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Fixing Swiss Potholes*

The Importance and Cyclical Nature of Improvements

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Abstract

This note sheds new light on the dynamic properties of maintenance and repair and examines the behavior of an additional form of capital spending—that of improvements. The analysis examines a unique long-run data set on Swiss road spending.

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1. Introduction

Standard macroeconomic models allow capital to be either employed in production or idle. Recent studies, however, by McGratten and Schmitz (1999), Collard and Kollintzas (2000), and Licandro and Puch (2000) consider that capital can also spend time undergoing maintenance and repair. They find empirically that maintenance and repair expenditures are large and that if this form of spending affects the rate of capital depreciation, then the dynamic effects of maintenance and repair in model economies are also large. In particular, such time-varying depreciation rates help model economies capture important dynamics observed in the U.S. labor market.[1]

Empirically, private spending on maintenance and repair appears to be countercyclical, whereas investment in new capital is highly procyclical. Until now, the empirical evidence that maintenance and repair spending is countercyclical to GDP is limited to McGratten and Schmitz's (1999) study using Canadian data. The rationale for maintenance's countercyclical behavior is that it is cheaper for the firm to repair and maintain machines during periods of lean demand. One avenue we explore here is to examine the cyclicality of spending on maintenance of public infrastructure, roads in particular.

In this note, we also consider an additional form of capital spending: outlays for *improvements*, which expand the functions or capabilities of existing physical capital. Examples include the addition of a lane or rest stops on an existing highway or the introduction

[1]See Ambler and Paquet (1994), Burnside, Eichenbaum and Rebelo (1992, 1996) and King and Rebelo (2000) for related research.

of new filters in engines to improve air or water quality. A priori, it is not clear how improvements should behave over the business cycle. On one hand, improvements may increase the productivity of a machine and help expand production during an economic upswing. On the other hand, improvements, as in the case of maintenance and repair, require brief periods of shutdown to conduct the upgrades. The opportunity cost of carrying out improvements might be lower during periods of economic slowdown. Alternatively in the case of improvements to public infrastructure, the cyclical trade-off for governments is that tax revenues are highly procyclical, encouraging spending on improvements during booms; a countervailing force is that governments often wish to stimulate the economy in a countercyclical fashion, in which case discretionary spending on improvments might be countercyclical.

The objective of this note is two-fold; (i) to document the size of improvements relative to the other forms of capital spending and (ii) to determine whether improvements have similar cyclical properties as maintenance and repair. To shed some light on these issues, we look at a unique data set on Swiss road spending. The data are broken down into new roads, road improvements, and road maintenance and repair (hereafter road maintenance). The long-run evidence finds that spending on road improvements is larger in size than spending on road maintenance and that its cyclical behavior vis-a-vis GDP varies over time, although both improvements to and maintenance of this type of public infrastructure are predominantly procyclical.

2. Maintenance, Improvements, and New Roads

The annual data on Swiss road costs are from the Bundesamt für Statistik (BfS) and cover the years from 1927 to 1984.[2] Spending on national and cantonal roads is divided between road maintenance, road improvement and new roads. New road investments represent new road and tunnel projects, road improvements include the building of rest stops, additional highway lanes, and safety improvements, and maintenance involves mainly road resurfacing. The road data are constructed by time of expenditure.

Table 1 shows that our measure of road spending averaged 1.6% of GDP during 1963-1984 compared to 5.8% for education and 2.8% for research and development for the same period. The addition of local roads, a component not included in our road measure, would have increased the percentage to 2.2%.

To gain a sense of the size of road improvements relative to other road outlays, Figure 1 plots spending on road maintenance and road improvement relative to investment in new roads. The figure shows that spending on road improvements is larger than road maintenance for each year except for the WWII period 1940-47. The average percentage difference between spending on road improvement and new roads is 29.0 over the full sample, whereas it is only 16.1 for road maintenance.

Another feature of Figure 1 is that spending on improvements and maintenance relative

[2] The publication of this information was discontinued after 1984. The data for improvements and maintenance were not published separately before 1927.

to new roads shifts over time. During the first 30 years of the sample, road improvements and road maintenance fluctuate considerably and both are larger than new road investment. In the second half of the sample, new road investment dominates spending on improvements or maintenance. In particular, new road spending increased substantially in the 1960s because of expensive freeway and tunnel projects.

Next, to examine business cycle movements in real Swiss GDP and real road spending, we detrend each series by taking logs and subtracting the trend using the Hodrick-Prescott filter to obtain our measure of cyclicality.[3] Because the long-run series reveal changing dynamics, our remarks are aided by rolling standard deviations and correlation, which are plotted in Figures 2 to 5. The first observation concerning the filtered data regards the low cyclical volatility of road maintenance. Figure 2 shows the rolling 15-year standard deviation of GDP and the different forms of road spending. Road maintenance exhibits the lowest cyclical volatility, whereas new road investment has the highest.

The second observation concerns the procyclical behavior of Swiss road spending. To examine the cyclicality, we calculated rolling 15-year correlations of the three types of road spending with GDP. In evaluating the movement in the rolling correlations, it is useful to recall Loretan and English's (2000) caveat that sub-sample and rolling correlations can change systematically with time-varying conditional volatilities. Suppose that GDP and a class of road spending have a constant unconditional correlation structure and covariance

[3]The official BfS series for nominal GDP (1948-1984) is linked with the estimated series from Andrist *et al.* (2000). Annual CPI is used to deflate the nominal variables. The weight on the squared second difference of the growth component in the H-P filter is set to 100.

matrix, where x is cyclical GDP and y is cyclical road spending:

$$\begin{aligned} x &= \mu_x + \sigma_x u, \\ y &= \mu_y + \rho\sigma_y u + (1-\rho^2)^{0.5}\sigma_y v, \end{aligned} \tag{1}$$

where u and v have unconditional distributions that are independent standard normals, although they may have time-varying conditional volatilities within the sample.

The conditional correlation coefficient between x and y would vary from its constant unconditional value ρ within the sample period according to the conditional volatilities $\sigma^2_{u,t}$ and $\sigma^2_{v,t}$:

$$\rho_t = \frac{\rho\sigma_{u,t}}{(\rho^2\sigma^2_{u,t} + (1-\rho^2)\sigma^2_{v,t})^{0.5}}. \tag{2}$$

We take the data x and y and sample-wide unconditional values of $(\mu_x, \mu_y, \rho, \sigma_x, \sigma_y)$ to derive from equation (1) a time series of values of u and v. From these vectors, we calculate 15-year rolling estimates of $(\sigma_{u,t}, \sigma_{v,t})$ and arrive at an estimate of ρ_t from equation (2). To the extent that the time series ρ_t can match the rolling correlation coefficients, we could attribute the movement in the rolling correlation coefficient to conditional volatilities temporarily deviating from their unconditional values.

Figures 3, 4 and 5 depict the rolling 15-year correlations with the values implied by their rolling conditional volatilities. Figure 3 shows the correlations for road improvements. Road improvements have a correlation coefficient with GDP in the neighborhood of 0.5 for most of the sample, except between the late 1950s and 1965. In that period, the rolling correlations become negative, which cannot be explained by a change in relative volatilities and a constant ρ. For most of the sample period, however, the rolling correlations between road improvements and GDP are well-explained by a constant underlying correlation structure (ρ) and time-varying conditional volatilities. Road maintenance also experiences negative rolling correlations with GDP from the late 1950s to 1965. Yet, compared with road improvements, road maintenance has a much less stable cyclical relationship with GDP. The rolling correlation between road maintenance and GDP depicted in Figure 4 does not remain at its volatility-implied level after 1965. Instead, the rolling correlation exceeds 0.8 by the mid-1970s and remains high. We postulate that as the Swiss roadway system became more complex by the 1970s, planning horizons increased for improvement projects, making improvement spending less cyclical relative to maintenance spending.

Figure 5 shows that cyclical spending on new roads has the most stable cyclical relationship with GDP, in that the rolling correlations conform closely to the volatility-implied levels. Figure 2 shows that the conditional volatilities of both GDP and new road spending are high at the beginning of the sample, where the Depression figures prominently, resulting in a high volatility-implied correlation that matches the actual rolling correlation. The volatility-implied correlation is relatively low from the mid-1960s until the late 1970s, a period when idiosyncratic volatility in new road construction ($\sigma_{v,t}$) holds down the implied correlation in a way that matches the actual rolling correlations. Thus, the cyclical correlation between new road spending and GDP is the most consistent with a constant underlying correlation structure that is perturbed temporarily by volatility changes. This analysis indicates that road improvements lie between new road spending and road maintenance in terms of having a stable cyclical relationship with GDP.

3. Concluding Remarks Regarding Improvements

The long-run data on Swiss road spending allow us to make some comparative statements concerning the findings of the Canadian survey data documented in McGratten and Schmitz (1999). First, maintenance expenditures do not show tremendous cyclical volatility, as found previously in the Canadian government, household and business sector. Nevertheless, the stability of the cyclical correlation between road maintenance and GDP appears to be lower than that of improvements and new roads. Second, Swiss spending on road maintenance and on road improvement as a percentage of spending on new roads shifts substantially over time. McGratten and Schmitz (1999) find that the ratio of maintenance and repair to new physical capital is trendless for the post-1960 period. Our long-run data shows that this is only true for the period considered in McGratten and Schmitz (1999). Prior to 1960, Swiss spending on road improvement and road maintenance was much larger in size than new road spending. This latter result strengthens the view of McGratten and Schmitz (1999) that spending on maintenance and capital improvements are too large to be ignored in business cycle analysis.

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Table 1: Type of Activity as a Percentage of GDP (1963-1984)

Public Road Spending (national, cantonal, and local roads)	2.2%
National and Cantonal Road Spending	1.6%
Education	5.8%
Research and Development	2.8%

Figure 1: Spending on road improvements and maintenance relative to new roads (in percent)

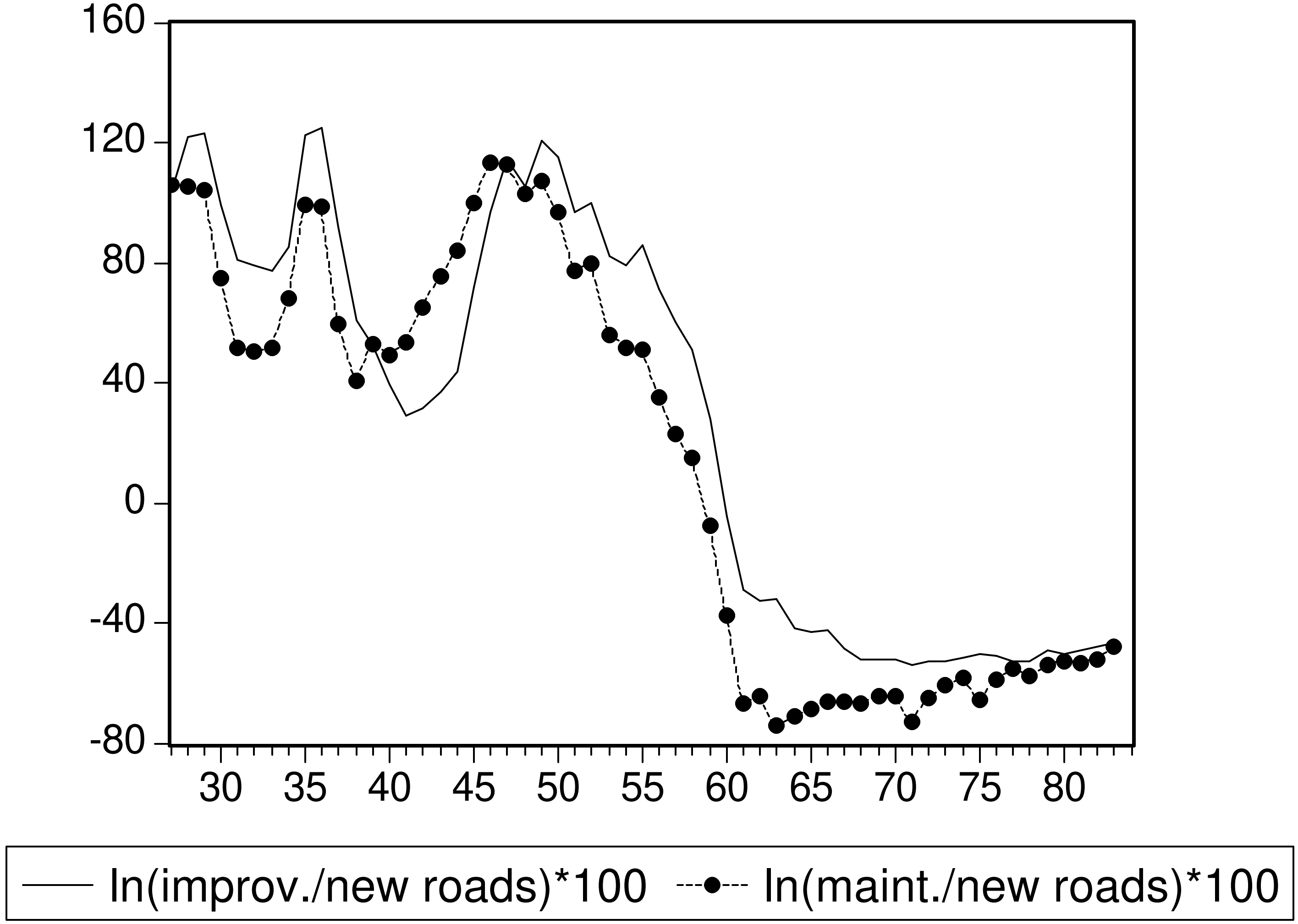

Figure 2: Rolling 15-yr. std. devs. of cyclical GDP, improvements, maintenance and new roads

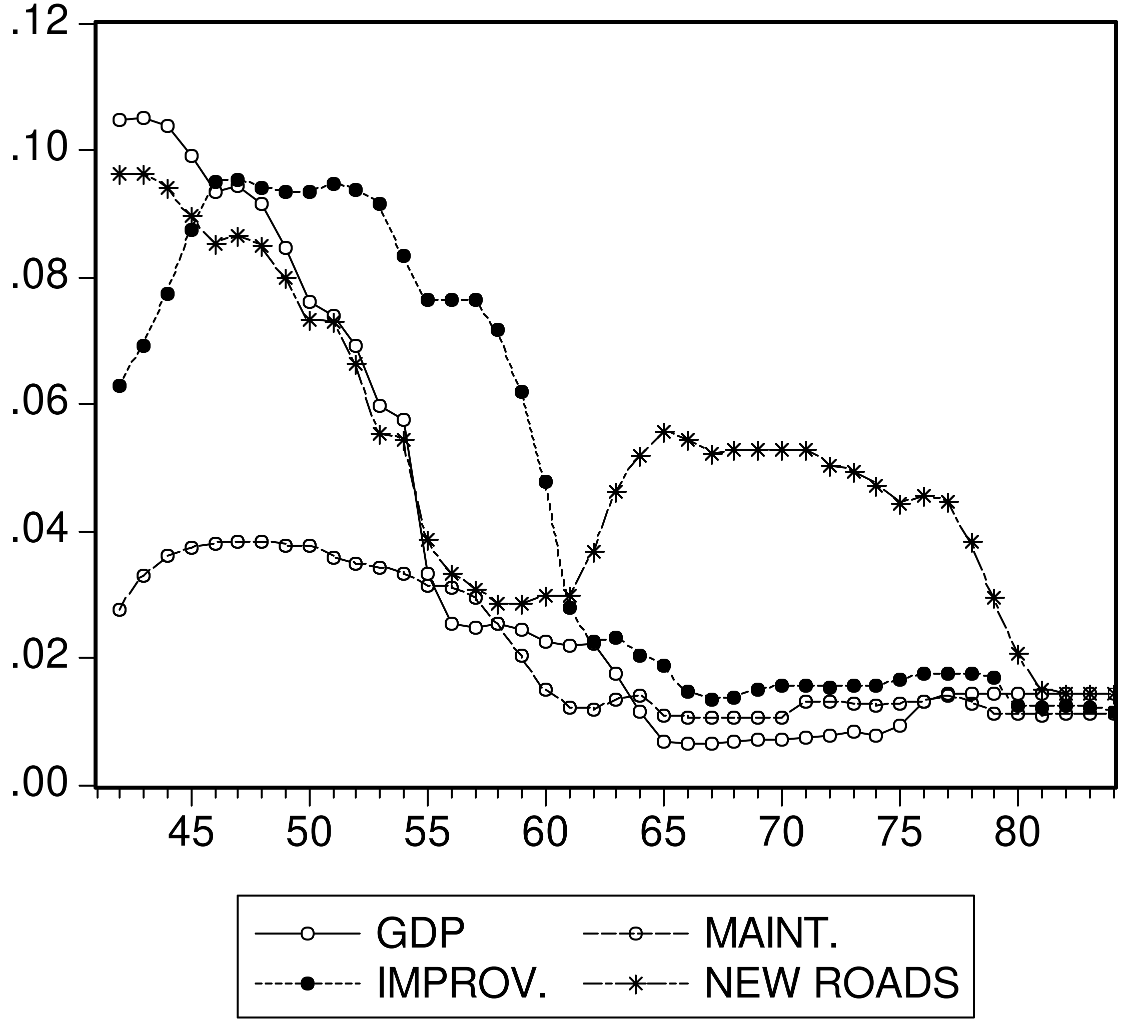

Figure 3: Rolling correlations between cyclical GDP and cyclical road improvements and values implied by volatility changes alone

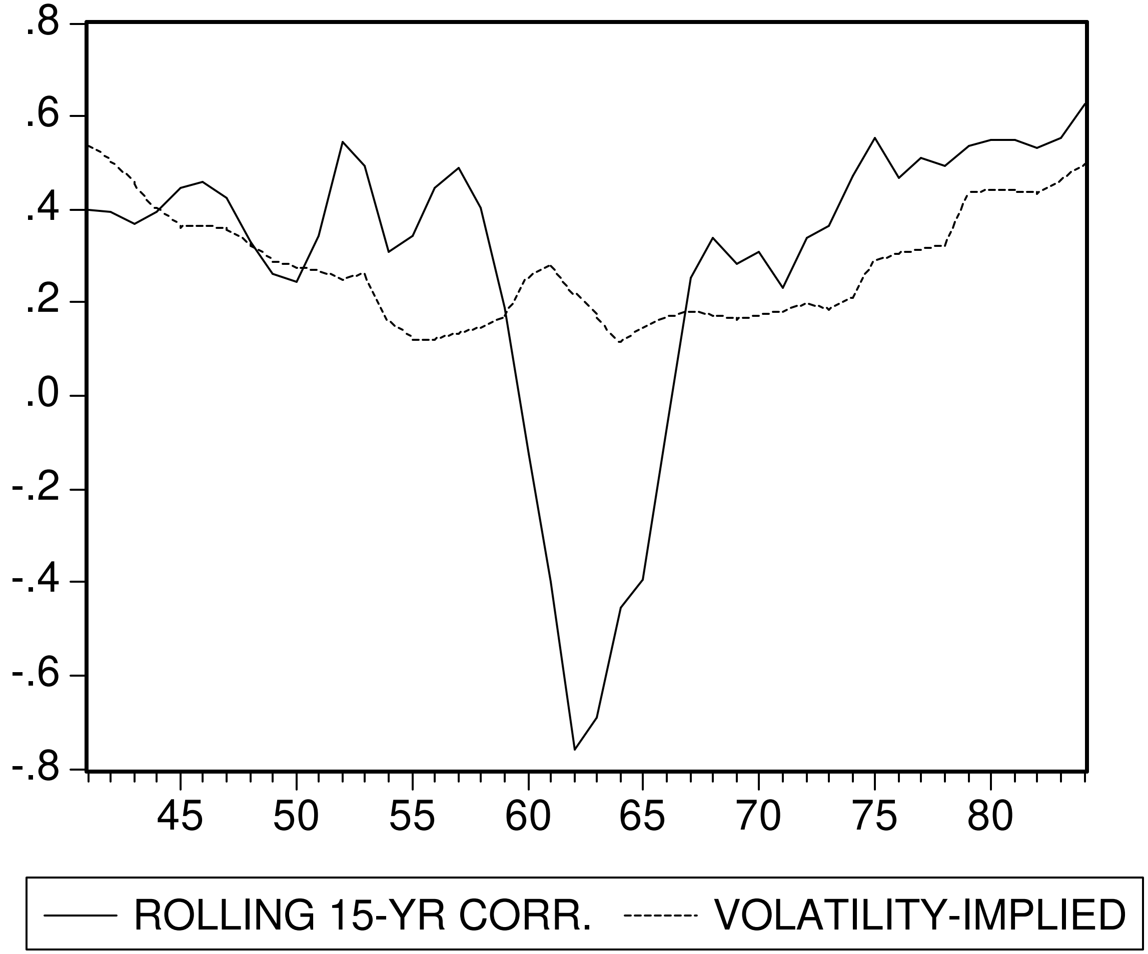

Figure 4: Rolling correlations between cyclical GDP and cyclical road maintenance and values implied by volatility changes alone

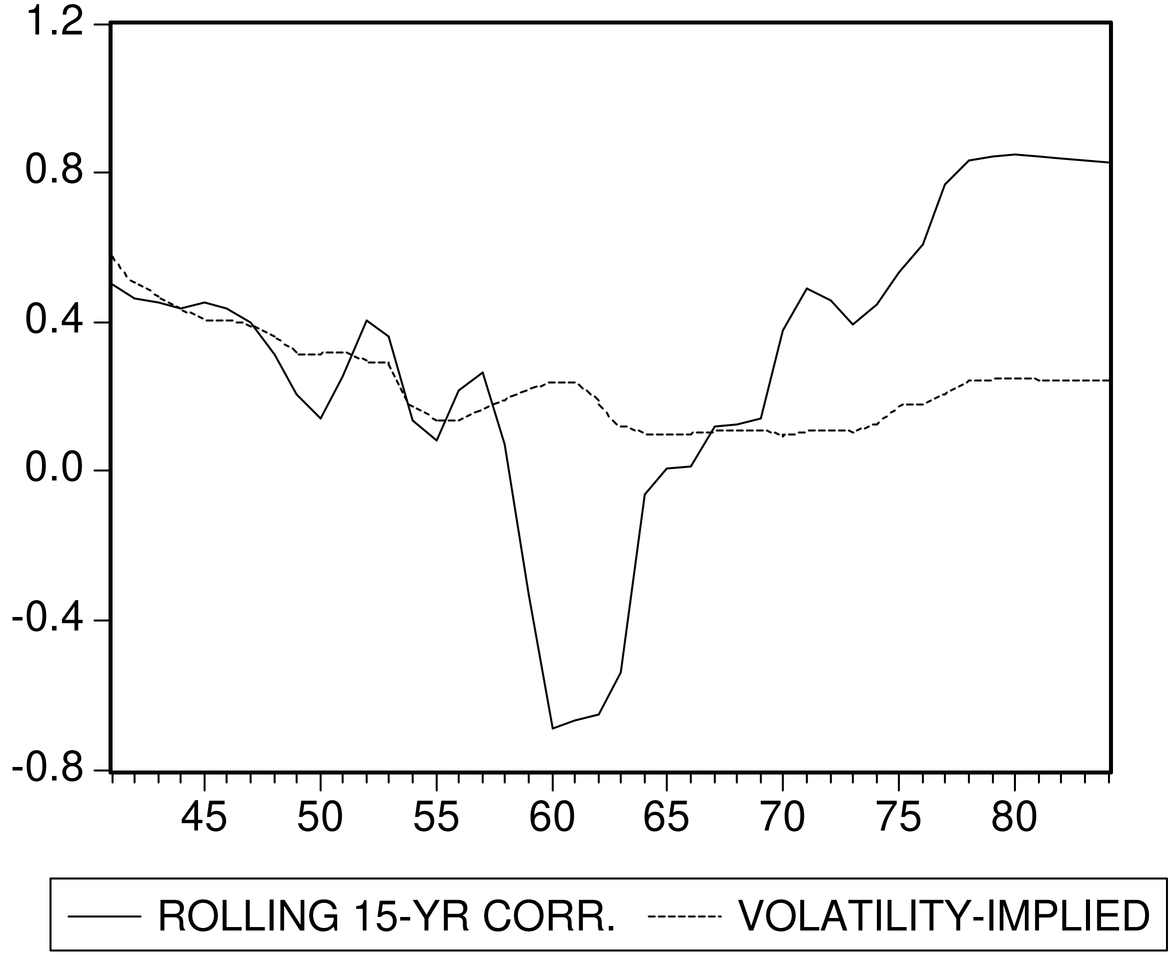

Figure 5: Rolling correlations between cyclical GDP and cyclical spending on new roads and values implied by volatility changes alone