviation to the mean. Source of raw data: The National Bank of Kazakhstan.

Table 2: Forecasting example

Variables	Level	Variance	Standard deviation
Price level	228.7	1,647.0	40.6
Output	128,036.7	979,119,830.8	31,290.9
M1 money	3,819,483.9	1,301,845,692,972.7	1,140,985.0
Velocity	7.7	1.9	1.4

Table 3: Marginal effects on variance of velocity

Variable	*Formula*	*Estimate*
Price level	Q^2/M^2	0.001123724
Output	P^2/M^2	3.58487E-09
Money	$3P^2Q^2/M^4$	1.20852E-11

Figure 1

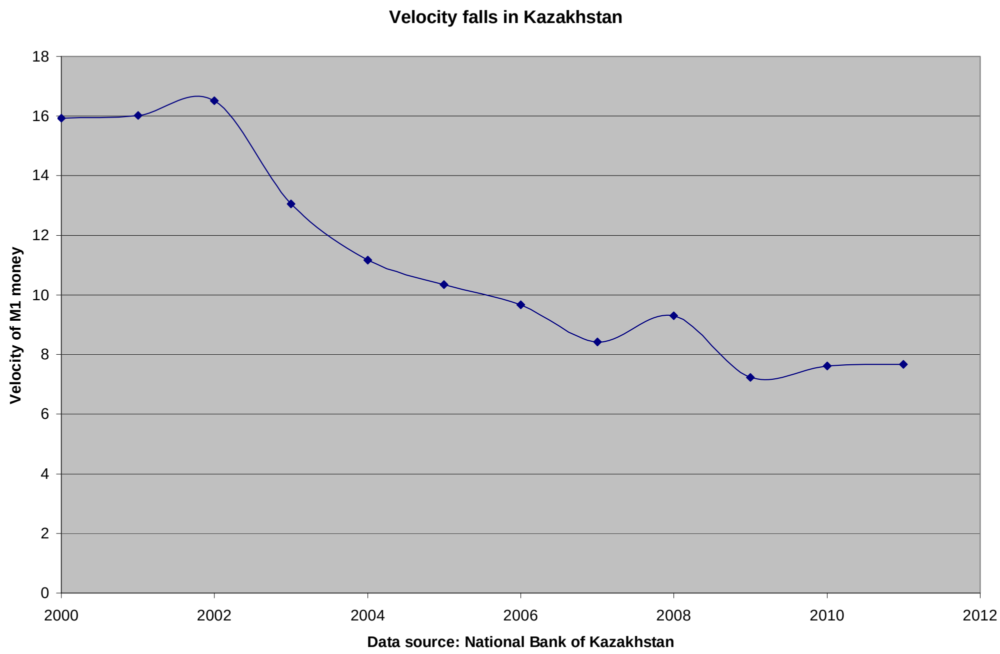

Figure 2