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PREFACE BY THE EDITOR-IN-CHIEF

Dear readers,

The current issue of the *Visnyk of the National Bank of Ukraine* deals with two research lines that are important for policymaking. The first one concerns the usefulness of, and prospects for, dynamic stochastic general equilibrium (DSGE) modeling for policy analysis and forecasting. The second line highlighted by our contributors addresses the question of market signals and market efficiency.

The first article, *Applications of DSGE Models in Central Banking: Key Issues Explored During a Research Workshop of the National Bank of Ukraine*, by Serhii Kiiashko, reviews an NBU research workshop on the application of DSGE models in central banking. The author summarizes the discussion on the key advantages and shortcomings of using DSGE models as a tool for policy analysis and forecasting. This article considers potential ways to resolve issues and improve the use of such models for central banks' practical purposes.

The second article, *Macroeconomic Effects of Minimum Wage Increases in an Economy with Wage Underreporting*, by Anastasiia Antonova, applies a DSGE model to answer a topical question for emerging markets, and for Ukraine in particular: What role does the presence and degree of underreporting play in forming the macroeconomic response to an increase in the minimum wage? The author shows that the macroeconomic effect of a minimum wage increase depends on the share of non-Ricardian households, who do not have any savings and consequently consume all of their income. An economy is concluded to be less responsive to minimum wage changes if there is wage underreporting.

Shaun Hargreaves-Heap and Oleksandr Talavera in the third article, *Efficiency in the Market for Financial Advice to Businesses*, examine empirically whether the quality of consulting services affects the decision of a business to switch advisors. The outcomes show that new hires bring an improvement in advisor quality only in less than 10% of all switches.

Although all three papers bring us important conclusions, many other issues that are still of interest to policymakers and academics remained unaddressed. Therefore, the Editorial Board encourages research contributors to conduct their own research and submit their manuscripts for publication in the *Visnyk of the National Bank of Ukraine*.

Best regards,
Dmytro Sologub

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APPLICATIONS OF DSGE MODELS IN CENTRAL BANKING: KEY ISSUES EXPLORED DURING RESEARCH WORKSHOP OF THE NATIONAL BANK OF UKRAINE

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Abstract This paper reviews a research workshop that was held by the National Bank of Ukraine (NBU) in November 2018 on the application of DSGE models in central banking. We summarize the discussion of the advantages and drawbacks of DSGE modeling and potential ways to resolve issues and improve the models. Furthermore, this paper provides guidance on using DSGE models for forecasting and policy analysis.

JEL Codes E37, E52, E58

Keywords macroeconomic models, dynamic stochastic general equilibrium models, monetary policy, forecasting, policy analysis

1. INTRODUCTION

Efficient monetary policy is impossible if a central bank is unable to accurately forecast macroeconomic variables and analyze various policy scenarios. For those needs, central banks currently use many classes of economic models of differing complexities based on data and/or theoretical derivations. Dynamic stochastic general equilibrium (DSGE) models are a relatively new and popular class of models (see Nikolaychuk and Sholomnytskyi, 2015) for details on the use of different economic models in central bank policy making.

DSGE models encompass a broad range of models including neoclassical and New Keynesian monetary models that feature many real and nominal frictions. The key distinction of this class of models is that the decisions made by economic agents (households, firms, lenders, government, etc.) are based on assumptions about preferences, information, technologies, etc., and are derived from intertemporal and intratemporal optimization problems. DSGE model forecasts of macroeconomic indicators have proven themselves to be competitive with other econometric and semi-structural models, while their theoretical coherence makes the models suitable for policy experiments.

Nonetheless, as all models are simplifications of reality, DSGE models often cannot capture all the dynamics and relationships between macroeconomic time series. In addition, many economists believe DSGE models are not better in projecting economic performance than some other econometric or semi-structural models, while the development and maintenance of DSGE models is much costlier. Finally, DSGE models were blamed for not having been able to predict the recent financial crisis.

These and other issues raise questions about whether DSGE models are still useful for forecasting and policy analysis at central banks. If they are not, what types of models can surpass them? If they remain useful, what can be done to improve them? Should economists develop more detailed and elaborate models, or will smaller-scale models do a better job? What is the role of DSGE models in the future:

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should central bankers use DSGE models as core models or as supplemental models? The NBU held a workshop in November 2018 to address these and other questions.

2. DSGE MODELS FOR POLICY ANALYSIS

Are DSGE models useful for policy analysis? Guido Ascari (University of Oxford and Pavia) started his talk by sharing his opinion on the future of macroeconomics and stating the two principles of economics: “all models are false” but “some models are useful.” Guido Ascari is certain that a “good” model exists, however, a model is only good for a particular research question. In his view, economists have been engaged in similar “macro wars” in the past (for example, after the Great Depression or the period of Stagflation) and each time it gave rise to new features in macroeconomic models that made them useful for analysis, forecasting, and policy making. This time is no different, according to Mr. Ascari, and he encouraged participants to avoid useless debates and instead focus on incorporating any missing features into DSGE models, including financial frictions and banking, heterogeneity, bounded rationality, robust control, information, coordination failures, and more.

Mr. Ascari then presented two applications of a state-of-the-art medium-scale New Keynesian DSGE model (in the spirit of Christiano et al. (2005) or Smets and Wouters (2007): “Business cycles, investment shocks, and the ‘Barro-King’ curse” (Ascari et al., 2016) and “On the welfare and cyclical implications of moderate trend inflation” (Ascari et al., 2015).

The first paper proposes a way to escape the well-known “Barro-King” curse: models with investment shocks predict a negative correlation between consumption and investment and a weak positive correlation between consumption and output, whereas post-war data suggest a positive correlation between consumption and investment and a strong positive correlation between consumption and output. The reason is that a positive shock to the rate of return on capital incentivizes households to save to invest more. In addition, an increase in the marginal utility of consumption shifts labor supply to the right, raising hours worked and output.

The authors find that the introduction of two realistic features, a “roundabout production” structure and realistic real per capita output growth in neutral and investment-specific technologies, are sufficient to eliminate the “Barro-King” curse. The introduction of intermediate goods producers decreases the sensitivity of the real marginal cost to changes in factor prices, flattening the New Keynesian Phillips Curve. Trend growth makes firms more forward-looking when setting prices. Consequently, following a positive shock to the marginal efficiency of investment, the marginal cost does not increase by that much, which leads to a larger and more prolonged increase in output. The latter in turn makes the income effect on consumption stronger overturning the negative substitution effect. As a result, consumption co-moves with investment and has stronger correlation with output.

The second paper focuses on the welfare losses of moderate trend inflation. After the Great Recession, many economists advocated for an increase in the inflation target from 2 to 4 or 5 percent. An argument in favor of such a measure is that it would allow to restore flexibility to lower nominal interest rates and to escape zero lower bounds in future recessions. In addition, as recent literature suggests, the costs of increasing trend inflation are low, and the benefits likely outweigh these costs. This raises the question of whether central banks are right opposing an increase in inflation targets.

Mr. Ascari and his co-authors find that once a “small-scale” model is augmented with several realistic features, the predicted cost of higher trend inflation increases significantly. An increase in trend inflation from 2 to 4 percent implies a 4.3% decrease of mean consumption and a 3.7% decrease in non-stochastic steady-state consumption compared to 0.17% and 0.22%, respectively, in sticky-price models that lack those main features. The authors conclude that wage rigidity is costlier than price rigidity and that the costs of trend inflation are amplified by trend growth, roundabout production, extended borrowing, and shocks to the marginal efficiency of investment.

Jesper Linde (Sveriges Riksbank) opened the NBU’s workshop with a presentation titled “DSGE Models: Still Useful in Policy Analysis?”. In his view, despite undisputed fundamental flaws and the inability of DSGE macroeconomic models to predict the Great Recession (2008-2009), they will continue to be an important tool for policy analysis and decisions. In addition, Jesper shared his view on how core macro models should be changed, and the list of criteria required for a model to be useful and influential.

Following the unexpected sharp economic decline in 2008, many held the view that DSGE models failed to predict the crisis and, thus, should be abandoned and substituted for alternative approaches. However, others, like Mr. Linde, believe there is nothing wrong with DSGE models, though, the models indeed should be revised to encompass all relevant features: the financial sector, financial frictions, non-linearities, heterogeneity, and other factors.

Mr. Linde agreed that the crisis revealed some severe weaknesses in DSGE modeling, for example, the models could not predict the crisis, especially not in expectation. However, professional forecasters who used alternative forecasting approaches, like Bayesian Vector Autoregression Models (see Linde et al., 2016), also failed to predict the crisis. Mr. Linde noted that policy model specification reflects an active interplay between policymakers and model builders. This was one of the reasons why DSGE models did not feature an elaborated financial system with financial frictions. And, since the prevailing belief among policymakers and model builders was that substantial financial sectors shocks were improbable, the models were unable to predict the crisis.

How should new models be developed? Mr. Linde believes economists should focus on smaller models first to study new mechanisms and to introduce those mechanisms to large-scale core models only after they are understood. In his view, medium-scale DSGE models will dominate at least in the nearest future as they better fit some of the criteria of useful core policy models, such as being in-line with the institutional view, being important in communicating future policies on outcomes today, being relatively accurate at forecasting, and, finally, being simple and transparent enough to be understood by policymakers and maintained when model builders leave.

Ahn Nguyen (Bank of Lithuania) presented a joint project with Aurelija Proskute titled “Lithuania, Euro Area, and global economy”. The project aims to study the transmission mechanism of the European Central Bank’s monetary policy to the Lithuanian economy. The model features four geographical regions (Lithuania, the rest of the euro area, the US, and the rest of the world), the Monetary Union (monetary policy reacts to the union's economic conditions), and intermediate goods. The regions are connected via trade and financial links to account for macroeconomic spillover.

Oleksandr Faryna (National Bank of Ukraine) presented a paper called "Short-term costs of disinflation in a closed economy and a small open economy" (with Magnus Jonsson and Nadiia Shapovalenko). Since inflation targeting has become a popular monetary policy regime, questions have emerged about the costs of disinflation – the reduction in long-term inflation. The existing literature is focused on closed economies (see Ascari et al., 2013), while empirical papers studying open economies have mixed results, so the paper contributes by studying the costs of disinflation (measured as a sacrifice ratio) for a small open economy and comparing the results with a benchmark closed economy.

The study finds that disinflation in a small open economy is costlier than in a closed economy. Following an increase in the real interest rate, the real exchange rate appreciates, causing a decrease in net exports which makes the output loss larger for a small open economy. An optimal policy that minimizes the central bank loss function should focus on output stabilization and not on stabilizing the exchange rate.

In addition, Mr. Faryna studies optimal policy rules in an environment with imperfect credibility. He concludes that the costs of disinflation can increase substantially under this assumption. An optimal policy in this case should pay more attention on inflation expectations rather than output stabilization. In addition, the pre-announcement of a new inflation target can decrease the sacrifice ratio especially in a model with imperfect credibility.

3. CHALLENGES IN DEVELOPING AND SOLVING DSGE MODELS

Despite the numerous benefits of using DSGE models for policy analysis and policy making, not all economists are convinced that this class of models will dominate in central banks. One such example is Jaromír Beneš, independent consultant and formerly of the International Monetary Fund (IMF) and the Czech National Bank (CNB). He presented a talk titled "Beyond traditional DSGEs in real-world policy making". The speaker was more pessimistic than other workshop participants about the application of DSGE models in forecasting and policy analysis.

In his view, even though DSGE models are useful in policy analysis, the transition from QPM (smaller-scale semi-structural models) to DSGE models does not necessarily constitute progress. One of the greatest drawbacks of DSGE models is the time dimension and uncertainty about the future. In the speaker's point of view, in the real world, people think of the future, form expectations, and make their choices differently than how economists model those decisions. For example, the Lehman Brothers bankruptcy led to the reevaluation of investment models, more conservatism, and a general disengagement from risky activity. This behavior clearly suggests an aversion to this kind of uncertainty rather than merely an increase in exposure to risk, indicating the non-ergodicity of the real world – a feature that conventional DSGE models miss. In Mr. Beneš' point of view, these types of issues are added to DSGE models as an afterthought which makes these models less consistent externally.

The other shortcoming of DSGE models, according to Mr. Beneš, is intertemporal optimization. While intratemporal optimization is the "greatest blessing of DSGEs," intertemporal optimization ignores many things like fundamental uncertainty and the non-ergodicity of the real world. To resolve this issue, the speaker proposes considering an optimization problem over a finite horizon with "scrap value" left after the planning horizon.

Marcin Kolasa (Narodowy Bank Polski) discussed challenges in forecasting using small open economy DSGE models. The talk was based on two papers: "Does the foreign sector help forecast domestic variables in DSGE models" with (Kolasa and Rubaszek, 2018), and "Exchange rate forecasting with DSGE models" with (Ca'Zorzi and Rubaszek, 2017).

Generally, there is a consensus that forecasts based on DSGE models are as accurate as forecasts based on time series models or professional forecasters. However, most studies that support this point of view are based on the US economy and closed economy set-up whereas central banks predominantly use open economy models. In the first paper, Marcin and his co-author study the forecasting performance of open economy DSGE models (based on Justiliano and Preston, 2010) in comparison to a New Keynesian closed economy benchmark. The authors use long period data from Australia, Canada, and the United Kingdom. The main finding of the paper is that small open economy models not only fail to outperform the closed economy benchmark models, but even have worse forecasts for important domestic variables.

Marcin concludes that even though there are potential gains from using larger models with richer specification and more observables, these models in fact can produce less accurate predictions due to misspecification (particularly, international competitiveness block), larger estimation forecast errors, or wrong priors.

A challenge in international economics is the poor performance macro models have in explaining exchange rate dynamics; even naïve random walk models tend to outperform them. Recent developments in empirical literature suggest, however, that the real exchange rate can be better described by a mean-reverting process. The second paper is, thus, devoted to the question of whether modern open-economy DSGE models that account for this feature of the exchange rate can be more useful than the simplest random walk process. The results are mixed.

The good news is that state-of-the-art open economy DSGE models consistently outperform random walk in forecasting real exchange rates over the medium-term. In addition, their performance is comparable to an autoregressive process and a Bayesian vector autoregressive process. On the downside, however, DSGE models fail to predict nominal exchange rates because they struggle to forecast the co-movement between domestic and foreign prices. To beat the random walk in forecasting both real and nominal exchange rates, models must hold true three principles: ignore high exchange rate volatility, exploit the mean reversion of real exchange rates, and account for the co-movement of international prices.

Guillermo Hausmann-Guil (Bank of Lithuania and Vilnius University) presented his paper titled "Solving recursive macroeconomic models around the ergodic steady state". Most DSGE models are solved using local (perturbation) methods, e.g., approximating the value and policy around the steady state. However, this approach has some limitations: it requires a well-defined steady state, there is a certainty equivalence up to the first order, and it cannot deal with incomplete markets.

The speaker introduced a method to resolve the aforementioned issues. That approach also allows the models to be extended by adding a continuum of ex-ante identical agents that are heterogeneous ex-post, idiosyncratic and aggregate risk, and portfolio choice.

Alon Binyamini (Bank of Israel) discussed ways to fit non-stationary data to standard models (including DSGE) that rely on stationarity assumptions like a balanced growth path and more.

4. DSGE MODELS WITH FINANCIAL FRICTIONS

DSGE models were blamed for being unable to predict the financial crisis in 2008. As a result, macroeconomists started to incorporate banking and financial sectors with various financial frictions to DSGE models to make the models more useful in predicting future financial crises and to be able to use these models to study efficient macroprudential policies.

One such model is outlined in a paper by Janius Karmelavicius (Bank of Lithuania) titled “Bank credit and money creation in a DSGE model of a small open economy” (with Tomas Ramanauskas (Bank of Lithuania)). In this project, the authors focus on the fact that the banking system not only reallocates real resources in an economy, but also is an important driver of money growth and, hence, inflation dynamics.

Mr. Karmelavicius considers a small open economy model within a monetary union with rigid prices and a bank with an explicit balance sheet. The model is calibrated to match Lithuania’s economic data. The authors show that the financial system is highly elastic, meaning that banks can extend credit irrespective of accumulated resources or the need to increase nominal interest rates. In the extension of the model, among other features, the authors consider housing, mortgages and endogenous mortgage defaults, multi-period loans etc., and analyze the efficiency of different prudential policy tools (LTV tightening, capital requirements, etc.) in minimizing default risks.

Another example is a paper by Ales Marsal (National Bank of Slovakia) titled “Trend inflation and asset pricing in a DSGE model” (with Lorant Kaszab (MNB) and Katrin Rabitch (Vienna University of Economics and Business)). This paper contributes to the discussion of the so-called “bond premium puzzle” – the fact that the term structure of interest rates is upward sloping which is hard to explain using conventional models and assumptions.

The authors show that the Rudebusch and Swanson (2012) model ability to explain large and volatile term premium and key macroeconomic variables at the same time relies heavily on an assumption of zero trend inflation. They show that once this assumption is added to the model, business cycle and bond price dynamics become implausible. Mr. Marsal also discussed several extensions of the model which can partially alleviate this issue.

5. DSGE MODELS IN MONETARY POLICY DECISION MAKING

Are DSGE models useful for forecasting and decision-making purposes and how are these activities organized at different central banks? These and other related questions were discussed in a separate session.

Karel Musil (Czech National Bank) discussed a core projection DSGE model used by the Czech National Bank (CNB). The speaker started his talk by highlighting that the CNB is one of the most transparent central banks in the world. The CNB not only publishes most details on its forecasts and macroeconomic projections, but also reveals its core model with coefficients and codes to allow outsiders to replicate the projections.

The CNB began developing its DSGE model (called “g3”) in 2007, and in 2008, it replaced the quarterly projection model previously used as the CNB’s main forecasting tool. g3 is a small open economy DSGE model that captures the main characteristics of the Czech economy. The model features standard frictions like Calvo price settings, habits in consumption behavior, capital formation, and more. It has a detailed structure of consumption prices, including regulated prices. Monetary policy is modeled as a forward-looking inflation targeting rule. Some other features incorporated to the model are balanced growth path, sector-specific price trends, trade openness, imperfect exchange rate pass-through, import intensity of exports, etc.

The CNB’s Forecasting and Policy Analysis System (FPAS) is comprised of near-term forecasting (nowcasting, short-term projections, etc.) and medium-term forecasting performed by the g3 DSGE model. The CNB forecasts in four major steps: 1) identification and interpretation of initial conditions; 2) projection simulation and judgement; 3) scenario analysis and decomposition of forecast dynamics; 4) communication. Mr. Musil noted that the forecast is never a mechanical procedure; it requires expert judgement. Nevertheless, the speaker is certain that the DSGE model is useful and practical for forecasting, policy analysis, and decision-making.

The CNB plans to expand the existing model by elaborating the external block to improve the outlook for external variables and by adding oil and energy prices, credit-constrained households, investment dynamics, the labor market, and more.

Annukka Ristiniemi (Sveriges Riksbank) presented DSGE-based forecasting practices at the Swedish central bank. According to Ms. Ristiniemi, the Riksbank’s DSGE model (called “Ramses II”) is the bank’s main projecting and scenario tool. However, they plan to switch to a new model soon to better capture international transmission, a challenge the current model face.

Ramses II is based on models by Christiano et al. (2010) and Adolfson et al. (2013). It is a small open economy model with a foreign sector that follows the vector autoregressive process. The model’s features include sticky prices, habits in consumption, unemployment, financial frictions, variable capital utilization and adjustment costs, monetary policy rules, etc.

The Riksbank's forecasts are based on revisions of previous predictions, meaning the forecasting team compares the outcomes from Ramses II with actual values, uses the model to identify the innovations that explain errors, and adjusts the forecast accordingly. In addition, the forecasting procedure uses inputs from other divisions such as nowcasts, foreign and financial forecasts, and others. According to Ms. Ristiniemi, Ramses II is a good core model; Iversen et al. 2016 found the DSGE forecasting performance is even better than final judgment forecasts.

Nonetheless, according to Ms. Ristiniemi, models like Ramses II struggle to account for foreign spillover. Other challenges include unconventional monetary policy and trend and exchange rate modelling. To address these issues, developers at the Riksbank are working on a new core model. The model is built on Ramses I (a previous version of Ramses II) and is focused on international linkages featuring a two-country small open-economy model with global correlated shocks and exports oriented towards investment.

Jacek Suda (Narodowy Bank Polski) discussed the role DSGE models play in forecasting at the National Bank of Poland. The first version of the model (called SoePL) was launched in 2007 and was based on Adolfson et al. (2007). Since then, the model has undergone five or six major revisions. SoePL is a New Keynesian small open economy model with floating exchange rate featuring price and wage stickiness, elaborated labor and capital markets, an exogenous foreign sector, taxes, inflation targeting etc. The most recent update extended the model to include heterogenous households, public consumption and investment, fiscal rules, and a non-zero debt-to-GDP ratio.

Even though the model's main task is forecasting, SoePL's forecasts are not announced publicly. Instead, the National Bank of Poland uses NECMOD model for its official published forecasts. In Mr. Suda's point of view, the DSGE forecasts can predict some turning points and medium-term trends, however, its forecasts often miss, and their accuracy is insufficient. Expert judgement is therefore required.

Ginters Buss (Latvijas Banka) shared his experience of working with DSGE models and their applications at Latvijas Banka. The bank uses smaller models for policy analysis only and a main model for policy simulations and forecasting. The first group includes a model with banks and housing for Latvia, a model with quantitative easing for the euro area, and a global model for Latvia, the rest of the euro area, the US, and the rest of the world. Latvijas Banka's main DSGE model was developed in several steps. The developers started with a small open economy model based on Christiano et al. (2010) featuring monetary union and financial accelerator (see Buss, 2014). At the next step search and matching frictions in the labor market were added to the model (Buss, 2015). In a recent version of the model (Buss, 2017), among other changes, labor market block was replaced with alternating-offer wage bargaining as in Christiano et al. (2016).

According to Mr. Buss, DSGE models were used to simulate tax reforms in Latvia, the overheated labor market in Latvia, the housing bubble bursting in Sweden and its possible effect on Latvia's economy, the consequences of Brexit, what if Latvia was not a member of the Euro Area, the impact of a fiscally less responsible government, and other policy scenarios.

In the speaker's point of view, forecasting using a DSGE model is complicated, specifically for a tiny small open economy like Latvia. For example, a large investment like the purchase of an airplane would represent a substantial spike in investment. The forecasts are relatively robust, but insufficient for forecasting. Therefore, model-based forecasts are used only as a base for any final forecasts as they require additional interpretation and judgement.

In the future, developers at Latvijas Banka plan to augment their DSGE model with fiscal sector and banking/financial sector to account for public consumption and investment, public debt, transfers, fiscal rules, long-term rates, long-term loans.

Finally, Shalva Mkhatrishvili (National Bank of Georgia) discussed the National Bank of Georgia's (NBG) use of macroeconomic models for monetary policy. The NBG's Forecasting and Policy Analysis System is based on a core semi-structural model, short-term forecasting models (error-correction model, ARIMA, and others), and additional satellite models. The NBG uses DSGE models for educational purposes and for cross-checking.

6. CONCLUDING REMARKS

Dynamic stochastic general equilibrium (DSGE) modeling has become a widely used tool for policy analysis and forecasting at central banks. The DSGE approach allows users to evaluate the consequences of various policy measures while the quality its predictions of macroeconomic dynamics is competing with other forecasting models. Nonetheless, the views of economists on the DSGE approach vary, as there are many challenges in developing and solving DSGE models.

In attempting to create models that replicate more empirical relationships between macroeconomic variables, economists often introduce too many ingredients to the model, making it less tractable but not always more useful or accurate. In addition, when conventional assumptions do not lead to desirable patterns consistent with empirical observations, economists are tempted to incorporate "exotic" assumptions. Although these assumptions help bring the models closer to the data, they likely do not reflect real economic processes, there is a risk that these assumptions won't work well if macroeconomic policies or conditions change. Thus, to improve DSGE models, instead of simply enlarging models, economists would do well to rethink conceptual macroeconomic insights to be able to use better assumptions.

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MACROECONOMIC EFFECTS OF MINIMUM WAGE INCREASES IN AN ECONOMY WITH WAGE UNDERREPORTING

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Abstract I have built a monetary DSGE model to investigate how wage underreporting in an economy characterized by a minimum wage regime affects the macroeconomic response to a minimum wage increase. The model is calibrated and estimated for Ukraine. The main result is that under a higher degree of wage underreporting, the economy is less responsive to a minimum wage shock. Quantitatively, the magnitude of the response to a minimum wage shock is affected by the share of non-Ricardian households, that is, households that do not have access to financial markets and consequently consume all of their income each period.

JEL Codes E24, E26, J31, J46

Keywords minimum wage, wage underreporting, shadow economy, DSGE, non-Ricardian households, New-Keynesian models

1. INTRODUCTION

Since 2017, the Ukrainian government adopted several substantial raises of the legal nominal minimum wage. In 2017, the legal minimum wage was increased by approximately 132% (comparing to the previous year), in 2018 – by 16%.

The main aim of the government in increasing the minimum wage is to ensure decent living standards for low-income working Ukrainians. However, since Ukrainian economy is characterized by a large degree of wage underreporting, the other goal of raising the minimum wage is to increase tax revenues.

In countries where the detection of tax evasion is not perfect, some firms tend to reduce their tax and social security contributions by paying part of their employees' salaries as "envelope wages" – unofficial, off-the-book wage payments. Moreover, if the economy is characterized by a legally established minimum wage regime, the minimum wage imposes a lower bound on the reported wages for those firms that don't want to take the risk of entering the shadow economy completely.

The practice of paying envelope wages is particularly widespread in the countries of Eastern Europe. For instance, according to a study by Williams (2009) conducted for EU member states, the countries characterized by the highest degree of earnings underreporting are Romania (23 percent), Latvia (17 percent) and Bulgaria (14 percent). In Ukraine, according to Williams (2007), 31 percent of workers were found to be paid envelope wages.

Firms engaged in wage underreporting are most likely to choose values close to the minimum wage level to report to the tax authorities. Consequently, the large share of workers clustering around the minimum wage level in the country's wage distribution may be a sign of underreporting activity. For instance, Tonin (2011) showed that there is a high degree of correlation between the share of workers receiving about 105 percent of the legal minimum wage in 2002, and the size of the informal economy in 2001, as calculated by Schneider (2005). Figure 1 presents the relationship between share of workers receiving the minimum wage in 2014 according to Eurostat, and share of workers who receive envelope wages, as estimated by Williams (2013). As one can see, there is a clear positive correlation between the size of the spike in the minimum wage level and the share of workers receiving envelope wages.

As the minimum wage imposes a lower bound on the amount of reported wages, and many firms are believed to report wages near this lower bound, the increase in the legal

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minimum wage level will lead to higher tax contributions from firms engaged in wage underreporting. According to the World Bank Ukraine Economic Update of April 10, 2018, the year of 2017 was characterized by a 20 percent increase in real tax revenues, driven by the hike in wages. That is, for Ukraine the minimum wage increase seemed to be an effective instrument for boosting tax revenues.

Economic theory predicts that a minimum wage increase will affect the economy through several channels. First, a minimum wage increase stimulates demand for goods from minimum wage workers, and increases their savings. Second, the costs of the firm increase, which induces the firm to adjust its output, prices and the combination of its inputs. Third, all other agents in the economy are affected through the change in demand for the inputs in their possession, and through the change in prices of final goods.

Wage underreporting complicates the mechanism by which minimum wage increases affect the economy. First, the wage of true minimum wage workers increases, which stimulates their demand for final goods and allows them to save more. Second, the disposable income of workers engaged in underreporting decreases, since now they have to reveal a larger part of their true income to the tax authorities, and consequently their consumption and savings fall. Third, the costs of firms increase both because of the higher wages of true minimum wage earners and the higher tax contributions for labor for which salaries are underreported. As a result, the firm adjusts its level of output, prices of output and the combination of inputs – including the number of workers receiving envelope wages. Fourth, the tax revenues of the government go up, which potentially leads to higher government spending. And finally, all other participants in the economy are affected through the new final prices for goods, and change in demand for inputs.

For the purposes of present study I built a New-Keynesian DSGE model on a basic NK DSGE framework with capital accumulation (Gali, 2008; Yun, 1996), and price stickiness modeled as price adjustment costs a la Rotemberg (1982). The basic NK DSGE model is extended in three directions.

First, basic labor heterogeneity is added: low-skilled labor and high-skilled labor. Low-skilled labor is assumed to be subject to the minimum wage. Since the minimum wage is a policy instrument, it is modeled as a stochastic exogenous process.

The second extension of the basic model allows for two types of households: Ricardian households and Non-Ricardian households. Ricardian households have access to the capital and financial markets, and as a result can engage in intertemporal consumption smoothing. Non-Ricardian households are cut off from financial markets, and consequently each period consume all of their disposable income. The inclusion of the second type of household was motivated by empirical evidence that an increase in current income leads to a significant increase in consumption (Mankiw, 2000). Since nominal minimum wage shocks combined with sticky prices lead to changes in the real disposable income of agents, the inclusion of this second type of household aims to bring more plausible dynamics to aggregate variables.

Three types of taxes are explicitly modeled: the labor income tax imposed on households, the social security tax

Figure 1. Envelop Wages Percentage and the Spike in the Minimum Wage Level in the Wage Distribution of a Country

Source:
* Williams (2013).
**ec.europa.eu

imposed on firms, and the tax on final output. Labor income tax and social security tax are modeled because they are explicitly tied to the optimization problems of households and firms respectively. The tax on final output is included because the largest share of tax revenues in economies like that of Ukraine comes from the VAT tax.

Third, incentives for underreporting are included in the model. In the spirit of Orsi et al. (2014), I assume that high-skilled labor can be supplied both formally – that is with full reporting of wages to the tax authorities, and informally – that is with reporting of only the minimum wage to the tax authorities. Agents derive additional disutility from informal employment, but receive higher wages. Firms, on the other hand, hire both formal and informal labor and face the probability of being audited. In the case of its being audited, the firm is forced to pay a fine greater than the underpaid taxes.

This research aims to investigate the aggregate effects of a minimum wage increase in an economy in which there is the underreporting of wages, and, in particular, to answer this question: What role does the presence and degree of underreporting play in forming the macroeconomic response to an increase in the minimum wage?

The extended model allows us to examine how the presence and size of underreporting alters the aggregate effects of a minimum wage shock, as well as conventional structural shocks – productivity shocks and monetary shocks.

This paper is organized as follows. In section 2 a review of the literature is presented. Section 3 describes the model setup. Section 4 provides details on the calibration and estimation of model parameters. In section 5, results are discussed. Finally, section 6 provides conclusions.

2. LITERATURE REVIEW

The vast majority of the literature on minimum wages focuses on its employment effect, as there is conflicting evidence on the direction of this effect – see, for instance, Card and Krueger (1995). In particular, when estimating the effect of a minimum wage increase on employment in the U.S. fast-food industry, Card and Krueger obtained the striking result that a minimum wage increase has a positive effect on employment. However, Dickens et al. (1999) found there was a neutral effect from a minimum wage increase on employment – a result that again was not consistent with the predictions of the standard theory of the competitive labor market. Dickens et al. (1999) built a theoretical model of a labor market featuring monopsony power by firms, and showed that the absence of adverse effects of a minimum wage increase on employment might be due to the presence of monopsonistic competition on the labor market. Also, Dube et al. (2011) demonstrated a dynamic monopsony model in which a higher minimum wage attracts more workers to the firm, suggesting that a higher minimum wage may reduce labor flows rather than employment levels. However, Aaronson and French (2006) in their study of the fast-food industry in the United States showed that monopsony power is not an important factor contributing to the low response of employment to a minimum wage increase.

The number of studies addressing the effect of the minimum wage on prices is very limited. A comprehensive survey of such studies was done by Lemos (2008). Most of the empirical research seems to conclude that a minimum wage increase has a positive but very moderate effect. For instance, Aaronson (2001), using various sources of restaurant prices, concluded that prices do indeed rise in response to a minimum wage increase – the higher costs are passed onto consumers. According to Lemos (2008), in the United States, the average (across studies) increase in prices is about 0.4 percent from a 10 percent minimum wage increase. Lemos (2005) also studied the economy-wide price effects of a minimum wage increase, this time in Brazil, and found that a 10 percent increase in minimum wages was associated with a 3.5 percent increase in prices.

In addition, Lemos (2004) estimated the effects of a minimum wage increase on both the formal and informal sectors in Brazil. She found that the wage effects of the minimum wage increase were strong, as such an increase compresses the wage distribution, while there are no effects on employment. Generally, the size of the effect on prices of the minimum wage increase depends on the share of workers receiving the minimum wage. But in an environment characterized by the underreporting of earnings, the minimum wage imposes a lower bound on the reported (and therefore taxable) wages of firms and households who don't want to bear the risk of becoming completely informal. As a result, in such economies tax revenues also depend on the minimum wage policy, as well the income of workers and the costs of firms engaged in underreporting (World Bank, 2005).

The phenomenon of underreporting of earnings is particularly relevant to developing countries. For instance in 2007, the percentage of official workers receiving part of their wage as envelope wages was particularly high in the countries of Central and Eastern Europe: 23 percent for Romania, 17 percent for Latvia, and 14 percent for Bulgaria (Williams, 2009). In Ukraine in 2005 and 2006 about 31 percent of all workers were paid envelope wages (Williams, 2007).

As the minimum wage imposes the lower bound on the amount of declared earnings, a spike at the minimum wage level in the observed wage distribution may be an indicator of the degree of underreporting in the economy (Tonin, 2011) where workers and firms choose to report the minimum wage instead of the true wage. Tonin (2011) investigated data from Hungarian households, and found that the consumption of those who should have been positively affected by the minimum wage increase had in fact decreased, which is a strong sign of underreporting. Furthermore, Tonin (2011) developed a theoretical model of a labor market with wage underreporting and imperfect detection, where workers and firms agree to underreport part of the wage. He showed that the introduction of a minimum wage in the model creates a spike at the minimum wage level in the wage distribution similar to that observed in the data. Moreover, in the model of Tonin (2011), the presence of underreporting is associated with a lower impact of minimum wage shocks on employment.

Feldina and Polanec (2012) investigated the impact of a minimum wage increase on firms of different sizes, as it is assumed that smaller firms are more likely to participate in informal activities. They found that for smaller firms, the employment effects of a minimum wage increase are lower than for larger firms.

Since in economies characterized by earnings underreporting minimum wage policy affects not only those working under the minimum wage but also those who are engaged in underreporting and, consequently, tax revenues, the presence of underreporting may be an important mechanism modulating the macroeconomic effect of a minimum wage increase.

There is a limited amount of literature addressing the effects of minimum wage adjustments on the business cycle in the scope of a theoretical dynamic general equilibrium framework. Heberer (2010), however, includes the minimum wage in a simple DSGE framework, and finds that – as is predicted by theory – the economy is generally adversely affected when a minimum wage is introduced. Porter and Vitek (2008) estimated the impact of introducing the minimum wage on business cycle volatility in the Hong Kong SAR. Their conclusion is that introducing the minimum wage may increase macroeconomic volatility, as labor markets under the minimum wage are less flexible.

Glover (2018) investigates the aggregate effects of increasing the minimum wage when interest rates in the economy hit the zero lower bound, with the help of a New-Keynesian DSGE framework. His conclusion is that in normal times (away from the zero lower bound) under a monetary policy conducted according to the standard Taylor Rule, the effect of a minimum wage increase is contractionary.

A nominal minimum wage also results in a special type of downward nominal wage rigidity. The implications of the downward nominal wage rigidities (DWNR) for the economy have to this point been addressed in several studies, including Benigno and Ricci (2011), and Schmitt-Grohe and Uribe (2013). One particular feature of the nominal minimum wage is that, unlike the general type of downward nominal wage rigidity the nominal wage is a policy instrument. For instance, in high-inflationary environments the general type of DWNR loses its power (Schmitt-Grohe and Uribe, 2013), while the nominal minimum wage is repeatedly increased by the government in order to keep up with inflation, and consequently a mechanism preventing the economy from achieving full employment is maintained. Under high inflation, in periods of government inactivity with respect to the nominal minimum wage, the distorting power of the nominal minimum wage declines (as the real minimum wage decreases), but when a government pursues an active policy of increasing the nominal minimum wage, the situation is reversed.

The goal of increasing the minimum wage is to increase the disposable income of minimum wage workers. Aaronson et al. (2012) found that an increase in income due to a minimum wage hike is followed by an even larger increase in spending. There is extensive empirical evidence that increasing current income leads to a significant increase in consumption – see, for instance, Mankiw (2000) and Gali et al. (2007). In particular, as is stated in Mankiw (2000), the presence of very low-wealth households, in which making savings is not a typical activity, could explain the strong response of consumption to an increase in current income. Gali et al. (2007) built a New-Keynesian model in which one portion of the households behaves in the standard Ricardian fashion – that is they can save and borrow for future periods – while the other portion has no access to capital markets, and consequently consume their entire income each period (so called non-Ricardian households). According to Gali et al. (2007), an increase in government spending leads to an increase in aggregate demand, which in turn leads to an increase in real wages, since firms, facing sticky prices, adjust their output. The increase in labor income stimulates consumption in non-Ricardian households. The presence of borrowing-constrained households also has important implications for monetary policy, as the presence of such households undermines the effectiveness of interest rate monetary policy – see Kaplan et al. (2018).

While to my knowledge there are no theoretical dynamic general equilibrium models specifically modeling wage underreporting, there is extensive literature on modeling informality and the shadow economy. Busato and Charini (2002) developed a two-sector dynamic stochastic general equilibrium model to study the influence of the shadow economy on the business cycle. They found that informal economic activity presents income smoothing opportunities for households. Castillo and Montoro (2010) built a New-Keynesian model with informal labor and search frictions, and showed that the presence of an informal economy serves a “buffer” that diminishes the effect of demand shocks. Orsi et al. (2014) studied the underground economy in a modified two-sector stochastic growth model estimated for Italy, and found that the size of the shadow economy is very sensitive to the tax rate. Cesaroni (2014) built a New-Keynesian model with a formal and informal sector and showed that the presence of downward nominal wage rigidities in the formal sector strongly affects the allocation of labor between the two sectors.

3. MODEL

The model is built on the basis of a textbook monetary DSGE model of a closed economy with capital accumulation (see Gali, 2008; Yun, 1996). The time of the model is discrete and the time horizon is infinite. The model consists of two types of households: Ricardian and non-Ricardian, perfectly competitive intermediate, and monopolistically competitive final goods producers, a monetary authority following the interest rate rule, and a fiscal authority collecting taxes from households and firms.

3.1. Households

There are two types of households. Ricardian households, which have access to financial markets, and consequently can smooth their consumption intertemporarily, and Non-Ricaridian households, which are cut off from the financial markets and consume all of their disposable income every period. The share of non-Ricardian households is γ. Both types of households supply low and high-skilled labor. The high-skilled labor can be supplied formally or informally. By informal labor I mean high-skilled labor for which only the minimum wage is reported to the tax authorities.

3.1.1. Ricardian Households

Ricardian households can invest in capital and trade one-period nominal interest bearing private bonds Such households also own private firms and receive their profits. They consume, supply low-skilled labor and high-skilled labor, and pay tax from labor income.

These households maximize expected lifetime utility:

$$E_0\left(\sum_{t=0}^{\infty}\beta^t\left(\frac{c_{r,t}^{1-\sigma}}{1-\sigma}-\Gamma^u\frac{(n_{r,t}^u)^{1+\varphi^u}}{1+\varphi^u}-\Gamma^h\frac{(n_{r,t}^f+n_{r,t}^i)^{1+\varphi}}{1+\varphi}-\Gamma^i\frac{(n_{r,t}^i)^{1+\varphi^i}}{1+\varphi^i}\right)\right). \tag{1}$$

Their inter-temporal budget constraint is:

$$\begin{aligned} P_t c_{r,t} + P_t(k_{r,t} - (1-\delta)k_{r,t-1}) + R_{t-1}b_{t-1} + \\ + P_t\xi_{k,t}(k_{r,t}, k_{r,t-1}) = (1-\tau_h)(W_t^u n_{r,t}^u + \\ + W_t^f n_{r,t}^f) + W_t^i n_{r,t}^i - \tau_h W_t^{min} n_{r,t}^i + \\ + r_t^k k_{r,t-1} + b_t + d_{r,t}, \end{aligned} \tag{2}$$

where $c_{r,t}$ — consumption of the household; $k_{r,t}$ — capital savings; W_t^u — wage paid for low-skilled labor; W_t^f — wage paid for high-skilled formal labor; W_t^i — wage paid for high-skilled informal labor; $n^u_{r,t}$, $n^f_{r,t}$, $n^i_{r,t}$ — household labor supplied as low-skilled and high-skilled, formal or informal, respectively; r_t^k — real return on capital; b_t — bond holdings; $d_{r,t}$ — dividends from owning firms; Γ^u, Γ^h, Γ^i — disutility parameters for low-skilled labor, total high-skilled labor and informal labor; φ^u, φ, φ^i are inverse Frisch labor supply elasticity parameters for low-skilled, high-skilled and informal labor.

Since private bonds are zero in net supply and all households holding bonds are identical, bond holdings of the household are 0 in equilibrium.

Capital adjustment costs are given by:[1]

$$\xi_{k,t}(k_t, k_{t-1}) = \psi \frac{k_{t-1}}{2\delta}\left(\frac{k_t - (1-\delta)k_{t-1}}{k_{t-1}} - \delta\right)^2, \tag{3}$$

where ψ is the parameter regulating the costs of capital adjustment.

3.1.2. Non-Ricardian Households

Non-Ricardian households have no access to capital and financial markets. The reason for including non-Ricardian households is to obtain a more plausible response to the minimum wage increase, as when current real income goes up, the large increase in consumption demand is mainly generated by households behaving in a non-Ricaridan fashion. Each period, non-Ricaridan households consume all of their income. Otherwise, they are identical to the Ricardian households. Non-Ricardian households maximize current period utility:

$$\begin{aligned} \frac{c_{n,t}^{1-\sigma}}{1-\sigma} - \Gamma^u \frac{(n_{n,t}^u)^{1+\varphi^u}}{1+\varphi^u} - \\ - \Gamma^l \frac{(n_{n,t}^f + n_{n,t}^i)^{1+\varphi}}{1+\varphi} - \Gamma^i \frac{(n_{n,t}^i)^{1+\varphi^i}}{1+\varphi^i}. \end{aligned} \tag{4}$$

Their budget constraint each period is:

$$\begin{aligned} P_t c_{n,t} = (1-\tau_h)(W_t^u n_{n,t}^u + W_t^f n_{n,t}^f) + \\ + W_t^i n_{n,t}^i - \tau_h W_t^{min} n_{n,t}^i. \end{aligned} \tag{5}$$

3.2. Production

Homogeneous intermediate goods are produced using labor and capital and are then sold to final goods producers (retailers). Final goods producers are involved in monopolistic competition and are price setters.

3.2.1. Intermediate Goods Producers

Intermediate goods producers employ inputs on the respective perfectly competitive markets and produce homogeneous goods. Their production function is:

$$Y_{I,t} = A_{I,t}(K_t)^{\alpha}(L_t)^{1-\alpha}, \tag{6}$$

where Y_I — intermediate output; K_t — capital input; L_t — labor input; $A_{I,t}$ — stochastic total factor productivity or TPF).

The TFP process is given by:

$$\begin{aligned} ln(A_t) - ln(\bar{A}) = \rho_A(ln(A_{t-1}) - \\ - ln(\bar{A})) + \epsilon_A, \epsilon_A \sim N(0, \sigma_A). \end{aligned} \tag{7}$$

Labor input is constructed from high-skilled labor and low-skilled labor with the help of a constant elasticity of substitution aggregator:

$$L_t = \left(b(L_t^u)^{\frac{\epsilon_L - 1}{\epsilon_L}} + (1-b)(L_t^f + L_t^i)^{\frac{\epsilon_L - 1}{\epsilon_L}}\right)^{\frac{\epsilon_L}{\epsilon_L - 1}}. \tag{8}$$

Firms choose inputs to maximize profits expected for the current period (at the beginning of the period):

$$E\{P_{I,t}Y_{I,t} - C(Y_{I,t})\}. \tag{9}$$

Uncertainty arises because, following Orsi et al. (2014), it is assumed that firms face tax on labor and are involved in tax evasion. Each period they face the probability *p* of being audited, in which case they pay a surcharge *s* over the minimum wage for each informal worker.

In contrast to Orsi et al. (2014), in this paper firms do not hide any output, but instead underreport wages for part of their hired labor. That is, for high-skilled labor, an informal firm reports that this labor is paid the minimum wage, when in reality this wage is higher.

The expected costs of the firm are given by:

$$\begin{aligned} E\{C(Y_{I,t})\} = r_t^k K_t + W_t^{min} L_t^u(1+\tau_s) + \\ W_t^f L_t^f(1+\tau_s) + W_t^i L_t^i + W_t^{min} L_t^i(\tau_s + ps), \end{aligned} \tag{10}$$

where τ_s is a social security tax.

3.2.2. Final Goods Production

There is a continuum of monopolistically competitive final goods producers of measure 1. The *i*-th producer buys intermediate goods and produces differentiated final good. Their production function is:

$$Y_{F,t}(i) = Y_{I,t}(i). \tag{11}$$

Each producer faces a downward-sloping demand curve for its product.

[1] Adjustment costs are needed in New-Keynesian models in order to eliminate an absurd increase in the capital to output ratio in response to nominal interest rate changes. Authors often use investment adjustment costs in NK models as opposed to capital adjustment costs, since this brings a hump-shaped response of investment to a monetary shock, see Christiano, Eichenbaum and Evans (2005). Here capital adjustment costs are used for simplicity – this form of adjustment costs is found, for example, in Gornemann et al. (2012) and Iacovello (2005).

Final goods producers face quadratic costs of price adjustment, as in Rotemberg (1982), and maximizes the stream of real profits:

$$E_0 \sum_{t=0}^{\infty} Q_{0,t}((1-\tau_c)P_t(i)Y_{F,t}(i)- \\ - P_{I,t}Y_{I,t}(i) - P_t\xi_{p,t}Y_{F,t}(i)), \tag{12}$$

where τ_c – VAT tax.

Since households own the firms, the discount factor of future nominal profits is (see Gali textbook):

$$Q_{t,t+1} = E_t\left(\beta \frac{c_{r,t+1}^{-\sigma}}{c_{r,t}^{-\sigma}} \frac{1}{\pi_{t+1}}\right). \tag{13}$$

Price adjustment costs are given by:

$$\xi_{p,t} = \frac{\Phi}{2}\left(\frac{P_t(i)}{P_{t-1}(i)} - \pi_{ss}\right)^2. \tag{14}$$

The final goods index, aggregated via the CES aggregator (as in Gali textbook):

$$Y_{F,t} = \left(\int_0^1 (Y_{F,t}(i))^{1-\frac{1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}. \tag{15}$$

From the final goods index the demand for the *i*-th firm's final goods is derived to be:

$$Y_{F,t}(i) = Y_{F,t}\left(\frac{P_t(i)}{P_t}\right)^{-\epsilon}. \tag{16}$$

The final goods index is used for consumption, capital investment and bearing price adjustment costs.

Dividends from the *i*-th firm are:

$$D_t(i) = (1-\tau_c)P_t(i)Y_{F,t}(i) - P_t^I Y_{I,t}(i)- \\ - P_t\xi_{p,t}(P_{t-1}(i), P_t(i))Y_{F,t}(i). \tag{17}$$

Dividends of all firms are divided between the firms' owners:

$$D_t = \int_0^1 D_t(i)di. \tag{18}$$

3.3. Central Bank

Monetary policy is conducted via a Taylor (1999) -type interest rate rule:

$$ln(R_t) - ln(R_{ss}) = (1-\rho_R)(\rho_\pi(ln(\pi_t)- \\ - ln(\pi_{ss})) + \rho_Y(ln(Y_{F,t}) - ln(Y_{F,ss})))+ \\ + \rho_R(ln(R_{t-1}) - ln(R_{ss})) + \epsilon_R. \tag{19}$$

Since the monetary transmission mechanism is not modeled explicitly, it is assumed that the interest rate set by the Central Bank is passed perfectly to the interest paid on private bonds, so that both are equal.

3.4. Minimum Wage

Since low-skilled labor is demand-constrained under the minimum wage, it is assumed that both non-Ricardian and Ricardian households face the same demand for low-skilled labor, and consequently both supply the sam amount of low-skilled labor:

$$n_{n,t}^u = n_{r,t}^u. \tag{20}$$

The wage paid to low-skilled labor is specified by the government:

$$W_t^u = W_t^{min}. \tag{21}$$

It is assumed that households always want to supply more low-skilled labor than is demanded at the minimum wage, so the quantity of low-skilled labor supplied is fully determined by demand.

The real minimum wage process is:

$$ln(W_t^{min}) - ln(W_{ss}^{min}) = \rho_W(ln(W_{t-1}^{min})- \\ - ln(W_{ss}^{min})) + \rho_{\pi W}(ln(\pi_t) - ln(\pi_{ss})) + \epsilon_W, \tag{22}$$

where ε_W is an exogenous stochastic process with zero mean.

If the indexation of the nominal minimum wage was perfect, the real minimum wage wouldn't depend on inflation. But since the government doesn't perfectly index the nominal wage each period, there is a negative relationship between the real wage and inflation ($\rho_{\pi W}$<0).

3.5. Fiscal Authority

It is assumed that each period government runs balanced budget:

$$G_t = (\tau_s + \tau_h)(W_t^u L_t^u + W_t^f L_t^f + W_t^{min} L_t^i)+ \\ + \tau_c P_t Y_{F,t} + spW_t^{min} L_t^i, \tag{23}$$

where G_t – government spending.

3.6. Market Clearing

The capital market clears:

$$(1-\gamma)k_{r,t-1} = K_t. \tag{24}$$

The low-skilled labor market clears:

$$n_{n,t}^u = n_{r,t}^u = L_t^u. \tag{25}$$

The high-skilled labor market clears:

$$\gamma n_{n,t}^f + (1-\gamma)n_{r,t}^f = L_t^f. \tag{26}$$

The informal labor market clears:

$$\gamma n_{n,t}^i + (1-\gamma)n_{r,t}^i = L_t^i. \tag{27}$$

The intermediate goods market clears:

$$Y_{I,t} = Y_{F,t} \tag{28}$$

The final goods market clears:

$$\begin{aligned} Y_{F,t} &= \gamma c_{n,t} + (1-\gamma) c_{r,t} + \\ &+ G_t + (1-\gamma)(k_{r,t} - (1-\delta) k_{r,t-1} + \\ &+ \xi_{k,t}(k_t, k_{t-1})) + \int_0^1 \xi_{p,t} Y_{F,t}(i) di. \end{aligned} \tag{29}$$

Dividends are paid to firm owners:

$$(1-\gamma) d_{r,t} = D_t. \tag{30}$$

See Appendix A1 for the non-linear model system of equations and Appendix A2 for the log-linearized model. Steady-state ratios are calculated in Appendix A3.

4. CALIBRATION AND ESTIMATION

The subset of parameters is calibrated according to Ukrainian data. Other parameters are calibrated from the literature or estimated using a Bayesian estimation method.

I set the relative risk aversion coefficient σ equal to 1, which corresponds to the logarithmic utility function. For the calibration of π_{ss}, β, ε, α and the minimum wage to average wage steady-state ratio $SHwag$, I use quarterly data for Ukraine for the period Q1 2006 to Q4 2017 obtained from Ukrstat, except for the interest rate time series, which is obtained from the NBU open dataset. The final dataset consists of a deseasonalized time-series for nominal GDP, nominal capital investment, nominal profits, the minimum wage, the average wage, and the yearly nominal interest rate on 3-6 month deposits. Steady-state inflation π_{ss} is calibrated to match average quarterly inflation. As the model has the steady-state relationship $\beta = \frac{\pi_{ss}}{R_{ss}}$, I calibrate β to match the average of the inflation to interest rate ratio, where the annual interest rate is modified to bring a quarterly return. The elasticity of substitution between various consumer goods in the model is steady-state $\varepsilon = \frac{(1-\tau_c)Y_{ss}}{D_{ss}}$. Therefore, I calibrate ε to match the average profits to output ratio multiplied by 1-τ_c. The capital income share α is calibrated according to the average investment to output ratio, since $\alpha = \frac{K_{ss}}{Y_{ss}} r_k^{ss} = \frac{I_{ss} r_k^{ss}}{Y_{ss}\delta}$, where $r_k^{ss} = \delta - 1 + \frac{1}{\beta}$. The minimum wage to average wage steady-state ratio $SHwag$ is calibrated to match the average ratio in the data. The rate of depreciation of physical capital δ is set to the quarterly equivalent of the average over the sample available in the Penn World Table (1990-2014). The probability of being audited p is set to the ratio of the number of firms that the Ukrainian fiscal authority plans to inspect in the year 2018 (according to the announcement on their website) to the total number of firms in Ukraine (available at Ukrstat), and adjusted for quarterly frequency. The fine or surcharge s is calibrated according to Article 265 of the Ukrainian Labor Code, which prescribes the special fine in the case of underreporting being detected to be equal to 30 monthly minimum wages, and is also adjusted for quarterly frequency. Tax rates τ_s, τ_h and τ_c are set to much Ukrainian social security tax, income tax and VAT tax rates. The share of labor reporting the minimum wage, $SHmin$, is calibrated, in accordance with Ukrstat's September 2017 data on the distribution of wages, to be equal to share of workers whose earnings are less than UAH 4,000. As the minimum wage set in that period was UAH 3,200, the reported minimum wage share in the model corresponds to the share of people who report less than 125 percent of the minimum wage. The share of underreporting of labor, $SHinf$, is calibrated according to the results of a poll conducted by the HeadHunter labor agency[2] in 2017. Minimum wage parameters $\rho_{\pi W}$, ρ_W, $\sigma_{\varepsilon W}$ are calibrated by regressing the real minimum wage on the respective variables. Monetary rule parameters and monetary shock standard deviations ρ_R, ρ_π, ρ_Y and $\sigma_{\varepsilon R}$ are calibrated according to Smets and Wouters (2003).[3] The share of non-Ricardian households, $SHnon$, is set to 0.35.[4] The elasticity of substitution between low and high skilled labor ε_L is set to 2, see (Behar, 2010). Calibration results are presented in Table B1 (Appendix B).

The remaining parameters are estimated using a Bayesian estimation method. Prior distributions for the productivity autocorrelation parameter ρ_A, the productivity shock standard deviation σ_A, the capital adjustment cost parameter ψ are chosen as in Iacovello (2015). The prior for ρ_A is a beta distribution with a mean of 0.8 and a standard deviation of 0.1. The prior for σ_A is inverse gamma distribution with a mean of 0.005 and a standard deviation of 0.025. The prior for ψ is a gamma distribution with a mean of 1 and a standard deviation of 0.5. Price adjustment costs parameter Φ prior is set to a gamma distribution with a mean of 20 and standard deviation of 10 as in Shintaniv (2016). The inverse Frich elasticity of labor supply φ is set to have gamma distribution prior, with a mean of 1 and a standard deviation of 0.1, following Orsi et al. (2014). The inverse Frich elasticity of the informal labor supply φ^i is set to follow a gamma distribution prior with a mean of 1 and a standard deviation of 0.5. The time series used for estimation are quarterly GDP, and capital investment and inflation taken for the period Q1 2006 to Q4 2017. The GDP and investment series are detrended via a Hodrick-Prescott filter with standard for the quarterly data λ=1,600. Priors and estimation results can be found in Table B2 (Appendix B).

5. DISCUSSION OF RESULTS

In this chapter I conduct the following exercises. First, I look at and discuss the impulse responses to the minimum wage shock, depending on the degree of underreporting that takes place in the economy. Second, I investigate how the assumed share of non-Ricaridan households alters the impulse response of inflation to the minimum wage shock.

Figure C1.1. (in Appendix C1) shows the impulse responses of the key macroeconomic variables to a positive minimum wage shock of 1 standard deviation. Along with the calibrated version, I show impulse responses for alternative shares of underreporting of labor. As we can see in Figure C1.1. (in Appendix C1), a higher degree of underreporting leads to quantitatively lower (in absolute value) responses of inflation, output, and investment to the minimum wage shock. If the degree of underreporting is high, fewer households experience an actual increase in labor income, hence the demand increase is lower. On the other hand, firms' costs do not increase as much as they would have if the underreporting workers were actually minimum wage earners. Also, since the labor costs of firms don't rise as sharply as they would have under a low degree of underreporting, the drop in labor

[2] https://kiev.hh.ua/article/20673
[3] Since Ukraine adopted inflation targeting only recently, estimates of the interest rate rule obtained from Ukrainian data are unreliable.
[4] Marto (2013) notes that for European countries, the share of non-Ricadian households estimated in the literature is between 25 percent and 37 percent. I address the importance of share of non-Ricardian households for the model's dynamics in the discussion of the results.

hours is smaller under a higher degree of underreporting. Under a low degree of underreporting, the consumption of Non-Ricardian households initially rises due to the initial increase in real labor income.

Figure C1.2. (in Appendix C1) shows the relationship between the degree of underreporting and the impact response of inflation, output, and nominal interest rates to a minimum wage shock. We can see that under a higher degree of underreporting, the inflation increase and initial output deviation are not as severe. Moreover, under the assumption of a high share of non-Ricaridan households, the initial output response is positive, since the increase in non-Ricardian consumption following a real minimum wage hike stimulates output in the short run.

Generally, a minimum wage increase affects the economy through four main channels: output demand, output supply, inputs demand, and inputs supply.[5] In an economy characterized by underreporting, different groups of workers are affected in different ways by a minimum wage shock, and thus pull output demand in different directions. Moreover, since in an economy with wage underreporting a minimum wage increase leads to higher tax revenues, government spending also increases, which stimulates demand. Labor costs by firms are also affected differently when underreporting is present, since low-skilled workers become more expensive and the costs associated with underreporting also increase, which translates into a change in labor demand and into an increase in output prices.

Responses to other aggregate shocks are reported in Appendix C2. Notably, the degree of underreporting does not seem to have a strong effect on impulse responses to conventional aggregate shocks.

Now I look at how main result is altered if we assume different shares of non-Ricardian households. Impulse responses to a minimum wage shock for different shares of non-Ricaridan households are presented in Figure C1.3. (in Appendix C1). As we can see, a higher share of non-Ricardian households brings higher inflation in response to a minimum wage increase. This is because non-Ricaridan households are very responsive to changes in current income. And since under sticky prices a minimum wage increase affects current real income, demand for consumption is also affected more strongly when the share of non-Ricardian households is high.

Figure C1.4. (in Appendix C1) shows initial responses of inflation, output and nominal interest rates to a minimum wage shock. For higher assumed shares of non-Ricardian households, the initial responses are larger in magnitude. Generally, an economy populated with a larger share of non-Ricardian households is more responsive to shocks affecting the current real income of agents.

The impulse responses to other shocks for different shares of non-Ricaridan households are given in Appendix C2.[6]

6. CONCLUSIONS

Underreporting of wage earnings is a relevant issue in economies that have a minimum wage regime and the imperfect detection of tax evasion. The government's motivation for increasing the minimum wage in such economies often boils down to raising more tax revenues. On the other hand, there are general concerns associated with increasing the minimum wage, such as higher inflation, lower output, and a higher level of unemployment. In this research, I built a DSGE model featuring underreporting of earnings to answer the following question: How does underreporting affect the macroeconomic response to a minimum wage increase? The model predicts that a higher degree of underreporting results in a smaller increase of inflation and a smaller decrease in output, investment, and hours worked compared to an economy with a relatively low underreporting level. This is strong evidence that the presence of underreporting means that an economy is less affected by minimum wage shocks.

Qualitatively, the dynamics predicted by the model are in line with the general view on the effects of a minimum wage increase: in response to a minimum wage shock, inflation goes up, while output, investment and employment go down. The aggregate responses to conventional shocks do not depend on the degree of underreporting.

The final result depends rather on the share of non-Ricardian households: the higher the share of non-Ricardian households, the higher is the volatility of inflation and output in response to a minimum wage shock.

Overall, in an economy with a high degree of wage underreporting, the negative effect of a minimum wage increase is smaller compared to an economy with a lower degree of underreporting.

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[5] For a description of the mechanism through which a minimum wage increase affects inflation, see, for example, Lemos (2008).
[6] Although beyond the scope of this study, it is worth mentioning that responses to monetary shocks are amplified if there are higher shares of non-Ricardian households, while responses to TFP shocks are partially stabilized with a higher non-Ricardian share, which is in line with Marto (2014).

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APPENDIX A1. NON-LINEAR MODEL

Ricardian Households

Budget constraint:

$$c_{r,t} + k_{r,t} - (1-\delta)k_{r,t-1} + \psi\frac{k_{t-1}}{2\delta}\left(\frac{k_t - (1-\delta)k_{t-1}}{k_{t-1}} - \delta\right)^2 = \\ = (1-\tau_h)(W_t^u n_{r,t}^u + W_t^f n_{r,t}^f) + W_t^i n_{r,t}^i - \tau_h W_t^{min} n_{r,t}^i + r_t^k k_{r,t-1} + D_{r,t}. \quad \text{(A1.1)}$$

First order conditions:

$$c_{r,t}^{-\sigma} - \lambda_{r,t} = 0, \quad \text{(A1.2)}$$

$$-\Gamma^h(n_{r,t}^f + n_{r,t}^i)^\varphi + \lambda_{r,t}(1-\tau^h)W_t^f = 0, \quad \text{(A1.3)}$$

$$\Gamma^i(n_{r,t}^i)^{\varphi^i} = \lambda_{r,t}(W_t^i - \tau^h W_t^{min} - (1-\tau^h)W_t^f), \quad \text{(A1.4)}$$

$$\lambda_{r,t} - \beta\lambda_{r,t+1}R_t/\pi_{t+1} = 0, \quad \text{(A1.5)}$$

$$-\lambda_{r,t}\left(1 + \frac{\psi}{\delta}\left(\frac{k_{r,t}}{k_{r,t-1}} - 1\right)\right) + \beta\lambda_{r,t+1}\left(1 - \delta + r_{t+1}^k + \frac{\psi}{2\delta}\left(\left(\frac{k_{r,t+1}}{k_{r,t}}\right)^2 - 1\right)\right) = 0. \quad \text{(A1.6)}$$

Non-Ricardian Households

Budget constraint:

$$c_{n,t} = (1-\tau_h)(W_t^u n_{n,t}^u + W_t^f n_{n,t}^f). \quad \text{(A1.7)}$$

First order conditions:

$$c_{n,t}^{-\sigma} - \lambda_{rn,t} = 0, \quad \text{(A1.8)}$$

$$-\Gamma^h(n_{n,t}^f + n_{n,t}^i)^\varphi + \lambda_{n,t}(1-\tau^h)W_t^f = 0, \quad \text{(A1.9)}$$

$$\Gamma^i(n_{n,t}^i)^{\varphi^i} = \lambda_{n,t}(W_t^i - \tau^h W_t^{min} - (1-\tau^h)W_t^f). \quad \text{(A1.10)}$$

Intermediate Gods Producers

Technology is:

$$Y_{I,t} = A_{I,t}(K_t)^\alpha(L_t)^{1-\alpha}. \quad \text{(A1.11)}$$

Labor aggregate is:

$$L_t = \left(b(L_t^u)^{\frac{\epsilon_L - 1}{\epsilon_L}} + (1-b)(L_t^f)^{\frac{\epsilon_L - 1}{\epsilon_L}}\right)^{\frac{\epsilon_L}{\epsilon_L - 1}}. \quad \text{(A1.12)}$$

First order conditions:

$$P_t^I A_{I,t}\alpha(K_t)^{\alpha-1}(L_t)^{1-\alpha} = r_t^k, \quad \text{(A1.13)}$$

$$P_t^I A_{I,t}(1-\alpha)(K_t)^\alpha(L_t)^{-\alpha+\frac{1}{\epsilon_L}}(\chi L_t^u)^{\frac{-1}{\epsilon_L}} b\chi = (1+\tau^s)W_t^u, \quad \text{(A1.14)}$$

$$P_t^I A_{I,t}(1-\alpha)(K_t)^\alpha(L_t)^{-\alpha+\frac{1}{\epsilon_L}}((L_t^f + L_t^i)^{\frac{-1}{\epsilon_L}} = (1+\tau^s)W_t^f, \quad \text{(A1.15)}$$

$$(1+\tau^s)W_t^f = W_t^i + \tau^s W_t^{min} + spW_t^{min}. \quad \text{(A1.16)}$$

TFP process is:

$$ln(A_t) - ln(\bar{A}) = \rho_A(ln(A_{t-1}) - ln(\bar{A})) + \epsilon_A. \quad \text{(A1.17)}$$

Aside: Condition for Existence of Both Formal and Informal Employment

As household derives additional disutility from working informally, it will supply labor to both formal and informal markets if:

$$W_t^i - \tau^h W_t^{min} > (1-\tau^h)W_t^f.$$

Since formal and informal skilled labor is indistinguishable in production, the expected costs of both for the output producer are equal:

$$W_t^i + \tau^s W_t^{min} + spW_t^{min} = (1+\tau^s)W_t^f.$$

The above two statements hold for the $W_t^f > W_t^{min}$ whenever:

$$sp < (\tau^s + \tau^h)(\frac{W_t^f}{W_t^{min}} - 1).$$

Final Goods Producers

Technology:

$$Y_{F,t} = Y_{I,t}. \quad (A1.18)$$

Stochastic discount factor:

$$Q_{t,t+1} = E_t\left(\beta \frac{c_{r,t+1}^{-\sigma}}{c_{r,t}^{-\sigma}} \frac{1}{\pi_{t+1}}\right). \quad (A1.19)$$

First order condition:

$$\begin{aligned} &Y_{F,t}(-\epsilon(P_t^\star)^{-\epsilon-1}((1-\tau^c)P_t^\star - P_t^I - \frac{\Phi}{2}\left(\frac{P_t^\star \pi_t}{P_{t-1}^\star} - \pi_{ss}\right)^2)+ \\ &+(P_t^\star)^{-\epsilon}((1-\tau^c) - \frac{\Phi\pi_t}{P_{t-1}^\star}(\frac{P_t^\star\pi_t}{P_{t-1}^\star} - \pi_{ss})))+ \\ &+Q_{t,t+1}Y_{F,t+1}\Phi(P_{t+1}^\star)^{-\epsilon}\pi_{t+1}^2 P_{t+1}^\star(\frac{P_{t+1}^\star\pi_{t+1}}{P_t^\star} - \pi_{ss})\frac{1}{(P_t^\star)^2} = 0. \end{aligned} \quad (A1.20)$$

$$P_t^\star = 1. \quad (A1.21)$$

Dividends:

$$D_t = (1-\tau_c)Y_{F,t} - P_t^I Y_{I,t} - \frac{\Phi}{2}\left(\frac{P_t(i)}{P_{t-1}(i)} - \pi_{ss}\right)^2 Y_{F,t}. \quad (A1.22)$$

Fiscal Authority

$$G_t = (\tau_s + \tau_h)(W_t^u L_t^u + W_t^f L_t^f + W_t^{min} L_t^i) + \tau_c P_t Y_{F,t} + spW_t^{min} L_t^i. \quad (A1.23)$$

Minimum Wage Process

$$ln(W_t^{min}) - ln(W_{ss}^{min}) = \rho_W(ln(W_{t-1}^{min}) - ln(W_{ss}^{min})) + \rho_{\pi W}(ln(\pi_t) - ln(\pi_{ss})) + \epsilon_W. \quad (A1.24)$$

Central Bank

$$\begin{aligned} &ln(R_t) - ln(R_{ss}) = (1-\rho_R)(\rho_\pi(ln(\pi_t) - ln(\pi_{ss}))+ \\ &+\rho_Y(ln(Y_{F,t}) - ln(Y_{F,ss}))) + \rho_R(ln(R_{t-1}) - ln(R_{ss})) + \epsilon_R. \end{aligned} \quad (A1.25)$$

Markets Clearing

$$(1-\gamma)k_{r,t-1} = K_t, \quad (A1.26)$$

$$n_{n,t}^u = n_{r,t}^u = L_t^u, \quad (A1.27)$$

$$\gamma n_{n,t}^f + (1-\gamma)n_{r,t}^f = L_t^f, \quad (A1.28)$$

$$\gamma n_{n,t}^i + (1-\gamma)n_{r,t}^i = L_t^i, \quad (A1.29)$$

$$Y_{I,t} = Y_{F,t}, \quad (A1.30)$$

$$\begin{aligned} &Y_{F,t} = \gamma c_{n,t} + (1-\gamma)c_{r,t} + G_t + (1-\gamma)(k_{r,t} - (1-\delta)k_{r,t-1} + \xi_{k,t}(k_t, k_{t-1}))+ \\ &+\int_0^1 \xi_{p,t} Y_{F,t}(i)di, \end{aligned} \quad (A1.31)$$

$$(1-\gamma)D_{r,t} = D_t. \quad (A1.32)$$

APPENDIX A2. LOG-LINEARIZED MODEL

Ricardian Households

Budget constraint:

$$\frac{Cr}{Y}c_t^r + \frac{K}{Y}k_t^r - (1-\delta)\frac{K}{Y}k_{t-1}^r - r^k\frac{K}{Y}k_{t-1}^r =$$
$$= (1-\tau_h)\frac{Lrf}{Lf}\frac{IF}{Y}(w_t^f + n_{r,t}^f) + (1-\tau_h)\frac{Lru}{Lu}\frac{IU}{Y}(w_t^{min} + n_{r,t}^u) + \quad \text{(A2.1)}$$
$$+\frac{Lri}{Li}\frac{II}{Y}(w_t^i + n_{r,t}^i) - \tau_h\frac{Lri}{Li}\frac{II}{Y}\frac{W^{min}}{W^i}(w_t^{min} + n_{r,t}^i) + r^k\frac{K}{Y}r_t^k + \frac{D}{Y}d_t^r.$$

First order conditions:

$$\phi(\frac{Lrf}{Lrf+Lri}n_{r,t}^f + \frac{Lri}{Lrf+Lri}n_{r,t}^i) = -\sigma c_t^r + w_t^f, \quad \text{(A2.2)}$$

$$\phi^i n_{r,t}^i = -\sigma c_t^r + \frac{Wi}{Wd}w_t^i - \tau_h\frac{Wmin}{Wd}w_t^{min} - (1-\tau_h)\frac{Wf}{Wd}w_t^f, \quad \text{(A2.3)}$$

$$\pi_{t+1} - \sigma c_t^r = -\sigma c_{t+1}^r + r_t, \quad \text{(A2.4)}$$

$$(1+\beta)\frac{\psi}{\delta}k_t^r - \frac{\psi}{\delta}k_{t-1}^r - (\beta\frac{\psi}{\delta})k_{t+1}^r - \beta((\frac{1}{\beta}+\delta-1)r_{t+1}^k + \sigma c_{t+1}^r - \sigma c_t^r = 0. \quad \text{(A2.5)}$$

Non-Ricardian Households

Budget constraint:

$$\frac{Cn}{Y}c_t^n = (1-\tau_h)\frac{Lnf}{Lf}\frac{IF}{Y}(w_t^f + n_{n,t}^f) + (1-\tau_h)\frac{Lnu}{Lu}\frac{IU}{Y}(w_t^{min} + n_{n,t}^u) + \quad \text{(A2.6)}$$
$$+\frac{Lni}{Li}\frac{II}{Y}(w_t^i + n_{n,t}^i) - \tau_h\frac{Lni}{Li}\frac{II}{Y}\frac{W^{min}}{W^i}(w_t^{min} + n_{n,t}^i).$$

First order conditions:

$$\phi(\frac{Lnf}{Lnf+Lni}n_{n,t}^f + \frac{Lni}{Lnf+Lni}n_{n,t}^i) = -\sigma c_t^n + w_t^f, \quad \text{(A2.7)}$$

$$\phi^i n_{n,t}^i = -\sigma c_t^n + \frac{Wi}{Wd}w_t^i - \tau_h\frac{Wmin}{Wd}w_t^{min} - (1-\tau_h)\frac{Wf}{Wd}w_t^f. \quad \text{(A2.8)}$$

Intermediate Goods Producers

Technology is:

$$y_t = a_t^i + \alpha k_t + (1-\alpha)l_t. \quad \text{(A2.9)}$$

Labor aggregate is:

$$(b + (1-b)(\frac{Lf+Li}{Lu})^{\frac{\epsilon_l-1}{\epsilon_l}})l_t = bl_t^u + (1-b)(\frac{Lf+Li}{Lu})^{-\frac{1}{\epsilon_l}}(\frac{Lf}{Lu}l_t^f + \frac{Li}{Lu}l_t^i). \quad \text{(A2.10)}$$

First order conditions:

$$p_t^I + a_t^I + (\alpha-1)k_t + (1-\alpha)l_t = r_t^k, \quad \text{(A2.11)}$$

$$p_t^I + a_t^I + \alpha k_t + (\frac{1}{\epsilon_l} - \alpha)l_t + (-\frac{1}{\epsilon_l})l_t^u = W_t^{min}, \quad \text{(A2.12)}$$

$$p_t^I + a_t^I + \alpha k_t + (\frac{1}{\epsilon_l} - \alpha)l_t + (-\frac{1}{\epsilon_l})(\frac{Lf}{Lf+Li}l_t^f + \frac{Li}{Lf+Li}l_t^i) = w_t^f, \quad \text{(A2.13)}$$

$$(1+\tau_s)\frac{Wf}{Wmin}w_t^f = \frac{Wi}{Wmin}w_t^i + (\tau_s + sp)w_t^{min}. \quad \text{(A2.14)}$$

TFP process is:

$$a_t^I = \rho_A a_{t-1}^I + \epsilon_A. \quad \text{(A2.15)}$$

Final Goods Producers

First order condition:

$$\pi_t = \frac{(\epsilon - 1)(1 - \tau_c)}{\Phi \pi_{ss}^2} p_t^I + \beta \pi_{t+1}. \tag{A2.16}$$

Dividends:

$$d_t = y_t - (\epsilon - 1) p_t^I. \tag{A2.17}$$

Fiscal Authority

$$\frac{TR}{Y} g_t = (\tau_h + \tau_s) \frac{IU}{Y} (w_t^{min} + l_t^u) + (\tau_h + \tau_s) \frac{IF}{Y} (w_t^f + l_t^f) + \\ +(\tau_h + \tau_s) \frac{II}{Y} \frac{Wmin}{Wi} (w_t^{min} + l_t^i) + \tau_c y_t + ps \frac{II}{Y} \frac{Wmin}{Wi} (w_t^{min} + l_t^i). \tag{A2.18}$$

Minimum Wage Process

$$w_t^{min} = \rho_W w_{t-1}^{min} + \rho_{\pi W} \pi_t + \epsilon_W. \tag{A2.19}$$

Central Bank

$$r_t = (1 - \rho_R)(\rho_\pi \pi_t + \rho_Y y_t) + \rho_R r_{t-1} + \epsilon_R. \tag{A2.20}$$

Markets Clearing

$$k_t = k_{t-1}^r, \tag{A2.21}$$

$$d_t = d_t^r, \tag{A2.22}$$

$$n_{n,t}^u = n_{r,t}^u = l_t^u, \tag{A2.23}$$

$$\frac{Lni}{Li} n_{n,t}^i + \frac{Lri}{Li} n_{r,t}^i = l_t^i, \tag{A2.24}$$

$$\frac{Lnf}{Lf} n_{n,t}^f + \frac{Lrf}{Lif} n_{r,t}^f = l_t^f. \tag{A2.25}$$

Total Consumption

$$(\frac{Cn}{Y} + \frac{Cr}{Y}) c_t = \frac{Cn}{Y} c_t^n + \frac{Cr}{Y} c_t^r. \tag{A2.26}$$

Total Investment

$$\delta i_t = k_t^r - (1 - \delta) k_{t-1}^r. \tag{A2.27}$$

Total Labor

$$lt_t = \frac{Lu}{Lt} l_t^u + \frac{Luf}{Lt} l_t^f + \frac{Li}{Lt} l_t^i. \tag{A2.28}$$

APPENDIX A3. STEADY-STATE RATIOS

Reported minimum wage labor to total labor:

$$\frac{Lmin}{Lt} = SHmin. \tag{A3.1}$$

Informal labor to reported minimum wage labor:

$$\frac{Li}{Lmin} = SHinf. \tag{A3.2}$$

Minimum wage to average wage:

$$\frac{Wmin}{Wa} = SHwag. \tag{A3.3}$$

Minimum wage to formal wage:

$$\frac{Wmin}{Wf} = \frac{1 - SHmin}{\frac{1}{SHwag} - SHmin}. \tag{A3.4}$$

Non-Ricardian low-skilled labor to total unskilled labor:

$$\frac{Lnu}{Lu} = SHnon. \tag{A3.5}$$

Non-Ricardian formal labor to total formal labor:

$$\frac{Lnf}{Lf} = SHnon. \tag{A3.6}$$

Non-Ricardian informal labor to total informal labor:

$$\frac{Lni}{Li} = SHnon. \tag{A3.7}$$

Capital rental rate:

$$r_k = \delta - 1 + 1/\beta. \tag{A3.8}$$

Capital to output ratio:

$$\frac{K}{Y} = \frac{\alpha}{r_k}. \tag{A3.9}$$

Formal labor to total labor:

$$\frac{Lf}{Lt} = 1 - \frac{Lmin}{Lt}. \tag{A3.10}$$

Informal labor to total labor:

$$\frac{Li}{Lt} = 1 - \frac{Li}{Lmin}\frac{Lmin}{Lt}. \tag{A3.11}$$

Low-skilled labor to total labor:

$$\frac{Lu}{Lt} = 1 - (1 - \frac{Li}{Lmin})\frac{Lmin}{Lt}. \tag{A3.12}$$

Labor aggregate to low-skilled labor:

$$\frac{L}{Lu} = (b + (1 - b)(\frac{Lf + Li}{Lu})^{\frac{\epsilon_l - 1}{\epsilon_l}})^{\frac{\epsilon_l}{\epsilon_l - 1}}. \tag{A3.13}$$

Informal wage to minimum wage:

$$\frac{Wi}{Wmin} = \frac{Wf}{Wmin}(1 + \tau_s) - (\tau_s + ps). \tag{A3.14}$$

Ricardian low-skilled labor to total low-skilled labor:

$$\frac{Lru}{Lu} = 1 - \frac{Lnu}{Lu}. \tag{A3.15}$$

Ricardian formal labor to total formal labor:

$$\frac{Lrf}{Lf} = 1 - \frac{Lnf}{Lf}. \tag{A3.16}$$

Ricardian informal labor to total informal labor:

$$\frac{Lri}{Li} = 1 - \frac{Lni}{Li}. \tag{A3.17}$$

Non-Ricardian informal labor to total labor:

$$\frac{Lni}{Lt} = \frac{Lni}{Li}\frac{Li}{Lt}. \tag{A3.18}$$

Ricardian informal labor to total labor:

$$\frac{Lri}{Lt} = \frac{Lri}{Li}\frac{Li}{Lt}. \tag{A3.19}$$

Non-Ricardian formal labor to total labor:

$$\frac{Lnf}{Lt} = \frac{Lnf}{Lf}\frac{Lf}{Lt}. \tag{A3.20}$$

Ricardian formal labor to total labor:

$$\frac{Lrf}{Lt} = \frac{Lrf}{Lf}\frac{Lf}{Lt}. \tag{A3.21}$$

Low-skilled labor before tax income to output:

$$\frac{IU}{Y} = (1-\alpha)b(\frac{Lu}{L})^{1-\frac{1}{\epsilon_l}}/(1+\tau_s). \tag{A3.22}$$

Formal labor before tax income to output:

$$\frac{IF}{Y} = \frac{IU}{Y}\frac{Lf}{Lu}\frac{Wf}{Wmin}. \tag{A3.23}$$

Informal labor before tax income to output:

$$\frac{II}{Y} = \frac{IU}{Y}\frac{Li}{Lu}\frac{Wi}{Wmin}. \tag{A3.24}$$

Tax revenue to output:

$$\frac{TR}{Y} = (\tau_h + \tau_s)(\frac{IU}{Y} + \frac{IF}{Y} + \frac{II}{Y}\frac{Wmin}{Wi}) + \tau_c + ps\frac{II}{Y}\frac{Wmin}{Wi}. \tag{A3.25}$$

Wage difference to minimum wage:

$$\frac{Wd}{Wmin} = \frac{Wi}{Wmin} - \tau_h - (1-\tau_h)\frac{Wf}{Wmin}. \tag{A3.26}$$

Non-Ricardian consumption to output:

$$\frac{Cn}{Y} = (1-\tau_h)\frac{Lnu}{Lu}\frac{IU}{Y} + (1-\tau_h)\frac{Lnf}{Lf}\frac{IF}{Y} + \frac{Lni}{Li}\frac{II}{Y} - \tau_h\frac{Lni}{Li}\frac{II}{Y}\frac{Wmin}{Wi}. \tag{A3.27}$$

Ricardian consumption to output:

$$\frac{Cr}{Y} = 1 - \delta * \frac{K}{Y} - \frac{TR}{Y} - \frac{Cn}{Y}. \tag{A3.28}$$

Dividends:

$$\frac{D}{Y} = (1-\tau_c)/\epsilon. \tag{A3.29}$$

Low-skilled labor share parameter:

$$b = \frac{1}{1 + (\frac{Lu}{Lf+Li})^{-\frac{1}{\epsilon_l}}\frac{Wf}{Wmin}}. \tag{A3.30}$$

APPENDIX B. TABLES

Table B1. Calibrated Parameters

Parameter Name	Description	Value
σ	Relative risk aversion coefficient	1.000
π_{ss}	Steady-State Inflation	1.034
β	Utility time discount factor	0.996
ε	Elasticity of substitution between different consumer goods	5.617
α	Capital income share	0.268
$SHwag$	Minimum wage to average wage ratio	0.330
$SHnon$	Share of non-Ricaridan households	0.350
ε_L	Elasticity of substitution between high- and low-skilled labor	2.000
ρ_R	Interest rate rule autocorrelation parameter	0.928
ρ_π	Interest rate rule response to inflation	1.668
ρ_Y	Interest rate rule response to output gap	0.144
$\sigma_{\varepsilon R}$	Standard deviation of monetary shock	0.129
ρ_W	Minimum wage autocorrelation	0.944
$\rho_{\pi W}$	Minimum wage response to inflation	-1.542
$\sigma_{\varepsilon W}$	Standard deviation of minimum wage shock	0.209
δ	Capital depreciation rate	0.008
p	Probability of being audited	0.006
s	Surcharge over minimum wage in case of the detection of underreporting	7.500
τ_s	Social security tax rate	0.180
τ_h	Income tax rate	0.220
τ_c	VAT rate	0.167
$SHmin$	Steady state of workers reporting minimum wage	0.331
$SHinf$	Steady-state share of underreporting of workers reporting minimum wage	0.690

Table B2. Estimated Parameters, Priors and Posteriors

Parameter Name	Description	Prior form	Prior mean	Prior st. dev.	Post. mean	Post. 90% HPD interval
ρ_A	TFP autocorrelation	beta	0.850	0.100	0.827	[0.697, 0.950]
σ_A	TFP shock std. dev.	invg	0.005	0.025	0.0892	[0.064, 0.115]
ψ	Capital adjustment cost	gamma	1.000	0.500	1.120	[0.713, 1.466]
Φ	Price adjustment cost	gamma	20.000	10.000	40.237	[24.313, 58.735]
φ	Inverse Frich elasticity of labor supply	gamma	1.000	0.100	1.007	[0.865, 1.175]
φ^i	Inverse Frich elasticity of informal labor supply	gamma	1.000	0.500	0.823	[0.438, 1.287]

APPENDIX C1. MAIN RESULTS

Figure C1.1. Impulse Responses to the Minimum Wage Shock of 1st. dev. (Depending on the Share of Underreporting)

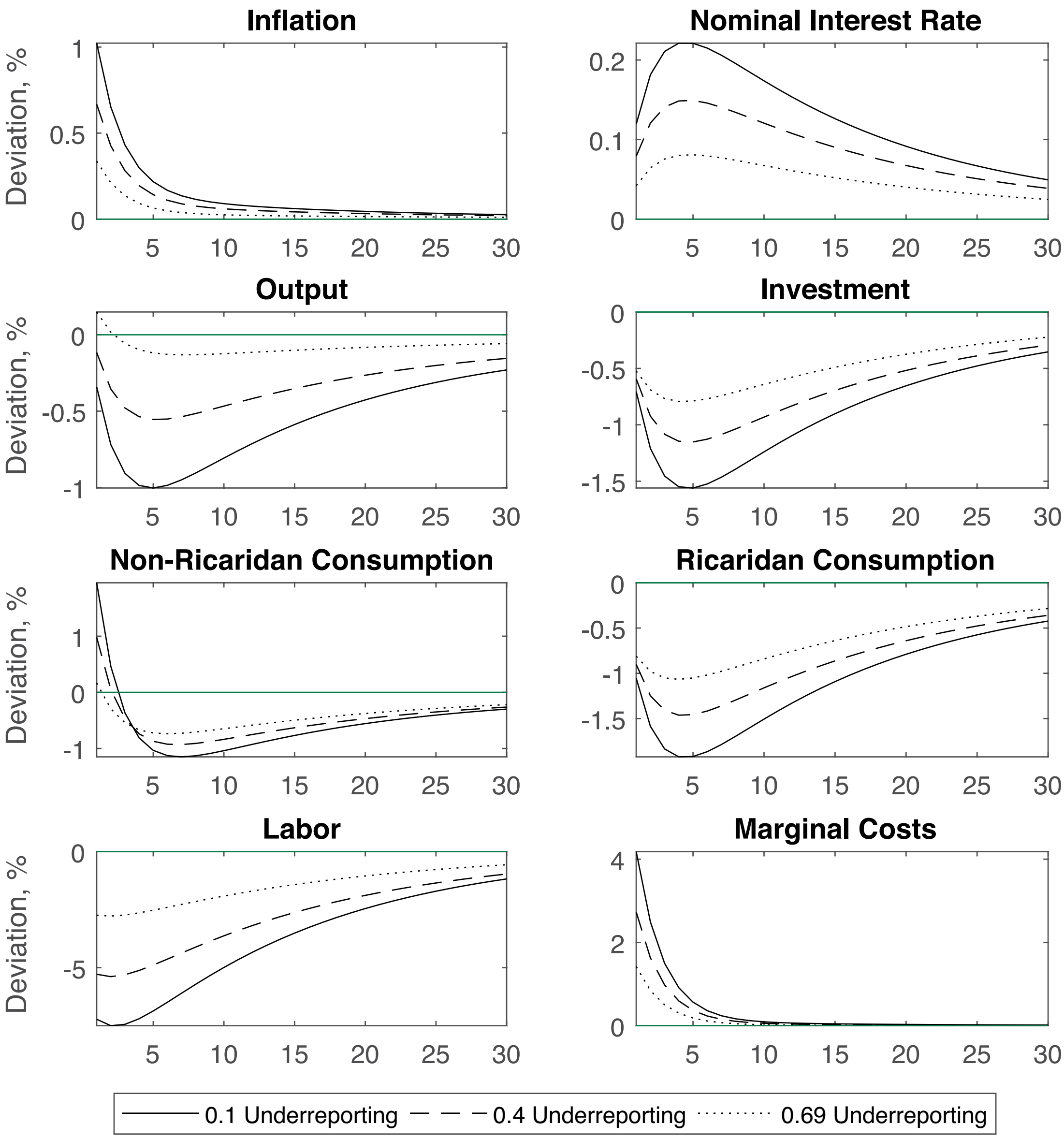


Figure C1.2. Impact Response to Minimum Wage Shock of 1st. dev.

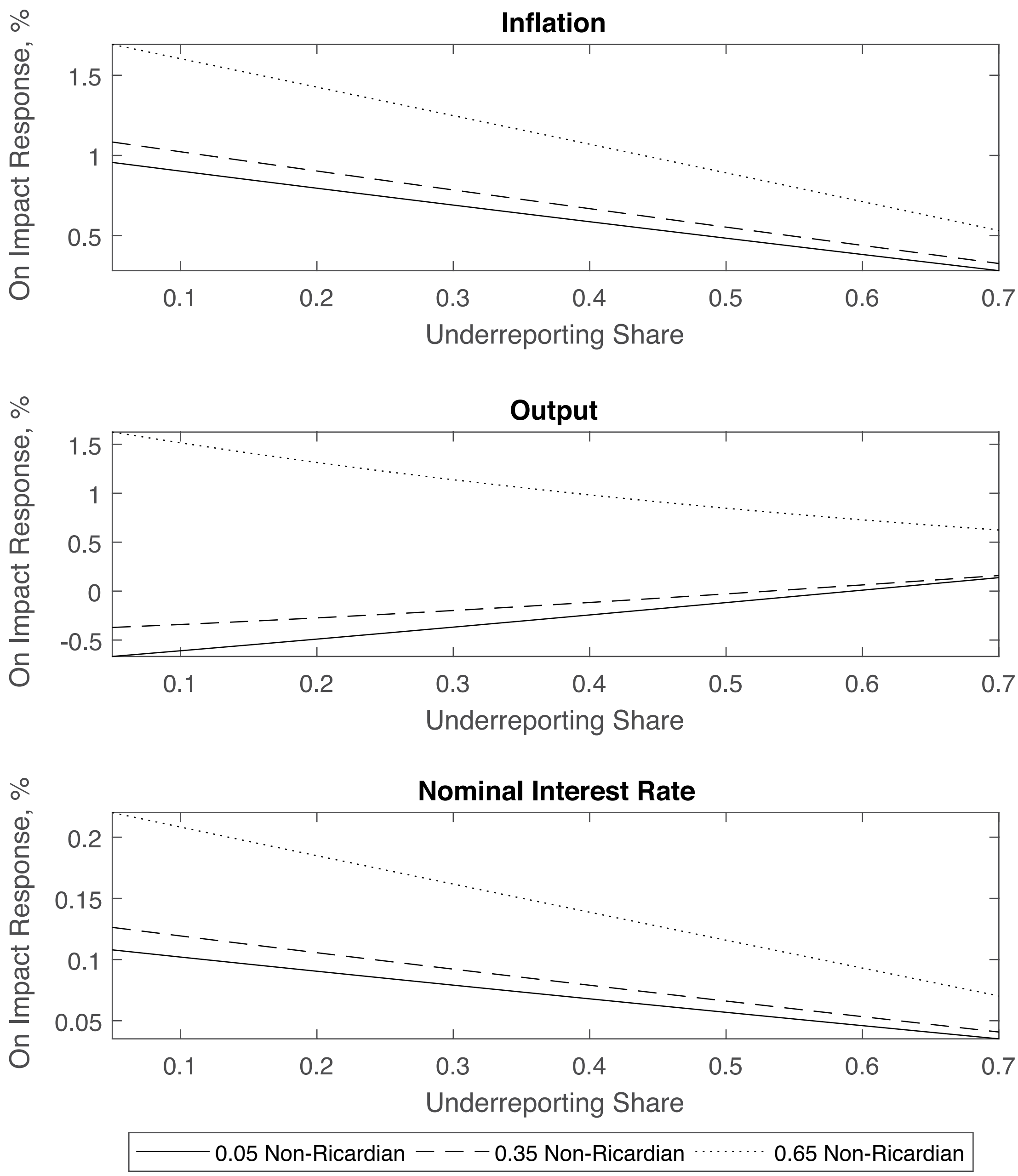


Figure C1.3. Impulse Responses to a Minimum Wage Shock of 1st. dev. (Depending on Non-Ricardian Households Share)

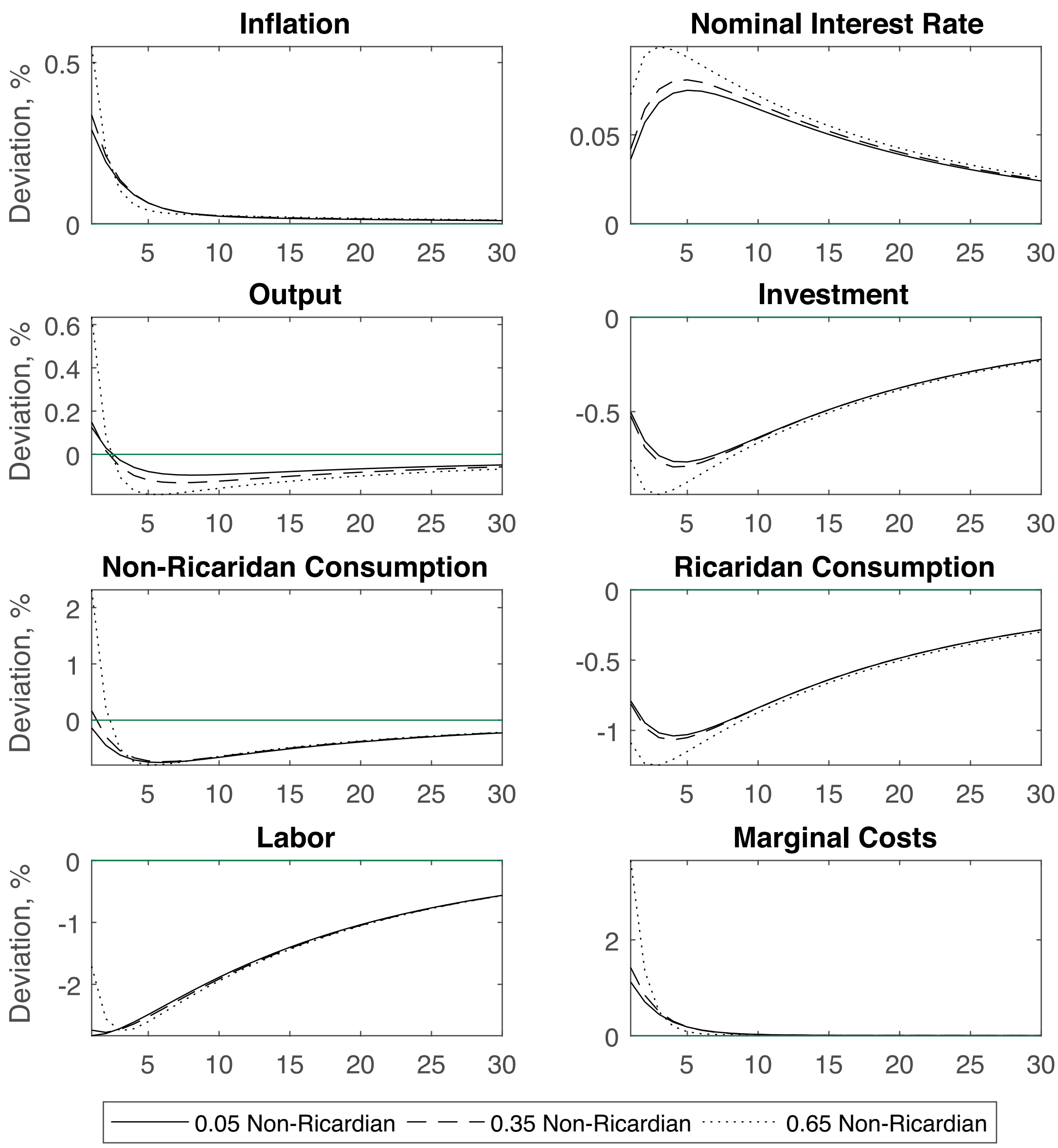
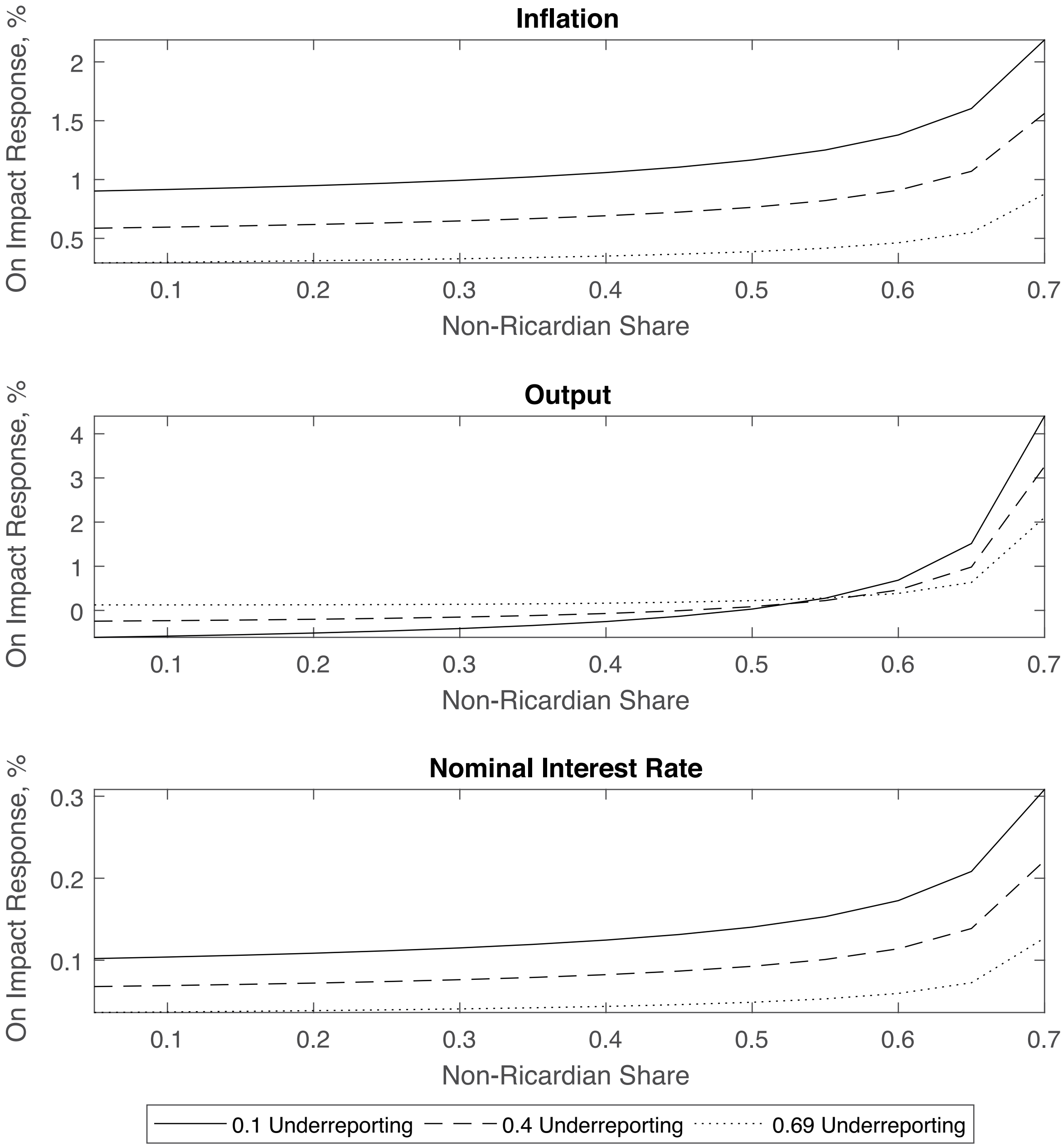


Figure C1.4. Impact Response to Minimum Wage Shock of 1st. dev.



APPENDIX C2. IMPULSE RESPONSES

**Figure C2.1. TFP Shock of 1st. dev.
(Depending on Underreporting Share)**

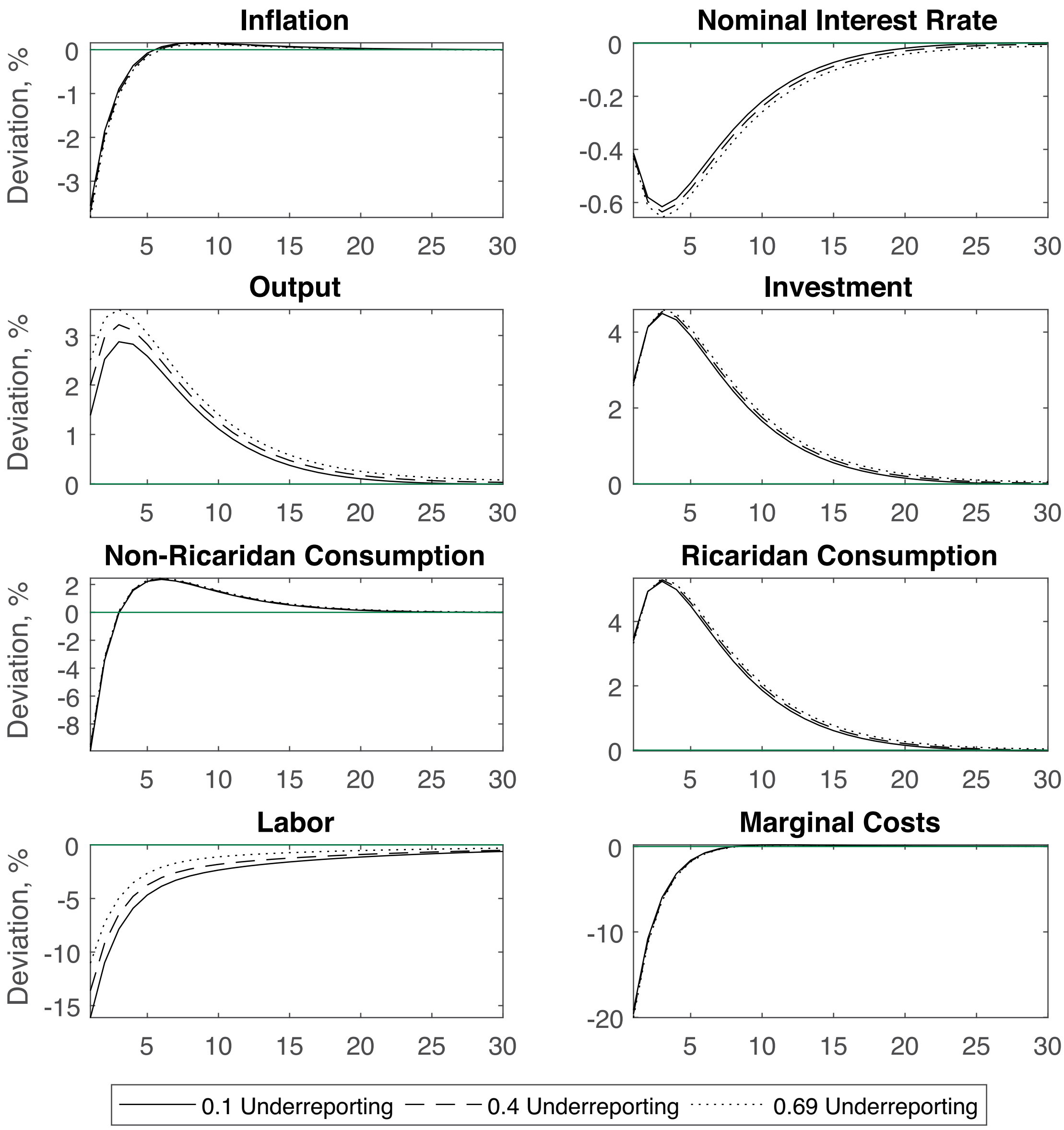


Figure C2.2. Monetary Shock of 1st. dev.
(Depending on Underreporting Share)

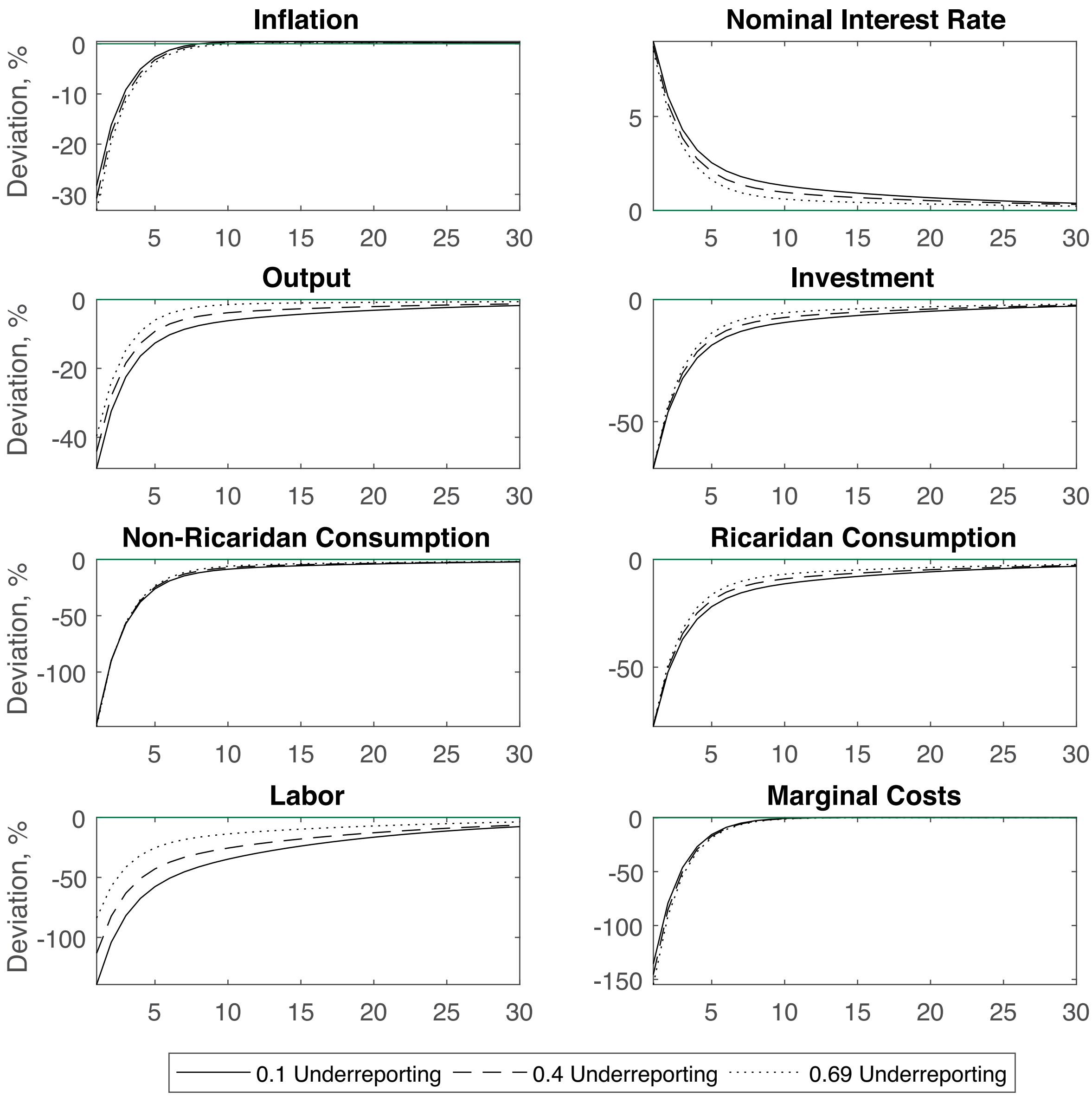


Figure C2.3. TFP Shock of 1st. dev.
(Depending on Non-Ricardian Share)

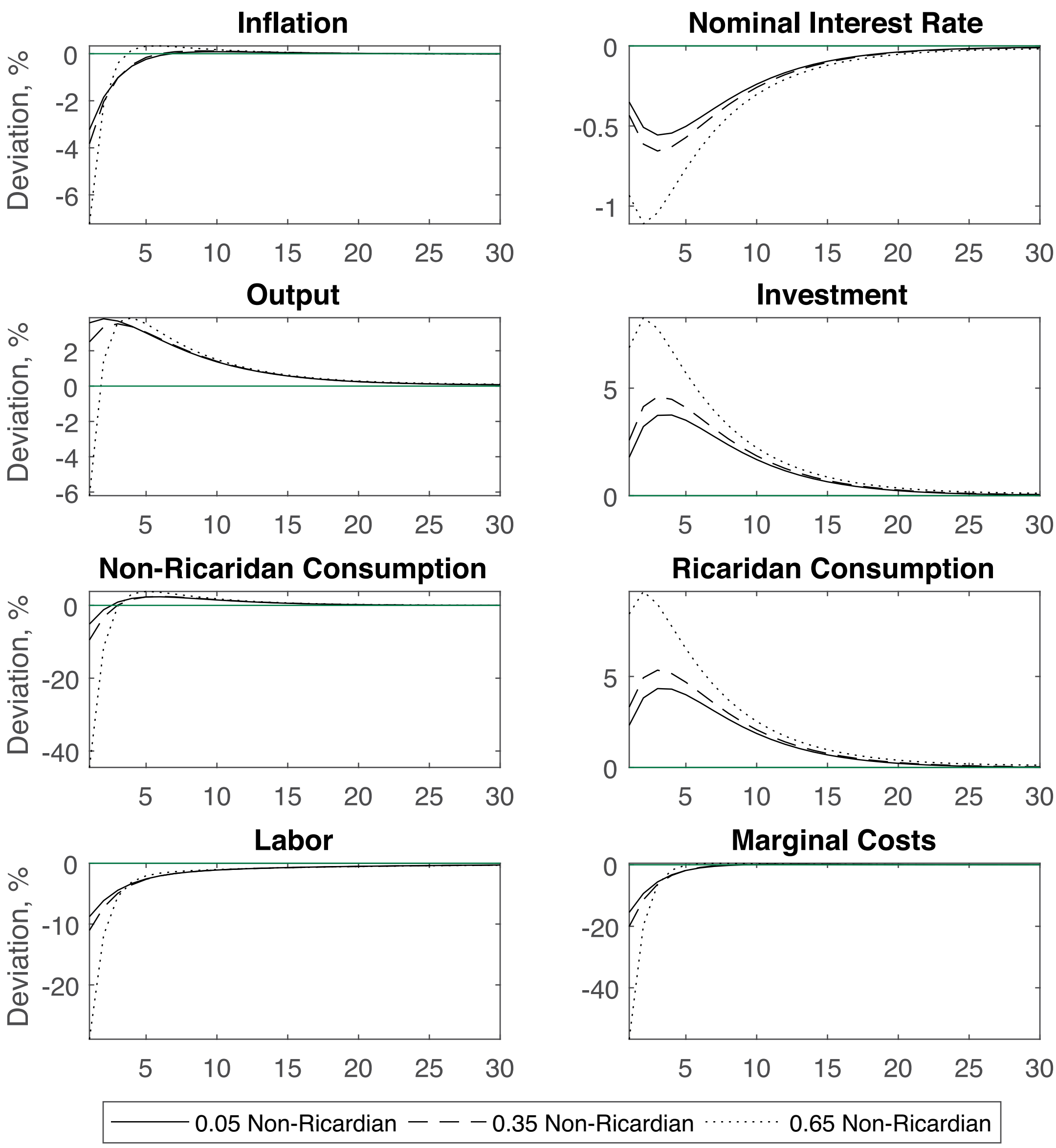
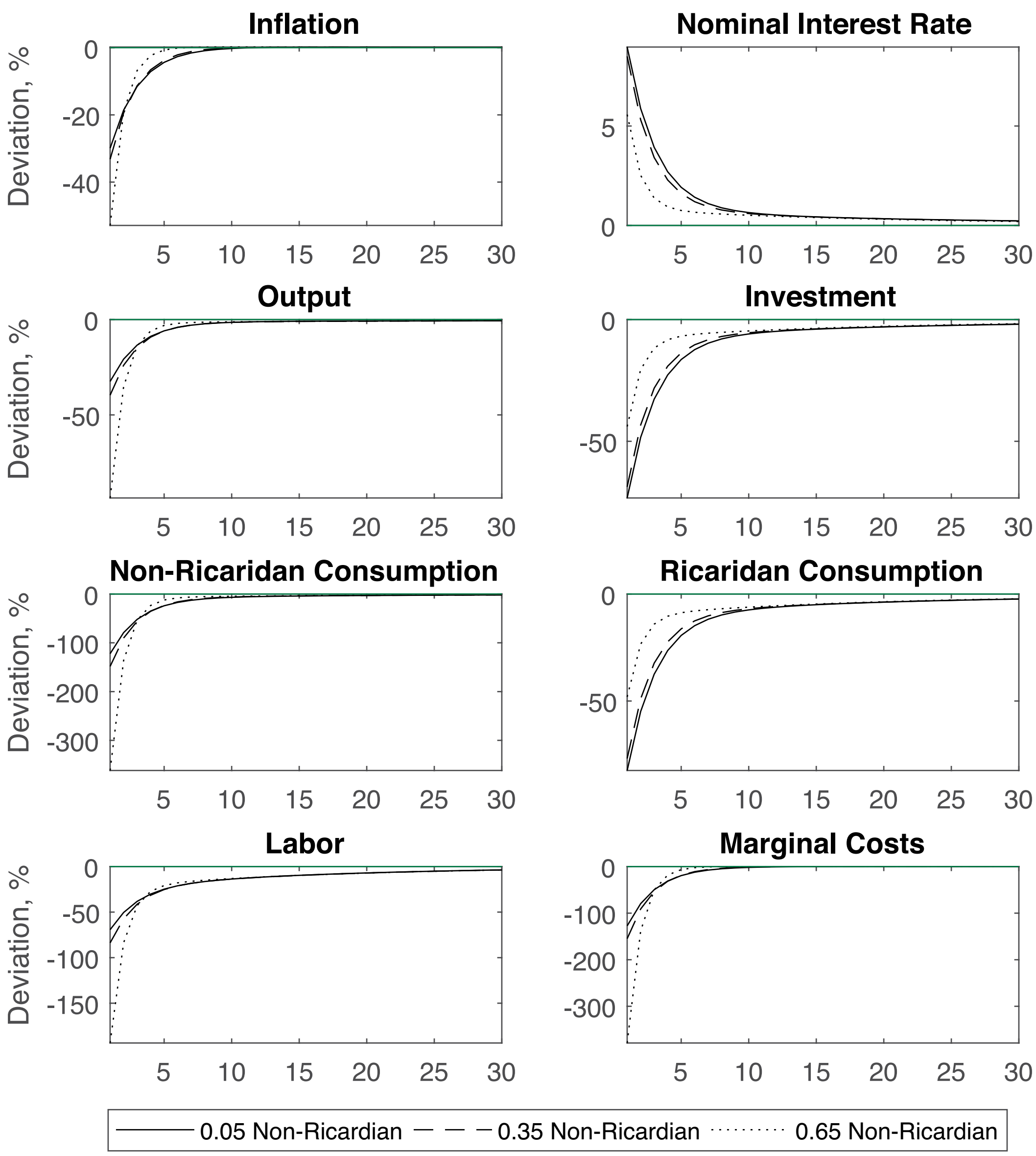


**Figure C2.4. Monetary Shock of 1st. dev.
(Depending on Non-Ricardian Share)**



EFFICIENCY IN THE MARKET FOR FINANCIAL ADVISORY SERVICES TO BUSINESSES*

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Abstract This paper considers whether company decisions on their advisors promote efficiency in the market for business advisory services. We employ a fixed effects measure of advisor quality and find that no fine-grained measure of performance seems to influence separation and hiring decisions. We do find that, under a rule of thumb measure of advisor performance, firms are more likely to ditch "bad" and "neutral" advisors than "good" ones. Unfortunately, using the same rule of thumb measure, firms appear no more likely to hire "good" quality new advisors than could be expected by chance. As a result, in less than 10% of all separations the new hire yields an improvement in advisor quality. In short, there is a substantial amount of movement in the market with no benefit.

JEL Codes G30, G39

Keywords financial advice, performance

1. INTRODUCTION

Do businesses switch from financial advisors that perform poorly to better advisors? This is the core question considered in this paper, and it is important for two related reasons. First, this type of change is crucial for the functioning of any market. Of course, other behaviours also affect efficiency, but unless buyers respond to differences in supplier performance, there is no incentive for poor performing suppliers to improve or to quit the market and thus reallocate business to better advisors. For precisely that reason, buyer switching decisions have recently attracted attention in other contexts (see Giulietti et al., 2005 and Waddams and Zhu, 2016 for recent studies of consumer switching in the retail energy market). Secondly, unless purchasers switch in this way, the connection between the performance of financial advisors and their earnings is weakened. Denton (1985), for instance, offered an early model in which purchasers do not reward good performance from their advisors, which resulted in a greater price for the advice over time without an increase in quality.

It has long been understood that information markets, as in advisory services, are likely to pose difficulties for the claim that markets promote efficiency. The quality of advice can only be known with certainty (if at all) after one has acted upon it, by which time it is too late to influence the original decision (Arrow, 1963). Of course, reputation can help, but it too depends on market participants being able to identify advice that is proven good, bad, or indifferent. That may not always be possible because outcomes can depend on luck as well as skilled advice and sometimes the counterfactual of a non-advised outcome is not well defined.

For these reasons, one may hypothesize that the market in business advice is likely to be less efficient and earnings are more attributed to luck than skill than in other non-informational markets. This view may help explain why investment bankers' earnings (which depend partly on financial advice) are controversial; high earnings that are owed to skill are typically perceived as legitimate, while earnings related to "luck" are not (Balafoutas et al., 2013). However, businesses may be better placed than individuals in dealing with these difficulties. Businesses can direct more resources to assess advisor reputations and are more likely to act on these assessments than individuals are. That suggests a more efficient functioning of the advisory market and that advisor earnings are related to performance. In this paper, we delve into these two conflicting arguments and examine the relevant related evidence.

Businesses typically retain financial advisors in two capacities: for a general range of services over time and for a concrete service in relation to a specific corporate action, like an Initial Public Offering (IPO) or underwriting. Studies have been conducted on the selection of advisors for specific tasks, but there are no studies we are aware of on the switching behaviour of businesses with respect to general financial advice. This paper is dedicated to that gap in the literature. This gap is notable both because there is a market for general financial advice, but also because the results from the studies on selecting financial advisors for concrete tasks is mixed. One possible explanation for that is that these decisions are connected to advisor performance across a range of services and not just for one task. Krigman et al. (2001) find evidence that switching decisions for underwriting advisory services is influenced by the prospect

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of gaining access to a wider range of advisory services. This is not surprising (since advisors typically have expertise in an industry and can advise across a range of activities), but it means that the choice of advisor for a specific task likely depends on an advisor's general performance rather than simply in underwriting.

Krigman et al. (2001) also find little systematic evidence that recent advisor under-pricing performance affects switching decisions for this service. Likewise et al. (2010) in their study of switching behaviour find that the decision to stay/switch when banks merge is largely driven by broader considerations: in their case, by the firm's desire to avoid possible information leakage from sharing an underwriter with other firms in its industry. The prospect of moving to an advisor with a better reputation is, however, important in Krigman et al. (2001). That reputation matters, when performance on a specific task does not, might seem strange, but it is consistent with the evidence on this relationship (outside of the context of switching). For instance, while early studies of bank advice on IPOs typically found that reputable banks under price new offerings less frequently than less reputable banks (e.g. Logue, 1973; and Neuberger and Hammond, 1974), more recent studies (like Chemmanur and Krishnan, 2012) find that reputable firms tend to price further from intrinsic value. Recent studies of certification services on high yield bonds come to a similar negative conclusion on the signal provided by reputation because it seems that reputable underwriters are more often associated with downgrades and default risks (Andres et al., 2014). This is apparently recognised by bond purchasers with the result that the issuers, in effect, pay for the relatively poor service from the underwriter. However, there is contrary evidence on certification (Fang, 2005). Likewise, in studies of mergers and acquisition advisory, some studies find that employing more reputable banks yields higher returns (e.g., Kale et al., 2003); other studies find the opposite (e.g., Michel et al., 1991).

The lack of a clear relationship between reputation and performance on a specific task would not be surprising if reputation depends on performance across a range of tasks and not just a particular task. If this was the case, and, indeed reputation matters in switching, then we would expect to find that switching decisions are related to general performance. This is what we examine in relation to the choice of a general financial advisor.

The difficulty we face in addressing that question is how to measure the general quality of financial advisors. Quality is more measurable when focusing on specific actions. For example, the quality of advice for underwriting can be measured by the extent of underwriter under-pricing. A price-based measure of quality was also available to Waddams and Zhu (2016) in their study of consumer switching in retail energy markets because, with a homogenised product, price is a simple indication of the quality of a supplier's offer. Unfortunately, there is no obvious price-based measure for the quality of general advisory services. Therefore, our approach is different. We follow the fixed effects method of Bertrand and Shoar (2003) in quantifying a manager's performance in identifying advisor performance; that is, we identify financial advisor performance with their fixed effects contribution to business performance.

In the study that is closest to ours, Bao and Edmans (2011) used the same fixed effects method to identify advisor contribution in mergers and acquisitions. They find that significant differences in advisor contribution and that these differences tend to persist. The persistence, they argue, suggests that there is some inefficiency; if business clients chased better performance, this should erode persistence (as it appears to in the retail mutual funds market). But they do not directly examine whether business switching decisions are influenced by these measures of performance. This paper considers this in relation to the fixed effects measure of general advisor performance. We then examine whether businesses encourage efficiency when they switch advisors in response to advisor performance; that is, there is a shift away from poor advisors to good advisors.

We introduce our data on advisor choice in the next section and explain how we construct measures of advisor performance in Section 3. The data on advisor choice comes from company reports. Our approach to the construction of measures of perceived advisor performance is deliberately eclectic. We generate a range of possible measures of performance to guard against a dependency on a particular and possibly questionable measure of perceived performance. We do this through plausible variation along three dimensions. First, since there are a variety of possible measures of company performance, we construct several measures of advisor performance using the Bertrand and Shoar method: one for each possible measure of company performance. Second, we allow for the possibility that companies can judge an advisor's contribution either using its contribution to absolute company performance or, possibly as a result of reference dependence, by its contribution to the change in company performance. Finally, we consider several possible connections between actual advisor performance and expected or perceived performance: expectations can be formed adaptively, rationally, or using a simple heuristic.

Section 4 considers whether advisor switching is sensitive to these measures of advisor performance. In this analysis, we allow for other possible influences on this choice. For example, own firm performance may matter both because this can lead firms to change a variety of things and because it would produce a change in advisor when matching models best explain advisor choice (see Fernando et al., 2005). Likewise, the number of other firms using a particular advisor may affect its perceived desirability. This is not only for the reasons outlined in Asker and Ljunquist (2010) over information leakage, but also because there are arguments that social influences, like herding, can play a role in the assessment of advice and opinion with the result that private information is inadequately weighted (see DeMarzo et al., 2003). There is also some experimental evidence that the willingness to pay for advice is distorted by a bias in favour of the advice from those who are similar and that excessive weight is given to this type of advice when weighing difficult decisions (see Nyarko et al., 2006; and Gino and Moore, 2007).

Section 5 discusses the results. We find that there are significant differences in our measures of advisor fixed effects and these differences in measures of advisor performance persist over time. There is also some evidence that advisor separations are related to advisor performance when we employ the simple heuristic for generating expectations. In addition, it seems the number of clients that an advisor has also affects (negatively) the probability of switching. This may be for sociological or economic reasons. There is some evidence to support the latter interpretation because it seems that future advisor performance is positively associated with the current number of clients. However, it is difficult to reconcile this interpretation with the evidence on the advisors that companies switch to. There is no evidence that they shift to advisors with a larger number of clients, which is what would be expected if firms understood the economic relationship between current numbers of clients and future advisor performance. Indeed, it seems that firms have difficulty anticipating the quality of their new advisor when they switch. Ditching an old advisor and hiring a new one actually only improves the quality of a company's advisor in under 10% of all separations in our sample. Section 6 concludes.

2. DATA ON THE EMPLOYMENT OF ADVISORS AND THEIR PERFORMANCE

Our data come from two sources. The financial data are drawn from the Extel Financial database. It is a comprehensive database that contains key financial reporting information across a large number countries and industries. Our initial sample covers about 5,000 UK listed companies from 1998 to 2008. The data on the employment of advisors are hand-collected from Corporate Register books that contain basic information about companies, including market capitalization, ownership, information about management, banks, and advising companies. This information has been self-reported by companies. Unfortunately, the publisher of Corporate Register changed several times over the 11-year span and the list of companies is not consistent. While both database providers claim to cover the population of listed companies, there is less than 50% overlap for firms. Nevertheless, we manage to link about 2,000 advisor observations with financial information on the companies they advise.

Then we apply several selection criteria. First, we exclude companies with three or fewer observations. Second, we exclude financial advisors if the number of linked companies is less than 10 per year because this might reduce noise in measuring the fixed effects. Third, occasionally firms report more than one affiliated advisor and we have omitted these companies. Finally, to diminish the potential problem with outliers, we classify as missing the top and bottom 1% of all firm-specific indicators. As our dataset is heavily unbalanced, our estimation sample contains about 5,900 firm-years pertaining to 1,145 firms. We believe the substantial reduction of the estimation sample is entirely due to the unavailability data and can be considered exogenous.

Table B1 (in Appendix B) summarizes the variables used in the analysis and provides descriptive statistics.

3. ADVISOR EFFECTS

To identify the relative contribution of different advisors to firm performance in any year, we follow Bao and Edmans (2011) in adapting the Bertrand and Shoar (2003) method for estimating individual managers' influence on firm policies and performance. We estimate a fixed effects contribution that an advisor makes to the performance (or change in performance) of the firms it advises in a given year, having controlled for other determinants of firm success. For this purpose, our controls for the other possible determinants of firm performance are a vector $X_{i,t-1}$ that includes lagged values of the debt-to-assets ratio ($Leverage_{i,t-1}$) and the logarithm of total assets ($Log(TA)_{i,t-1}$) as explanatory variables in the regression. These are commonly treated as determinants of firm performance (e.g. see Mehran, 1995). This company information is also readily available to market participants and, since we are interested in the perceived contribution of advisors, this procedure may plausibly capture how market participants form these kinds of judgements.

Since there are a variety of possible measures of firm performance and we have no obvious reason to prefer one over another, we use five measures of firm performance: return on equity (ROE), return on assets (ROA), return on sales (ROS), operating profit to total assets ratio, and Tobin's Q. For similar reasons of inclusivity, we also allow for two possible measures of advisor contribution: their contribution to the absolute performance of the firm they advise and their contribution to the change in the performance of their firms, as in (1) and (2) below. This is because it can be argued that the judgements about performance are liable to be reference-dependent (in the sense of Kahneman, 2013) with the result that changes matter more than absolute levels.

$$Performance_{it} = \alpha_1 + \Omega_{\text{it}}\beta + X_{i,t-1}\delta_1 + \epsilon_{1ti}\,, \qquad (1)$$

$$\Delta Performance_{it} = \alpha_2 + \Omega_{\text{it}}\gamma + X_{i,t-1}\delta_2 + \epsilon_{2i}\,. \qquad (2)$$

In specification (1), the fixed effect is a measure of the advisor's contribution to its firms' performances in that year. We call this Measure 1. In the second specification, the fixed effect is a measure of the advisor's contribution to its firms' change in performance in that year. We call this Measure 2. To avoid collinearity, we restrict: $\sum_{a=1}^{A}\beta_{at} = \sum_{a=1}^{A}\gamma_{at} = 0$, so that β_{at} and γ_{at} measure advisor's a fixed effect at year t as deviations from the average. Both sets of year-by-year cross-sectional regressions are estimated by OLS with robust standard errors.

Table B2 (in Appendix B) shows the estimates of specifications (1) and (2). Each row reports estimates from a cross-sectional regression for a given year in the 1998-2008 range. Column (2) and (3) report adjusted R^2 with advisors' fixed effects and F-tests for the joint significance of advisors' fixed effects. In addition, we also report a benchmark specification, without any advisors' effects, in column (1). There are five panels in Table B2 that correspond to the five performance variables, namely ROA, ROE, operating income over total assets, ROS, and Tobin's Q.

Overall, Table 2 suggests that advisor fixed effects are important. They are typically statistically significant whichever of the five financial measures is used (i.e. in all 5 panels) and in both the absolute level of and change in performance equations. Notably, we have achieved improvements in goodness of fit for the majority of cross-sectional estimates. Also, the F-test p-values from test of joint significance are small and allow us to reject the null that advisor's fixed effects are zero in 103 out of 110 regressions. The size of the fixed effect coefficients would also appear to be economically significant. To see this, we plot in Figure A1 (in Appendix A) the difference in company performance associated with having an advisor in the top quartile as compared with one in the bottom quartile in each year. In every year, this difference is as big as the mean performance of companies in that year.

We now test for whether these identified measures of advisor performance are random variables by considering whether they can be described by an autoregressive process. In these regressions, we allow for the possibility that the current number of company advisees as well as the current performance of the advisor might help predict the future performance of that advisor. These regressions are set out in Table B3 (in Appendix B).

It is apparent from these regressions that both Measure 1 and Measure 2 are not random variables: i.e. it is not just the throw of a dice and knowing current advisor performance would be useful in predicting future performance for both measures. We also note that the number of companies served is also typically a useful predictor of advisor performance.

The autoregressive structure of our advisor performance measure is important. It means that a simple adaptive expectation mechanism of projecting current own advisor performance into the future would be better than assuming that own advisor's future performance was a random draw. For this reason, we use previous own advisor performance to predict own current advisor performance under adaptive expectations in the next section.

We also consider the possibility that companies use a simple rule of thumb to judge their advisors. Given the difficulty of judging advisor quality, and the evidence that people often use simple behavioural rules in these circumstances, this is not implausible. One such rule first distinguishes advisors broadly according to whether advisors are above or below average in any year and then judges advisor quality in the following way: advisors are deemed "good" if they have been above average for the last two years, "bad" if they have been below average for the last two years, and "neutral" if they flip-flop between the two. This is, of course, plausible. The virtue of this approach is that it recognises, albeit imperfectly, i) that companies may appreciate broad differences between advisors but not the fine-grained differences generated by our fixed effects; and ii) that, given the random element in performance, only persistence in advisor performance is useful. We call these "simpler" measures of perceived advisor performance SMeasure1 and SMeasure2. Table B4 (in Appendix B) provides the distribution of advisors according to this simpler measure of performance.

4. DETERMINANTS OF ADVISOR SWITCHING AND ITS EFFECTS ON ADVISOR QUALITY

In this section, we distinguish two decisions: i) whether to change an advisor and; ii) if a separation occurs, the new hiring decision; and we consider what factors appear to affect each decision. We are especially concerned with whether advisor performance plays a role in these decisions such that they promote efficiency in the market for business financial advice.

Towards this end, and following the discussion at the end of the last section, we consider first whether the probability that a firm i changes its advisor in the current period is affected by the performance of its advisor in the previous period (for advisor $j = \beta_{j,t-1}$ for Measure 1 and $\gamma_{j,t-1}$ for Measure 2). In addition to the performance of advisors, we have the lagged performance of the firm itself ($Performance_{i,t-1}$) as a possible determinant of the switching decision and the number of other firms that use the same advisor in the previous period ($N_{j,t-1}$), and we also have firm size measure by the lagged natural logarithm of total assets, $\log(TA)_{i,t-1}$. Thus, we estimate versions of equations (3) and (4).

$$Prob(Switch_{it} = 1) = \Lambda(\alpha_3 + \nu_3 Performance_{i,t-1} + \mu_3 \hat{\beta}_{j,t-1} + \eta_3 N_{j,t-1} + \omega_3 \log(TA)_{i,t-1} + \epsilon_{3i}), \tag{3}$$

$$Prob(Switch_{it} = 1) = \Lambda(\alpha_4 + \nu_4 Performance_{i,t-1} + \mu_4 \hat{\gamma}_{j,t-1} + \eta_4 N_{j,t-1} + \omega_4 \log(TA)_{i,t-1} + \epsilon_{4i}). \tag{4}$$

Equations (5) and (6) substitute the simpler measures of advisor performance in these equations: that is, instead of $\beta_{j,t-1}$ and $\gamma_{j,t-1}$, we have dummies that take on a value of 1 when the advisor was either "good" or "bad" in the previous time period based respectively on $\beta_{j,t-1}$ and $\gamma_{j,t-1}$.

$$Prob(Switch_{it} = 1) = \Lambda(\alpha_5 + \nu_5 Performance_{i,t-1} + \mu_5 GOOD^{\hat{\beta}}{}_{j,t-1} + \zeta_5 BAD^{\hat{\beta}}{}_{j,t-1} + \eta_5 N_{j,t-1} + \omega_5 \log(TA)_{i,t-1} + \epsilon_{5i}), \tag{5}$$

$$Prob(Switch_{it} = 1) = \Lambda(\alpha_6 + \nu_6 Performance_{i,t-1} + \mu_6 GOOD^{\hat{\gamma}}{}_{j,t-1} + \zeta_6 BAD^{\hat{\gamma}}{}_{j,t-1} + \eta_6 N_{j,t-1} + \omega_6 \log(TA)_{i,t-1} + \epsilon_{6i}). \tag{6}$$

Table B5 (in Appendix B) provides the results of equations 3 (panel A) and 5 (panel B): i.e. those based on Measure 1 and SMeasure1. Each column refers to one of the 5 ways of measuring firm financial performance. Table B6 (in Appendix B) shows the results of equations 4 (panel A) and 6 (panel B): i.e. those based on Measure 2 and SMeasure 2.

It is apparent from these tables that advisor performance is only significant in determining the probability of switching in equation 5 (i.e. when we use SMeasure 1). In particular, the only indicator of advisor performance that affects the probability of switching (negatively) is whether the advisor was deemed "good" under our simple rule in the previous period because it had performed above average in the previous two years. So firms tend to hold on to a "good" advisor but they are no more likely to separate from a "bad" advisor than a "neutral" advisor. Own firm performance weakly tends to affect the probability of switching (the better the performance in the past, the less likely a switch). Finally, the number of clients an advisor has also always seems to reduce the likelihood of a switch.

We turn now to the decision over new advisors when there has been a separation. Since we have found that the simple heuristic measure of advisor performance seems to influence the separation decision, we focus on this measure of advisor performance in what follows. We examine in Panel A of Table B7 (in Appendix B) whether a change leads to an improvement in their advisor's performance and whether this change is different to what would be expected if the choice of new advisor was random (given the distribution of advisors between these types given in Table B4).

We find no evidence here that the firms' new choice of advisor is any more likely to improve advisor quality than that which would be expected from chance and there is a considerable number of these choices that in practice have no effect on advisor performance (i.e. it remains in the same category as before). Perhaps not unsurprisingly in view of this result, there is also no evidence that a switch tends to shift a firm to a more popular advisor.

Finally, we report in Panel B of Table B7 on whether as a group those companies that switch perform better in the period of the switch than those that do not. It seems they do not.

5. DISCUSSION

Advisor quality is not easily observable. This is a problem for companies, and as a result, it is also a problem for any research concerned with whether company advisor decisions promote efficiency in the advising market. We have tackled this problem by generating a variety of possible measures of advisor performance. There are, in effect, two sets of measures. One is fine-grained and assumes that companies can make use of relevant information on a range of indicators of company performance to extract the contribution made by advisors. The other assumes that companies can only make coarse judgements about whether an advisor is above or below average in any one year and they use simple rules of thumb to project from these judgments to the underlying quality of an advisor. With both types of measures, we allow for judgments to be based on the absolute performance of the company and, to allow for the possibility that these judgments may be reference dependent, to be based on the change in company performance. Of course, all these measures depend on the strategy of using fixed effects to capture the contribution of advisors to firm performance. This has been used in other contexts. Nevertheless, it may fail. There could be omitted variables that explain both company performance and their choice of advisor. In defence of the strategy, we have included the variables that are standard in company performance equations.

We find no evidence that a company's decision to change an advisor is related to any of our fine-grained, fixed effect measures of expected advisor performance. This conclusion holds whether we assume companies form expectations adaptively or rationally or whether they focus on advisor contribution to absolute company performance or changes in company performance. However, we do find evidence that if companies use a simple rule of thumb to judge advisor performance, then the decision to separate is influenced by this measure of expected performance. This is so in all the regressions where advisor performance is based on this rule when applied to absolute company performance. Given the difficulties of disentangling the influence of an advisor from the range of other factors affecting company performance, it would not be surprising if companies had recourse to such a simple rule of thumb. Of course, there are many such rules but ours has the virtue of a broad distinction between whether advisors are above or below average in any year and it has a simple way of projecting from annual performance that is subject to randomness to an assessment of underlying quality.

If the evidence on rule of thumb measures is accepted, then it seems that company separation decisions do promote efficiency, albeit only weakly. These decisions promote efficiency because we find evidence that if an advisor is judged using this rule to be "good", then the company is less likely to separate. Having a bad advisor, though, does not increase the chances of separation. So the separation decision tends to promote efficiency on this measure, but only weakly as there is no apparent distinction between "bad" and "neutral" advisors. This contrasts with the evidence on the company choice of underwriters, which seem unrelated to success in underwriting (e.g. Asker and Ljunquist, 2010; and Krigman et al., 2001). It is possible that our stronger result in this respect arises because we use a general measure of advisor performance (rather than the narrower one of underwriting success) and companies select an advisor for a range of tasks and so are concerned with more general measures of performance (as suggested by Krigman et al., 2001).

Whether we use the fine-grained measures or the rules of thumb for gauging advisor performance, we always find that the number of clients an advisor has reduces the probability of a separation. This is, therefore, a robust feature of our data set. That association may arise for sociological/psychological or economic reasons. Business leaders might assume, for example, that so long as an advisor is used widely by others in their social network, the advisor is acceptable. Numbers provides a kind of cognitive reassurance that there is nothing to worry about. Alternatively, since we find that the current number of clients actually helps predict future advisor performance, companies might appreciate this and for economic reasons be less inclined to maintain an advisor with few clients. The positive influence of client numbers on future performance suggests economies of scale. These may plausibly arise since the acquisition of knowledge on the economy and the financial sector that is a key cost in the provision of financial advice is largely a fixed cost.

However, in light of our evidence on new hires, this economic interpretation of the sensitivity of separation to client numbers is difficult to maintain. There is no evidence that companies move to advisors with a larger number of clients as would be expected if companies understood the role of client numbers in influencing advisor performance. There is, however, a simple explanation of how this case might arise (for both the economic and the social/psychological explanations). In so far as knowledge of client numbers is largely drawn from the events that are organised by advisors for the benefit of their clients, then this builds in such an asymmetry. Advisors frequently organise or sponsor business and sporting events to which they invite their clients. Attendance at such events gives clients an immediate impression of the number of fellow clients who employ their advisor, but, of course, it offers no information on the number of clients at other advisors. In these circumstances, it would not be surprising, as we find, that the choice of a new advisor is much like a random draw from the advisor pool.

This fits with our final finding. When companies switch, they do not significantly improve advisor quality on any measure of advisor performance. This may seem a little surprising given the sensitivity of the separation decision to advisor performance when judged by the rule of thumb. But, again, if knowledge of advisor quality depends largely on that company's experience (i.e. it is largely local, for reasons that now include advisor-based social networks), then they will be much better informed about the quality of their current advisor than any prospective one.

One way of putting these results into perspective is to consider the proportion of switches that improve advisor performance judged by the rule of thumb measure. In our sample there are 459 switches (12.5% of the sample). The number of companies at good advisors increases by 43, but the number of companies at poor advisors also increases, albeit by a smaller number of 12. The net number of improvers (31) is less than 7% of all switches. In the aggregate, therefore, if switches are to improve performance when there are costs from switching, then the benefits from a switch will have to be about 12 times whatever the typical cost of a switch. This seems like a large net benefit and so perhaps it is not surprising that companies that switch do not on average seem to perform better than those that do not.

6. CONCLUSIONS

Markets depend for their efficiency on consumers switching from poor performing producers to better performing ones. We study whether this happens in the market for financial advisory services to businesses. The market is an interesting case study because there appear to be significant differences in advisor performance. That these differences persist to some degree over time suggests that whatever switching behaviour does occur, it does not erode all opportunities for gain. In fact, even though we use a large number of potential measures of advisor performance, we find only weak evidence that company separation and re-hiring decisions for their advisors are influenced by any measure of advisor performance. It is weak in two respects. First, there is no evidence that these decisions are sensitive to our fine-grained fixed effects measure of advisor performance. Second. while there is evidence that a rule of thumb judgment of advisor performance affects the separation decision in the sense that firms tend to retain “good” advisors on this measure (but don’t distinguish between “bad” and “neutral” ones), there is no evidence that performance on this or any measure influences new hiring decisions.

As a result, we find that, using this rule of thumb measure, on balance only 7% of all switches yield an improvement in advisor quality. In short, there is a substantial amount of switching with no benefit.

These are important results. First, they may help explain the growth in payments to advisors. Denton (1985) supplies one model of how this might arise when advisor quality is difficult to disentangle from luck. But, in general, it is not surprising that the market value of advisor services should at times appear to defy gravity if, as we find, business consumers of those services appear to have such little appreciation of their value.

Second, it provokes an obvious question about what explains company behaviour if they are responding only weakly to differences in the quality of advisors. There is one robust feature of our data set that may provide an insight into this question. The number of clients seems to reduce the likelihood of a company separating, but it does not affect the choice of new advisor. The effect on separation decisions is consistent with either a socio/psychological herd-like explanation or an economic one because there is evidence that client numbers help predict future advisor performance. But the lack of an effect on new hire decisions is difficult to understand on either account. This asymmetry might, however, be explained by the fact that advisors often invite their clients to social and business events. This gives companies an idea about how many other clients their advisor has, but, of course, it provides no information on the number of clients at other advisors. If client numbers are regarded as a signal of quality for whatever reason and this is the major source of information on these numbers, then this would explain how these numbers affect separation decisions but not new-hire ones.

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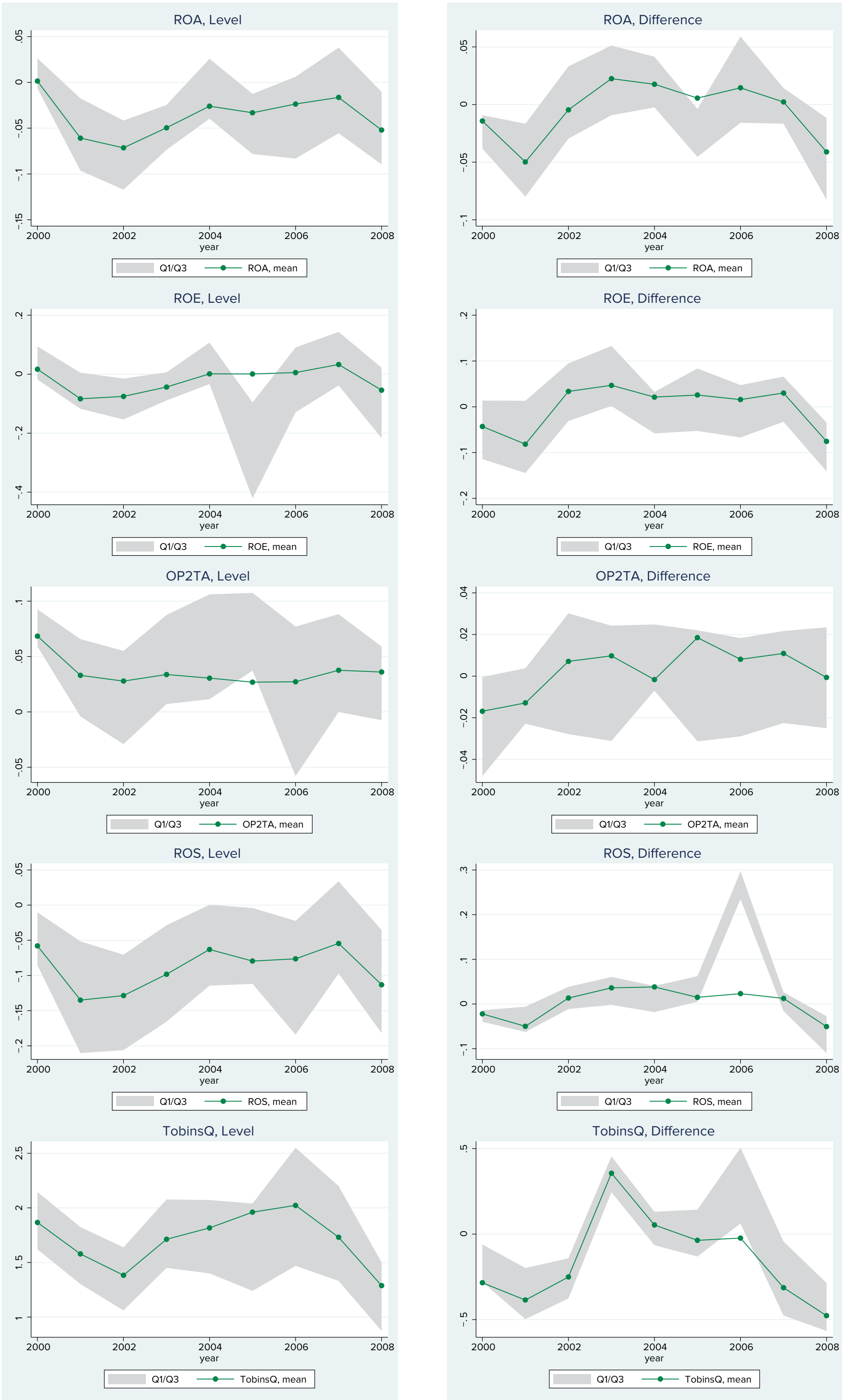
APPENDIX A. FIGURE

Figure A1. Average Performance and Quartiles of Advisors' Fixed Effects ($\hat{\beta}$ and $\hat{\gamma}$)

Panel A: Levels **Panel B: Differences**



Notes: The figures plot average, first quartile and third quartile advisor performance. Panel A measures are based on levels of firm performance, while Panel B measures are based on differences in firm performance. The study uses five measures of performance, namely ROA, ROE, Operating Income/Total Assets, ROS, and Tobin's Q.

APPENDIX B. TABLES

Table B1. Descriptive Statistics

Variable	Mean (1)	Standard Deviation (2)	Q1 (3)	Q2 (4)	Q3 (5)	N (6)
ROA (level)	0.00	0.17	-0.03	0.05	0.10	3,612
ROE (level)	0.01	0.38	-0.06	0.08	0.18	3,612
OP/TA (level)	0.07	0.16	0.03	0.09	0.15	3,612
ROS (level)	-0.04	0.28	-0.03	0.04	0.09	3,612
Tobins Q (level)	1.61	0.99	0.99	1.27	1.81	3,612
ROA (diff)	-0.01	0.14	-0.04	-0.00	0.03	3,612
ROE (diff)	-0.00	0.40	-0.09	-0.00	0.06	3,612
OP/TA (diff)	0.00	0.11	-0.04	0.00	0.04	3,612
ROS (diff)	-0.00	0.20	-0.03	0.00	0.03	3,612
Tobins Q (diff)	-0.10	0.66	-0.26	-0.03	0.13	3,612
Leverage	0.22	0.19	0.07	0.18	0.31	3,449
Log (Total Assets)	18.25	2.01	16.84	18.13	19.61	3,612
Log Firms_Total	3.31	0.60	3.04	3.43	3.74	3,612
$\hat{\beta}$ (level ROA)	0.01	0.05	-0.02	0.02	0.04	3,431
$\hat{\beta}$ (level ROE)	-0.02	0.15	-0.05	0.01	0.07	3,431
$\hat{\beta}$ (level OP/TA)	0.01	0.05	-0.01	0.02	0.04	3,431
$\hat{\beta}$ (level ROS)	0.02	0.08	-0.03	0.03	0.07	3,431
$\hat{\beta}$ (level Tobins Q)	-0.03	0.45	-0.32	-0.08	0.25	3,431
$\hat{\gamma}$ (diff ROA)	0.00	0.04	-0.02	0.00	0.02	3,431
$\hat{\gamma}$ (diff ROE)	0.01	0.11	-0.06	0.01	0.06	3,431
$\hat{\gamma}$ (diff OP/TA)	-0.01	0.03	-0.02	-0.00	0.01	3,431
$\hat{\gamma}$ (diff ROS)	-0.00	0.06	-0.03	0.00	0.03	3,431
$\hat{\gamma}$ (diff Tobins Q)	0.02	0.20	-0.08	0.02	0.14	3,431

Notes: Advisor performance measures are $\hat{\beta}$s, fixed effects based on level performance equation, and $\hat{\gamma}$, fixed effects based on different performance equations. Q1, Q2, Q3 correspond to the first, second, and third quartiles of distribution, respectively. N is the number of observations.

Table B2. Significance of an Advisor’s Fixed Effects

Panel A: ROA

	Levels			Differences		
	Adj R2 (1)	Adj R2 (2)	F (pval) (3)	Adj R2 (1)	Adj R2 (2)	F (pval) (3)
1999	-0.01	0.08	0.00	0.03	0.05	0.00
2000	0.05	0.07	0.16	-0.00	-0.02	0.60
2001	0.10	0.09	0.00	0.03	0.04	0.00
2002	0.12	0.17	0.00	0.01	0.02	0.00
2003	0.15	0.13	0.00	0.03	0.01	0.00
2004	0.19	0.19	0.00	0.00	0.04	0.00
2005	0.22	0.24	0.00	0.01	-0.01	0.00
2006	0.13	0.13	0.00	0.01	0.00	0.01
2007	0.15	0.16	0.00	0.02	0.05	0.00
2008	0.06	0.07	0.00	0.03	0.06	0.00

Panel B: ROE

	Levels			Differences		
	Adj R2 (1)	Adj R2 (2)	F (pval) (3)	Adj R2 (1)	Adj R2 (2)	F (pval) (3)
1999	0.01	0.06	0.00	0.06	0.10	0.00
2000	0.02	0.04	0.29	-0.00	0.01	0.12
2001	0.01	0.01	0.00	-0.00	-0.02	0.00
2002	0.03	0.03	0.00	0.00	0.01	0.00
2003	0.03	-0.00	0.00	0.02	0.01	0.00
2004	0.07	0.05	0.00	0.05	0.04	0.00
2005	0.11	0.16	0.00	0.00	0.02	0.00
2006	0.11	0.12	0.00	-0.00	-0.05	0.00
2007	0.06	0.04	0.00	0.04	-0.00	0.00
2008	0.03	0.03	0.00	0.01	0.01	0.00

Panel C: Operating Income / TA

	Levels			Differences		
	Adj R2 (1)	Adj R2 (2)	F (pval) (3)	Adj R2 (1)	Adj R2 (2)	F (pval) (3)
1999	0.02	0.01	0.24	0.02	0.03	0.39
2000	0.04	0.05	0.00	0.00	0.04	0.00
2001	0.16	0.15	0.00	0.03	0.03	0.00
2002	0.17	0.23	0.00	0.00	0.04	0.00
2003	0.19	0.20	0.00	0.02	0.05	0.00
2004	0.19	0.21	0.00	0.01	0.02	0.00
2005	0.13	0.12	0.00	0.07	0.06	0.00
2006	0.15	0.18	0.00	-0.00	-0.04	0.00
2007	0.15	0.14	0.00	0.04	0.03	0.00
2008	0.11	0.12	0.00	0.05	0.02	0.00

Table B2 continued

Panel D: ROS

	Levels			Differences		
	Adj R2	Adj R2	F (pval)	Adj R2	Adj R2	F (pval)
	(1)	(2)	(3)	(1)	(2)	(3)
1999	0.01	0.07	0.00	0.03	0.05	0.00
2000	0.05	0.06	0.13	-0.00	-0.04	0.95
2001	0.10	0.10	0.00	0.01	0.00	0.00
2002	0.13	0.14	0.00	-0.00	0.02	0.05
2003	0.12	0.12	0.00	0.05	0.02	0.27
2004	0.13	0.12	0.00	0.01	0.09	0.01
2005	0.16	0.14	0.00	0.03	0.03	0.00
2006	0.09	0.09	0.00	0.01	-0.00	0.00
2007	0.13	0.13	0.00	0.01	-0.02	0.00
2008	0.06	0.05	0.00	0.02	0.04	0.15

Panel E: Tobin's Q

	Levels			Differences		
	Adj R2	Adj R2	F (pval)	Adj R2	Adj R2	F (pval)
	(1)	(2)	(3)	(1)	(2)	(3)
1999	0.05	0.06	0.07	0.02	0.00	0.12
2000	0.03	0.03	0.00	0.00	0.05	0.00
2001	0.02	0.07	0.00	0.04	0.03	0.00
2002	0.07	0.12	0.00	0.01	0.05	0.00
2003	0.13	0.21	0.00	0.05	0.06	0.00
2004	0.11	0.19	0.00	-0.00	0.00	0.00
2005	0.06	0.12	0.00	0.02	0.07	0.00
2006	0.02	0.12	0.00	0.03	0.04	0.00
2007	0.05	0.13	0.00	0.01	0.05	0.00
2008	0.08	0.20	0.00	-0.00	0.07	0.00

Notes. Dependent variables are levels of difference of performance, based on ROA, ROE, Operating Income/TA, ROS, and Tobin's Q. Columns (1) and (2) report adjusted R^2 for the cross-sectional OLS specifications with and without an advisor's fixed effects, respectively. F(pval) in Column (3) is the p-value for the F-test of joint significance of an advisor's fixed effects.

Table B3. Autocorrelations

Panel A: The Dependent Variable is the Advisor's Fixed Effects Based on Levels, $\hat{\beta}$

	ROA	ROE	OP/TA	ROS	Tobin's Q
	(1)	(2)	(3)	(4)	(5)
$\hat{\beta}_{t-1}$	0.194***	0.017	0.297***	0.173***	0.174***
	(0.025)	(0.030)	(0.055)	(0.039)	(0.045)
Log (Firms)$_t$	0.020***	0.022***	0.030***	0.030***	-0.140***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.037)
Sargan, p-value	0.801	0.661	0.030	0.065	0.001
AR(2), p-value	0.280	0.546	0.387	0.461	0.319
N obs.	180	180	180	179	180

Panel B: The Dependent Variable is the Advisor's Fixed Effects Based on Differences, $\hat{\gamma}$

	ROA	ROE	OP/TA	ROS	Tobin's Q
	(1)	(2)	(3)	(4)	(5)
$\hat{\gamma}_{t-1}$	-0.154***	-0.146***	-0.172***	-0.111**	-0.167***
	(0.014)	(0.024)	(0.024)	(0.050)	(0.053)
Log (Firms)$_t$	-0.009***	0.016***	-0.020***	0.017***	0.040**
	(0.001)	(0.003)	(0.002)	(0.003)	(0.018)
Sargan, p-value	0.345	0.072	0.011	0.384	0.010
AR(2), p-value	0.962	0.124	0.504	0.319	0.010
N obs.	187	187	187	185	187

Notes: The table reports GMM-SYS 2-step dynamic panel data results with an advisor's performance as the dependent variable. The instrument set includes from t-2 to t-4 lags of advisor-specific variables. Year dummy variable are included but not reported. Robust standard errors are in parentheses. *, **, *** represent the 10, 5, and 1 percent significance level, respectively.

Table B4. Transition Matrices

	Level Bad *t-1*	**ROA Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	27	19	0	46
Neutral *t*	31	237	60	328
Good *t*	0	17	68	85
Total *t*	58	273	128	459

	Diff Bad *t-1*	**ROA Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	17	20	0	37
Neutral *t*	48	276	42	366
Good *t*	0	33	23	56
Total *t*	65	329	65	459

	Level Bad *t-1*	**ROE Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	27	25	0	52
Neutral *t*	33	276	48	357
Good *t*	0	22	28	50
Total *t*	60	323	76	459

	Diff Bad *t-1*	**ROE Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	13	27	0	40
Neutral *t*	50	284	32	366
Good *t*	0	24	29	53
Total *t*	63	335	61	459

	Level Bad *t-1*	**OP/TA Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	16	25	0	41
Neutral *t*	31	248	67	346
Good *t*	0	17	55	72
Total *t*	47	290	122	459

	Diff Bad *t-1*	**OP/TA Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	15	20	0	35
Neutral *t*	41	286	46	373
Good *t*	0	37	14	51
Total *t*	56	343	60	459

	Level Bad *t-1*	**ROS Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	32	24	0	56
Neutral *t*	21	246	65	332
Good *t*	0	23	48	71
Total *t*	53	293	113	459

	Diff Bad *t-1*	**ROS Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	15	20	0	35
Neutral *t*	33	301	47	381
Good *t*	0	29	14	43
Total *t*	48	350	61	459

	Level Bad *t-1*	**Tob Q Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	64	22	0	86
Neutral *t*	68	221	33	322
Good *t*	0	10	41	51
Total *t*	132	253	74	459

	Diff Bad *t-1*	**Tob Q Med *t-1***	**Good *t-1***	**Total *t-1***
Bad *t*	10	17	0	27
Neutral *t*	39	261	63	363
Good *t*	0	29	40	69
Total *t*	49	307	103	459

Notes: The table shows transition matrices for company switches among 'good', 'bad', and 'neutral' states. An advisor is defined as 'good' if it has been above average for the last two years; 'bad' if it has been below average for the last two years; and 'neutral' if it has flip-flopped between the two. The performance of advisors, fixed effects, is calculated based on either levels or different company performance measures (ROA, ROE, ROS, Operating Income/Total Assets, and Tobin's Q).

Table B5. Determinants of Advisor Switches, Level-Based Advisors’ Effects

Panel A:

	ROA (1)	ROE (2)	OP/TA (3)	ROS (4)	Tobin’s Q (5)
Performance$_{t-1}$	-0.015* (0.009)	-0.001 (0.003)	-0.018* (0.010)	-0.009* (0.005)	0.000 (0.001)
Advisor FE$_{t-1}$ ($\hat{\beta}$)	0.014 (0.014)	0.001 (0.002)	-0.009 (0.015)	0.026* (0.015)	-0.000 (0.001)
Log (Firms)$_{t-1}$	-0.014*** (0.005)	-0.014*** (0.005)	-0.013*** (0.005)	-0.015*** (0.006)	-0.014*** (0.005)
Log (Total Assets)$_{t-1}$	0.000 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)
Leverage$_{t-1}$	0.001 (0.005)	0.003 (0.006)	0.002 (0.005)	0.004 (0.006)	0.002 (0.005)
Pseudo R^2	0.069	0.066	0.069	0.069	0.066
N obs.	2,879	2,879	2,879	2,843	2,858

Panel B:

	ROA (1)	ROE (2)	OP/TA (3)	ROS (4)	Tobin’s Q (5)
Performance$_{t-1}$	-0.038* (0.023)	-0.000 (0.010)	-0.050** (0.024)	-0.018 (0.013)	0.003 (0.003)
Advisor Good$_{t-1}$	-0.024*** (0.007)	-0.027*** (0.008)	-0.019** (0.008)	-0.017** (0.008)	-0.034*** (0.009)
Advisor Bad$_{t-1}$	-0.013 (0.011)	-0.010 (0.010)	0.046** (0.023)	-0.003 (0.011)	-0.020** (0.009)
Log (Firms)$_{t-1}$	-0.040*** (0.007)	-0.041*** (0.007)	-0.038*** (0.006)	-0.039*** (0.007)	-0.041*** (0.007)
Log (Total Assets)$_{t-1}$	0.004 (0.002)	0.002 (0.002)	0.004 (0.002)	0.002 (0.002)	0.004 (0.003)
Leverage$_{t-1}$	0.009 (0.017)	0.014 (0.016)	0.008 (0.016)	0.011 (0.017)	0.011 (0.017)
Pseudo R^2	0.054	0.051	0.055	0.049	0.054
N obs.	4,021	4,021	4,019	3,932	3,994

Note: The dependent variable is a binary measure equal to one if there was a switch of an advisor between period *t-1* and *t*. Marginal effects estimated around mean points are reported. Robust standard errors are in parentheses. *, **, *** represent the 10, 5, and 1 percent significance level, respectively.

Table B6. Determinants of Advisor Switches, Difference-Based Advisor Effects

Panel A:

	ROA (1)	ROE (2)	OP/TA (3)	ROS (4)	Tobin's Q (5)
$Performance_{t-1}$	0.005 (0.009)	0.005 (0.003)	-0.009 (0.011)	0.009 (0.007)	-0.000 (0.002)
Advisor FE_{t-1} ($\hat{\gamma}$)	0.025 (0.029)	0.018 (0.012)	-0.054 (0.038)	-0.005 (0.020)	-0.001 (0.005)
Log $(Firms)_{t-1}$	-0.013^{**} (0.006)	-0.012^{**} (0.005)	-0.012^{**} (0.005)	-0.012^{**} (0.005)	-0.012^{***} (0.002)
Log (Total $Assets)_{t-1}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
$Leverage_{t-1}$	0.003 (0.005)	0.001 (0.005)	0.002 (0.005)	0.004 (0.005)	0.002 (0.005)
Pseudo R^2	0.072	0.077	0.071	0.076	0.071
N obs.	2,751	2,751	2,749	2,679	2,731

Panel B:

	ROA (1)	ROE (2)	OP/TA (3)	ROS (4)	Tobin's Q (5)
$Performance_{t-1}$	0.007 (0.009)	0.007^{*} (0.004)	-0.010 (0.011)	0.010 (0.007)	0.001 (0.002)
Advisor $Good_{t-1}$	-0.004 (0.003)	-0.003 (0.003)	0.003 (0.004)	-0.002 (0.004)	-0.002 (0.003)
Advisor Bad_{t-1}	-0.004 (0.003)	-0.007^{*} (0.004)	-0.000 (0.003)	-0.007^{*} (0.004)	-0.005 (0.004)
Log $(Firms)_{t-1}$	-0.012^{**} (0.005)	-0.012^{**} (0.005)	-0.011^{**} (0.005)	-0.012^{**} (0.006)	-0.012^{**} (0.005)
Log (Total $Assets)_{t-1}$	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
$Leverage_{t-1}$	0.003 (0.005)	0.001 (0.005)	0.002 (0.005)	0.005 (0.006)	0.001 (0.005)
Pseudo R^2	0.072	0.078	0.071	0.077	0.070
N obs.	2,449	2,449	2,447	2,411	2,431

Note: The dependent variable is a binary measure equal to one if there was a switch of advisor between period *t-1* and *t*. Marginal effects estimated around mean points are reported. Robust standard errors are in parentheses. *, **, *** represent the 10, 5, and 1 percent significance level, respectively.

Table B7. Differences in Variables Before and After an Advisor Change

Panel A: Advisor Based Variables

Variable	Before			Before			Diff:	p-value
	Mean	SD	N	Mean	SD	N		
$\hat{\beta}$ (level ROA)	0.01	0.06	321	0.01	0.08	321	0.00	0.94
$\hat{\beta}$ (level ROE)	-0.03	0.16	321	-0.02	0.52	321	-0.02	0.59
$\hat{\beta}$ (level OP/TA)	0.01	0.06	321	0.01	0.08	321	0.00	0.52
$\hat{\beta}$ (level ROS)	0.02	0.09	319	0.01	0.10	319	0.01	0.32
$\hat{\beta}$ (level TobinsQ)	-0.15	0.49	321	-0.09	0.77	321	-0.06	0.19
$\hat{\gamma}$ (diff ROA)	0.00	0.05	321	0.01	0.05	321	-0.00	0.48
$\hat{\gamma}$ (diff ROE)	0.01	0.11	321	0.02	0.20	321	-0.01	0.64
$\hat{\gamma}$ (diff OP/TA)	-0.01	0.04	321	-0.01	0.05	321	-0.00	0.99
$\hat{\gamma}$ (diff ROS)	0.01	0.07	319	0.00	0.07	319	0.00	0.34
$\hat{\gamma}$ (diff TobinsQ)	0.01	0.22	321	0.03	0.21	321	-0.02	0.19
Log (Firms Total)	3.13	0.88	398	3.11	0.85	398	0.01	0.82

Panel B: Firm-Based Variables

Variable	Before			Before			Diff:	p-value
	Mean	SD	N	Mean	SD	N		
ROA (level)	-0.03	0.20	398	-0.02	0.19	398	-0.00	0.74
ROE (level)	-0.02	0.40	398	-0.00	0.41	398	-0.02	0.44
OP/TA (level)	0.03	0.19	398	0.03	0.19	398	-0.00	0.68
ROS (level)	-0.08	0.34	382	-0.08	0.33	382	-0.00	0.94
TobinsQ (level)	1.76	1.12	395	1.82	1.17	395	-0.05	0.20
ROA (diff)	-0.00	0.14	275	0.01	0.15	275	-0.01	0.53
ROE (diff)	-0.00	0.46	275	0.07	0.48	275	-0.07	0.13
OP/TA (diff)	0.00	0.12	275	-0.00	0.13	275	0.01	0.59
ROS (diff)	-0.01	0.22	265	0.04	0.21	265	-0.04	0.03
Tobin's Q (diff)	-0.01	0.72	274	-0.02	0.77	274	0.01	0.87

Notes: The table reports descriptive statistics for key firm-specific and advisor-specific variables before and after switching advisors. P-value is the p-value for t-test of mean comparison.