BELARUSIAN BUSINESS CYCLE IN CROSS-COUNTRY COMPARISON: INDUSTRY AND AGGREGATE DATA

Kirill Shakhnov *

October 13, 2015

Abstract

The paper documents stylized facts about Belarusian business cycle based on aggregate and industry data and puts it into an international content. First, the aggregate fluctuations in Belarus are mostly driven by the wedge, which resembles a time-varying investment tax. Second, the fluctuation in relative prices of an industry is typically more important than volume fluctuation. Furthermore, the impact of price fluctuations is partially offset by volume fluctuation. Third, the aggregate cycle is smoother than the industry-specific one. In particular, agriculture, construction and finance experience a very sharp drop in a recession.

Keywords: bussiness cycle, industry data, Belarus.

JEL Classification: E32, L11.

BEROC Working Paper Series, Working Paper No. 30

Belarusian Economic Research and Outreach Center (BEROC) is as joint project of Stockholm Institute of Transition Economics (SITE) and Economics Education and Research Consortium (EERC) with financial support from Swedish International Development Cooperation Agency (SIDA). Today BEROC is an established economic academic think-tank in Belarus. BEROC supports academic and applied research, arranges educational programs on modern economics and other outreach activities.

*Einaudi Institute for Economics and Finance and Belarusian Economic Research and Outreach Center kirill.shakhnov@eief.it

1 Introduction

Starting from Kydland and Prescott (1982) economists have attempted to find regularities (stylized facts) that characterize business cycle. Economists have typically looked at a set of statistics: volatility of time series (standard deviations) and comovements of time series (correlations, serial correlations). Many papers have investigated this issue and several regularities have been established: consumption (of non-durables) is less volatile than output; investment is more volatile than output; hours worked are as volatile as output; all those variables are persistent and procyclical. However, the research typically employs aggregate level data of developed countries. Although there is growing data at an industry level, there is no well developed stylized facts that characterize business cycle at an industry level and/or developing countries. This paper is an attempt to fill this gap. The paper employs the aggregate level data as well as the 10-industry data for the EU countries and Belarus.

The paper contains two parts. First one, following Chari et al. (2007), investigates what time-varying wedge, that resembles either productivity, or labor tax, or investment tax, or government consumption, drives aggregate fluctuation in Belarus. Contrary to the most of countries in the sample, the main source of fluctuations in Belarus is the investment wedge, but not the efficiency wedge. This funding at least partially resurrects the importance of the investment wedge as a valid source of business cycle fluctuations in general, which was questioned previously by Chari et al. (2007), Brinca (2014). There is only one other country, Iceland, for which the investment wedge is important.

Second one is based on 10-industry data. I establish several "stylized facts". First, while manufacturing is the least volatile industry, agriculture and construction are the most volatile ones. Second, the relative price fluctuation is substantially more important than volume fluctuation. Third, the cycle is typically asymmetric: the short recession, about a year is followed by long expansion, about four years. The only industry that has a roughly symmetric cycle in both duration and amplitude is agriculture. All industries, but government, experience longer and more severe recession, but shorter and steeper expansions than overall GDP. Third, there is no industry that can be used as a leading indicator to predict a recession and/or an expansion. Furthermore, if any, it is harder to predict a expansion than a recession.

2 Data Source

The paper employs quarterly data, which are relatively scarce, especially for developing countries. Given that the average duration of recession is about a year, it is essential to use quarterly data for studying business cycle properties. The paper focuses on Belarus and the European Union countries, mostly due to data availability. The source of aggregate quarterly data on real GDP, hours, consumption, investment and government expenditure for all countries is International Financial Statistics (IFS) by the IMF. Industry value added is combined from two sources: the Eurostat for the EU countries and the Belstat for Belorussian data.[1] The length of data varies depending on a country.

[1] I would like to thank Dmitry Kruk for preparing the data.

3 Aggregate Data

This section performs a simple business cycle accounting exercise to understand, what class of models are likely to explain the behavior of the Belarusian economy. The section analyzes different types of distortions (wedges) to the equilibrium conditions of the neoclassical growth model. Based on Chari et al. (2007), Brinca (2014) further develops the methodology to asses the quantitative relevance of wedges in generating fluctuations. Brinca (2014) concludes that the labor wedge and total factor productivity are relevant to explain business cycle for many OECD countries over the period from 1970 to 2011, while the investment wedge is considerably less important. He uses deflated GDP, government consumption, gross fixed capital formation, total employment, total hours worked per employee and population from the OECD economic outlook to construct output per capita, investment per capita, total hours per capita, (government consumption + net exports) per capita, population to measure the wedges.

The idea behind this exercise is that many models with different frictions, such as labor market friction: sticky wages, unions, search, inefficient work rules, staggered wages; financial friction: collateral constraints, input financing frictions; agency costs, intangible investment and sudden stops, can be mapped into the standard Real Business Cycle growth model with time-varying wedges. Using theory and data we can measure these wedges. Furthermore, given estimated wedges, we can simulate "one-wedge-on" and "one-wedge-off" model economies to understand what wedge is more important in explaining data regularities. Proposed measures indicates how much of the observed aggregates fluctuation are accounted for by each of the simulated economies is, inter alia, the correlation between observed data and data simulated in the "one-wedge-on" economies.

3.1 The RBC model with time-variant wedges

Full-Fledged Model The following is a brief description of the procedure. All model's variables need to be expressed in per capita terms and detrended. consumption(c), labor(l), investment(x) solve

$$max c_t, l_t, x_t \sum_{t=0}^{\infty} \mathbb{E}\left[\beta\right]^t U(c_t, l_t) \tag{1}$$

subject to

$$\begin{aligned} \text{Household budget:} \quad & c_t + (1+\tau_{xt})x_t = (1-\tau_{lt})w_t l_t + r_t k_t + T_t \\ \text{Investment} \quad & k_{t+1} = (1\delta)k_t + x_t \\ \text{Resource:} \quad & c_t + g_t + x_t = y_t \\ \text{Production:} \quad & y_t = F(k_t, Z_t l_t) \end{aligned}$$

Two assumptions on function forms are made. First, The production function is assumed to be Cobb-Douglas with labor-augmented technology and constant return to scale:

$$F(k, Zl) = k^{\alpha}(Zl)^{1\alpha} \tag{2}$$

Second, Utility is assumed to be additive-separable:

$$U(c, 1l) = log(c) + \psi log(1 - l) \tag{3}$$

Taking first-order conditions of the model. We are left with four equations that defines four wedges

$$\begin{aligned}
\text{Efficiency wedge:} \quad & y_t = k_t^{\alpha}(z_t l_t)^{1\alpha} z && (4)\\
\text{Labor wedge:} \quad & \frac{\psi c_t}{(1 - l_t)} = (1 - \tau_{lt})(1 - \alpha)\frac{y_t}{l_t} && (5)\\
\text{Government wedge:} \quad & c_t + g_t + x_t = y_t && (6)\\
\text{Investment wedge:} \quad & 1 = \frac{\beta}{1 + g_z}\mathbb{E}_t \left[\frac{c_t}{c_{t+1}} \frac{\alpha \frac{y_{t+1}}{kt+1} + (1 + \tau_{xt+1})(1 - \delta)}{1 + \tau_{xt}} \right]] && (7)
\end{aligned}$$

The efficiency, labor and government wedge $z_t, 1 - \tau_{l,t}, g_t$ can be obtained directly from system (4), it is not the case for the investment wedge $1 + \tau_{x,t}$ since it involves expectations. This is why the stochastic process driving expectations (and the wedges) need to be estimated. The wedges turn to be state variables of the model. In the other words, Chari et al. (2007) have effectively assumed that agents use only past wedges to forecast future wedges and that the wedges in period t are sufficient statistics for the event in period t. It is assumed that the state variables follow a Markov process. The later assumption allows to estimate the investment wedge.

Data Using Belarusian and Eurostat data I follow Brinca (2014) as close as possible and I use following variables to estimate the wedges: output per capita, investment per capita, hours per capita, (government consumption + net exports) per capita, population.

Parameters Table 1 reports estimated parameters for Belarus and Italy:

Table 1: Calibrated Parameters

Parameters	Italy (for reference)	Belarus
g_n	0.0024	-0.0012
g_z	0.0050	0.0107
β	0.9930	0.9931
δ	0.0118	0.0118
ψ	2.24	2.24
α	0.35	0.35

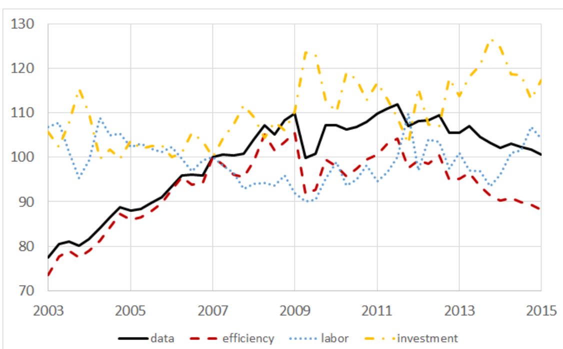
where β is a discount factor; g_n is a population growth; g_z is the trend of technology growth; δ is a depreciation rate of capital; ψ is the preference parameter (the Frish elasticity); α is the capital share in the Cobb-Douglas production function. The last two parameters are not calibrated, but set to values, which are standard for the literature.

If we look at table 1, we see that Belarus in contrast to Italy, as an example of a EU country, has higher productivity growth and declining population. The rest of parameters are remarkably similar.

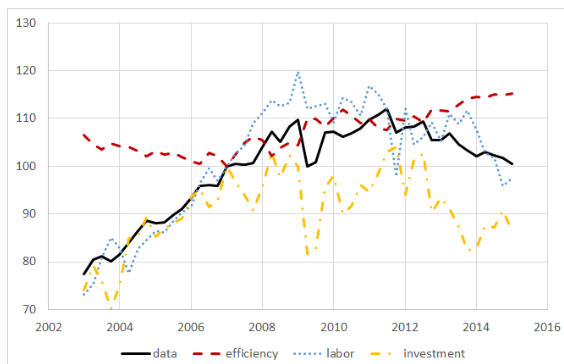
3.2 Wedges Estimation

I confirm Brinca (2014) result the most of the EU countries, but not for Belarus. In spite of all similarities in estimated parameters, the Belarusian economy has very different behavior with respect to an EU country. First, the main source of fluctuation in Belarus is the investment wedge, but not total factor productivity. This result is consistent with the previous findings by Kruk and Bornukova (2014). The investment wedge is an important factor only for one other country, which is Iceland. It is well-known that Iceland experienced the disruption of the banking system, which is consistent with an investment wedge story. Second, the labor wedge is the second important factor, which is the case for the majority countries in a sample.

Figure 1 plots the different one-wedge-on (left column 1a) and one-wedge-off (right column 1b) simulated output data against observed output data. The observed data is a solid black line. By the one-wedge-on economy I mean an economy, such as data is simulated using only one wedge, for example the efficiency wedge. Contrary, the one-wedge-off economy is an economy, such as data is simulated using all three remaining wedges, but selected one. The closer the one-wedge-on economy to the observed data there is the more important the wedge for explaining the fluctuation in output there is. The opposite is true for one-wedge-off economy: the further the economy with a particular wedge being switch-off there is, the more important the wedge for explaining fluctuation in output there is. All plots do not report the government wedge, because it has almost no impact.



(a) One-wedge-on



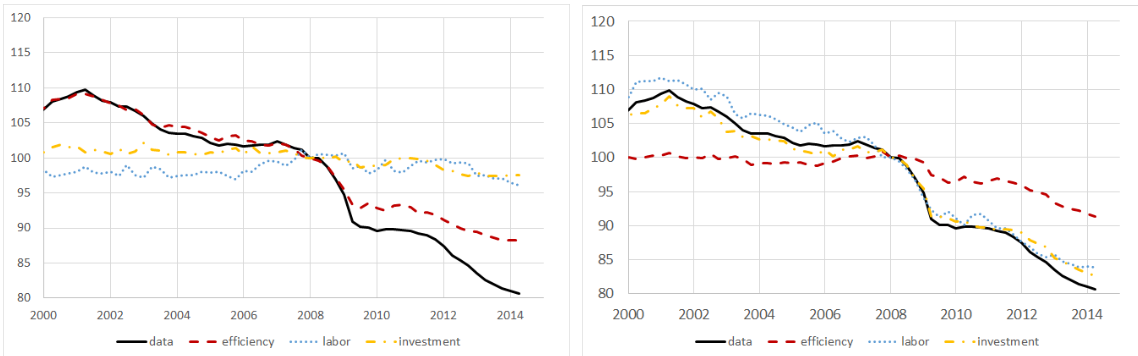
(b) One-wedge-off

Figure 1: Belarus

The efficiency wedge seems to be important for the early 2000s the period of a rapid growth in Belarus. However, it does not play an important role during the slowdown period, which starts around 2009. You can see it on both one-wedge-on and one-wedge-off plots. Contrary, the economy without the investment wedge, perform well up-to 2007 and very poorly afterwards. Similar, but to less extent is true for the labor wedge. The two wedges: investment and labor has a strong negative correlation starting from 2008. The latter might suggests that there is a common force, which drives both wedges at the same time. However, there is no theory that generates a simultaneous movement in labor and investment wedges. See Chari et al. (2007) for details.

Although the Belarusian results should be taken with caution, because it can be at least partially due to the short sample size for Belarus. If we take the result at face value, the result suggests that the combination of the credit market imperfections, such as collateral constraint, agency costs and the labor market imperfections, such as labor search costs, unions and sticky wages are key determinants of Belarusian business cycle. Consequently, policy that mitigate these imperfections, would contribute to the smoothness of business cycle.

Figure 2 represents the same exercise as Figure 1, but on Italian data. As you can see, the most important source of fluctuations is the efficiency wedge through the whole sample. The similar picture can be see for the majority of countries.



(a) One-wedge-on

(b) One-wedge-off

Figure 2: Italy

4 Industry Data

4.1 Seasonal Adjustment

The Eurostat provides both seasonally adjusted and non-seasonally adjusted data for industry value added. Only non-seasonally adjusted data for Belarus is available. The Belarusian data were seasonally adjusted using X-13ARIMA-SEATS seasonal adjustment software from the Census Bureau.

4.2 Descriptive Statistics

This section assesses the relative importance of different factors (seasonal, prices and volume) on the growth of industry value added. The nominal value added of an industry i equals to price index multiplied by volume.

$$Y_{it} = P_{it} V_{it} \tag{8}$$

Taking the change in the log from both sides of equation (8), we compute the growth rate of value added, which is the sum of the growth rate of price and the growth rate of quantity.

$$y_{it} = p_{it} + v_{it} \tag{9}$$

The change of prices (quantities) change contains a trend component, a seasonal component and a cyclical component. Given the relative short length of time series, especially for Belarus, I assume the trend component to be constant. As suggested by Canova (1998) detrending might play a role, the mean growth rate might be preferred for the short time series.

$$p_{it} = \alpha_i + \Delta p_{it}^c + \Delta p_{it}^s \tag{10}$$

Table 2 summaries the relative average growth of value added by industry for Belarus and compares it with the average among the EU countries. First, we can observe structural changes for an average EU economy, such as rapid decline the share of agriculture, manufacturing and the growth of services. However, there is no clear trend for Belarus over the five years period, for which data was available. The nominal shares of different industries remains roughly stable over the period. Although, all results for Belarus should be taken with caution due to possible short sample issues.

The last row represents the growth rate in %, while the rest is measured in the terms relative to GDP. The first and the fourth columns represent the relative growth of nominal value added by industry First, the prices (measured as a industry specific GDP deflator over the GDP deflator) grew at substantially higher rate in Belarus (7.2% in contrast to the country average 0.78 %), which is not surprising. What is surprising is that the prices grew relatively equally for all industries. In

Table 2: Relative growth rates

Industry	The growth of value added in industry as a fraction of the GDP growth					
	Bealrus			Average		
	Nominal	Vol.	Price	Nominal	Vol.	Price
Agriculture	100%	92%	108%	40%	17%	64%
Industry	98%	110%	94%	82%	87%	92%
Manufacturing	101%	107%	97%	72%	98%	14%
Construction	105%	49%	110%	90%	31%	84%
Consumer Serv.	105%	202%	93%	101%	140%	81%
Finance	111%	196%	99%	113%	148%	50%
Producer Serv.	114%	58%	118%	125%	111%	92%
Government	95%	-18%	106%	108%	76%	142%
Personal Serv.	109%	135%	101%	115%	52%	111%
GDP	8.10%	0.91%	7.19%	1.41%	0.55%	0.78%

the other words, there was no substantial relative price effect for Belarus. The most of countries experienced the sharp drop of relative prices for manufacturing and agricultural products, as well as financial services.

Many countries experience a real decline in some industries. The most prominent example is agriculture in the new member states, such as Cyprus, Bulgaria, Croatia, Greece, Czech Republic, but it is not the case for Belarus. Belarusian economy has a relatively strong growth in agriculture, which is only partially driven by the growth of relative price. Fewer ones experience a reduction in the size of public sector, including Belarus, Romania and Czech Republic. The real value added in Construction is typically growing twice as low in the comparison to real GDP. It is also true for Belarus.

The growth of real value added in finance is typically substantially higher than the overall GDP growth. Belarus is no exception in this respect.

Finally, with minor exception there is no industry that grows faster than GDP in terms of both real volume and price, while there are industries that grow slower in both terms.

It is interesting to assess the importance in terms of volatility of different factors. The variance of value added of an industry might be split into five components: a seasonal component, a cyclical component of price, a cyclical component of quantity, covariance of the two and an error term.

$$Var[y_{it}] = Var[y_{it}^s] + Var[p^c] + Var[v^c] + Cov[p^c, v^c] + Var[\epsilon_i t] \tag{11}$$

Normalizing by the total variance of value added, we can assess the relative importance of all components. Table 3 provides details.

The second and third columns represent volatility of the growth rate of value added for different industries of Belarus and the unweighted average of all countries respectively. All time series exhibit

Table 3: Variance Decomposition

	St. deviation of growth rate, in %		Seasonal Factors		Cyclical Factors					
					P	Q	cov(P,Q)	P	Q	cov(P,Q)
	BLR	Aver.	BLR	Aver.	Belarus			Average		
Agriculture	37%	43%	96%	78%	3%	0%	0%	22%	14%	-8%
Industry	28%	9%	41%	71%	63%	5%	2%	18%	20%	-5%
Manufacturing	28%	9%	38%	67%	56%	4%	2%	16%	23%	-5%
Construction	32%	26%	100%	83%	13%	3%	-2%	6%	7%	0%
Consumer Serv.	30%	13%	32%	80%	60%	13%	-6%	12%	8%	-1%
Finance	28%	15%	69%	47%	26%	10%	-1%	40%	25%	-9%
Producer Serv.	31%	10%	82%	70%	38%	3%	-1%	24%	12%	-3%
Government	28%	13%	79%	79%	30%	0%	0%	19%	5%	-2%
Personal Serv.	29%	15%	30%	72%	97%	21%	-23%	22%	15%	-4%
GDP	29%	9%	71%	84%	17%	3%	-2%	10%	4%	-1%

substantial fluctuation. The most volatile ones are typically Agriculture and Construction. The fourth and fifth columns indicate that all time series for countries contain a seasonal component. The strongest seasonal component can be typically found in Agriculture and Construction series, although there is a substantial degree of heterogeneity among countries, but typically more volatile industries have a higher share of volatility attributed to seasonal factors. It is true for the most of countries in a sample as well as for Belarus. For example in Belarus, the decline in Value Added in Agriculture due to seasonal factors from quarter to quarter can be as high as 50 % from the trend. However it is not even the highest decline in a sample (the Value added for Agriculture, Hunting and Forestry, Fishing declines up to seven times from the third quarter to the fourth quarter in the case of Romania.) Several countries manage to smooth seasonal factors for Agriculture and Construction. France and Belgium do a particular good job in this respect. On the opposite end of a spectrum is Finance, on average less than a half fluctuation in finance can be attributed to a seasonal factor. It is not the case for Belarus, possible due to low diversification and higher exposure of Belarusian banks to domestic agriculture and construction, which are strongly affected by seasonal factors. The least affected industries in Belarus are wholesale and retail trade, accommodation, transportation and communication; community, social and personal services, possible due to a higher degree of government regulation.

Columns P, Q and cov(P,Q) represent the share of variance, which can be explained by the cyclical component of prices, volumes and the covariance between the two. Price fluctuations are substantially more important, than volume fluctuation. Furthermore, the price fluctuations are partially offset by the volume fluctuation. Although, there is one notable exception, Construction. When the price increase coincide with the construction boom. It might suggest that Construction is the only industry which is driven by demand, rather than supply. Another exception is community, social and personal services in Belarus. However, it can be due to measurement errors due to the relative short sample of Belarusian data.

4.3 Duration and Amplitude of Booms and Busts

It is well known that the business cycle is often a boom-and-bust cycle, in which the expansions are prolonged and the contractions are steep and severe. This section intends to provide evidence on whether it is true for all industries and countries. I employ the Engel (2005) implementation of BBQ algorithm (Harding and Pagan, 2002) ,which is a quarterly approximation to Bry and Boschan (1971) to detecting and forecasting business cycle turning points. For the purpose of this exercise, I use only real data (volumes).

Table 4 summarizes the average data on duration and amplitude of a contraction and an expansion. A contraction (expansion) is defined as value added decline (growth), which lasts at least ***two quarters***. The duration of a contraction is a length of the preceding peak to the trough, while the duration of an expansion from the trough to the peak. The amplitude of the recessions is measured by the percent contractions in volumes from the peaks to troughs.

Table 4: Duration and Amplitude

	Duration		Amplitude	
	Recession	Expansion	Recession	Expansion
Agriculture	5.7	6.0	-14.5%	14.7%
Industry	4.4	12.6	-7.7%	17.5%
Manufacturing	4.6	10.8	-8.6%	17.8%
Construction	6.5	10.3	-14.4%	19.1%
Consumer Serv.	4.5	16.5	-7.1%	23.5%
Finance	4.5	11.2	-11.3%	23.9%
Producer Serv.	4.8	16.3	-4.3%	17.6%
Government	4.0	15.3	-3.8%	10.0%
Personal Serv.	5.8	13.5	-9.6%	15.6%
GDP	4.3	17.1	-3.9%	13.1%
NBER data	3.7	19.5	-1.7%	7.9%

Analyzing table 4, we can establish some facts. First, if we compare the last two columns of table 4, we see that the average duration and amplitudes of expansion is remarkable similar between the US and my sample of European countries. The contractions are shorter and less severe in the US though. Second, contrary to the rest of economy, Agriculture exhibits an almost symmetric cycle with total length of around three years. Third, Agriculture, Construction and Finance typically experience during recession a severe drop. Fourth, the longer a recession there is, the more severe it is. The opposite does not seems to be true: a longer expansion does not necessary has a high amplitude.

4.4 Leading Indicators of recessions and expansions

As suggested by 4, the industry fluctuations happens with high frequency. The interesting question, perhaps, is to see whether a drop/expansion of a particular industry can be a predictor for overall recession/expansion. Unfortunately, the lag of industry specific recession/expansion has a lower predictive for overall recession/expansion. However, forecasting of turning points is nontrivial as suggested by previous research (Zellner et al., 1991; Harding and Pagan, 2008).

Table 5 reports odd-ratios and unconditional probability of a recession/expansion. The odd-ratio measure how likely to have an overall recession next period after the recession starts of a particular industry in current period. No surprisingly, recessions are more likely after the recession of a particular industry occur. industrys, which have the strongest impact on overall probability of a recession, are manufacturing and Wholesale and retail trade, transport and communication, accommodation and food service activities. However, at best the recession in manufacturing leads to overall recession only in 11 % cases. It seems to predict expansion even harder, than recession. The recovery in finance and construction occasionally leads to the overall expansion. Although at best the expansion in construction leads to overall expansion only in 7 % cases.

Table 5: Leading Indicators

	Recession		Expansion	
	oddratio	Prob.	one quarter	Prob.
Agriculture	1.1		0.7	
Industry	3.0		1.7	
Manufacturing	3.9	11.3%	1.6	
Construction	2.6		2.5	7.3%
Consumer Serv.	3.7	10.0%	1.5	
Finance	1.9		2.4	7.1%
Producer Serv.	1.3		1.9	
Government	0.3		1.7	
Personal Serv.	2.2		1.8	
Number of events	75.0		77.0	

The total number of recession and expansion of GDP in the sample is 75 and 77 consequentially, reported in the last column of table 5.

References

Brinca, P. (2014): "Distortions in the neoclassical growth model: A cross-country analysis," *Journal of Economic Dynamics and Control*, 47, 1 – 19.

Bry, G. and C. Boschan (1971): *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, National Bureau of Economic Research, Inc.

Canova, F. (1998): "Detrending and business cycle facts," *Journal of Monetary Economics*, 41, 475–512.

Chari, V. V., P. J. Kehoe, and E. R. McGrattan (2007): "Business Cycle Accounting," *Econometrica*, 75, 781–836.

Engel, J. (2005): "Business Cycle Dating Programs," report, http://www.ncer.edu.au/data.

Harding, D. and A. Pagan (2002): "Dissecting the cycle: a methodological investigation," *Journal of Monetary Economics*, 49, 365–381.

——— (2008): "business cycle measurement," in *The New Palgrave Dictionary of Economics*, ed. by S. N. Durlauf and L. E. Blume, Basingstoke: Palgrave Macmillan.

Kruk, D. and K. Bornukova (2014): "Belarusian Economic Growth Decomposition," report, Belarusian Economic Research and Outreach Center.

Kydland, F. E. and E. C. Prescott (1982): "Time to Build and Aggregate Fluctuations," *Econometrica*, 50, 1345–70.

Zellner, A., C. Hong, and C.-k. Min (1991): "Forecasting turning points in international output growth rates using Bayesian exponentially weighted autoregression, time-varying parameter, and pooling techniques," *Journal of Econometrics*, 49, 275–304.