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Developing a Three-Statement Financial Model for Regional Airlines: A Case Study of Structured Hierarchical Financial Model with Automated Investment Schedule and Provisioning Features*

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ABSTRACT

The ***subject of study*** in the paper is the analysis of financial effects associated with the performance of regional airline projects from their launch to maturity, with the ***goal*** being the development of financial modeling tools to achieve the most thorough incorporation of such effects in the study context. Financial models as functional aids in optimal route planning for regional airlines have an under-explored potential, making the subject of study especially topical. The *research methods* utilized by the authors in the study are cash flow-based and accounting indicator-based investment project appraisal methods. These methods rely on integrated (three-statement) nominal financial modeling protocols developed at a monthly frequency and tailored for compliance with the Federal Aviation Guidelines. The resulting model provides and reconciles the derivation of free cash flows on the invested capital (FCFF) and free cash flows to equity (FCFE) under both the direct and indirect methods of cash flow derivation, thereby helping estimate the performance and efficiency of the aviation projects in a comprehensive way. It also incorporates some advanced features, such as accounting for aviation subsidies, provisioning for the overhauls of Airframes and Engines, compliance with the national Tax code and Federal Aviation Guidelines, as well as the treatment of initial Tax Loss Carryforwards. The ***findings*** of the model afford a conclusion that financial support measures in the form of existing regional airline subsidies in Russia may just about ensure a minimum acceptable rate of return on capital invested in regional airline projects. The ***practical significance*** of the model for regional airlines is in allowing them to support their business planning processes while seeking licenses, flight and subsidy approvals from Aviation Authorities, as well as actually optimize their long-term route maps and schedules with an eye to key financial parameters (e.g. ROE or NPV). In terms of ***research novelty***, the financial model innovates algorithms to endogenize and automate the timing of repair and overhaul flags for the aircraft fleet in the context of investment depreciation and maintenance schedules.

Keywords: aircraft maintenance; three-statement financial modelling; flight route optimization; provisions; regional airlines; structured hierarchical financial model

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Разработка интегрированной финансовой модели для региональных авиалиний: опыт структурированной иерархической финансовой модели с автоматизированным графиком инвестиций и формирования резервов

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* References to Rows and Cells of the Model that follow in the main body of the text relate to the model's Excel file. A freely downloadable and easy-to-audit Excel file of the model is available at the following link. URL: https://disk.yandex.ru/d/5sVf0dDqrJml1w

АННОТАЦИЯ

Предметом исследования является анализ финансовых эффектов, связанных с проектами региональных авиакомпаний с момента их запуска и до зрелости. **Цель** исследования — разработка инструментов финансового моделирования для достижения наиболее полного учета таких эффектов**.** Финансовые модели пока недостаточно изучены как инструменты для эффективного планирования проектов региональных авиакомпаний. Это делает исследование особенно актуальным. Авторы применили методы инвестиционного проектирования, основанные на анализе денежных потоков и бухгалтерских данных. Эти методы опираются на интегрированное финансовое моделирование, которое проводится ежемесячно и соответствует требованиям Федеральных авиационных правил. Создана финансовая модель, которая позволяет точно прогнозировать денежные потоки на совокупный инвестированный и собственный капитал авиационных проектов. Модель использует как прямые, так и косвенные методы расчета показателей FCFF и FCFE. Это дает возможность всесторонне оценить эффективность проектов. Она включает расширенные структурные элементы: учет авиационных субсидий; формирование резервов на капитальный ремонт, исходя из Налогового кодекса и Федеральных авиационных правил; перенос убытков на будущее. На основе результатов исследования сделан **вывод**, что субсидии для региональных авиалиний в России обеспечивают лишь минимальную рентабельность. **Практическая значимость** модели для региональных авиакомпаний заключается в поддержке бизнес-планирования при получении лицензий, разрешений и субсидий. Она также помогает оптимизировать маршрутные карты и расписания с учетом ключевых финансовых показателей, таких как ROE и NPV. **Научная новизна** модели заключается в автоматизации алгоритмов для динамического учета сроков текущего и капитального ремонта всего парка самолетов в рамках амортизационных и инвестиционных росписей финансовых моделей.

Ключевые слова: региональные авиакомпании; структурированная иерархическая финансовая модель; интегрированное финансовое моделирование; оптимизация маршрутов полетов; начисление резервов; техническое обслуживание воздушных судов

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INTRODUCTION

Financial modelling for regional aviation projects has certain peculiar features that are absent or less pronounced in the case of longer-haul airline projects, namely [1]:

- *Intricate routing maps and patterns* to provide for the maximal branching of operations from base airports over diurnal cycles, and a bias towards day-time operations only. Regional airlines don't tend to fly in the hub-and-spoke city pairs only [2]. Additionally, seasonal patterns of operations to tourist destinations are more pronounced, with a variable frequency of flights over the summer and winter seasons. This feature calls for a highly granular modular and temporal structure of associated financial models, including carrying out forecasting and budgeting at a monthly frequency.
- *Dependence on the risk of adverse weather conditions*, which calls for the incorporation of probabilistic no-fly allowances into the operating segments of the model.
- More frequent scheduled servicing of propeller and turboprop aircraft linked to accumulated flight-hours — necessitates the automation of investment and maintenance schedules for aircraft operations.
- Proportionately a much *more volatile structure of passenger miles travelled* and seat utilization compared to larger aircraft,[1] including over diverse daily routing — calling not only for stochastic financial modelling (e.g. with Monte-Carlo), but also supporting the case of higher operational granularity for such models.
- *Higher investment and operating costs per passenger* associated with regional flights necessitate government support for regional airline projects in the form of operating and investment subsidies. This is the uniform feature of regional airline operations: the world over, they are seldom viable without capital grants or operating subsidies [3]. Therefore, the mechanics of government grants and taxation, in conjunction with induced regional macroeconomic effects, have to be incorporated into the operating segments of the model.[2]
- For smaller airlines with scant fleets, provisioning features in the model to manage the volatility in the Profit and Loss (P&L) statement pro forms arising due to the engine and airframe overhauls is a desirable feature where accounting provisions are allowed under the applicable financial accounting standards reducing the annual profit tax liabilities.

[1] Regional aircraft usually have a take-off weight under 8,5 tonnes.

[2] One has to be careful to differentiate between public and commercial effects of the projects in that instance, though.

Regarded jointly, the above features militate against the view that regional airlines' financial models represent only a mix of other airline models [2].

Of specific interest are the issues involved in modelling the operating subsidy policies for regional airlines [4, 5]. In many countries, such policy is implemented based on monthly and quarterly payments disbursed by regional or national authorities in proportion to the number of flight segments/legs[3] of variable distance de facto performed by aircraft of a specific take-off weight or passenger capacity. In other countries, the subsidy constitutes a certain proportion of the airline-determined fare [6, 7].

In our case study, we have modelled the former situation of fixed per-flight-leg subsidies, which in conjunction with the regulated fares, make the pattern of revenue more predictable for the airlines and tied to the actual performance of flights. This model sits easily as well with the principle of maximum *regulated fares*, the compliance with which can be imposed on the regional airlines.

More specifically, our financial modelling case study addresses the context of a regional airline in Russia that is to be set up by a maker of regional turboprop jets, so the turboprop planes are modelled as being internally commissioned for completion at cost. Having regard to the "no-sunk costs" principle of financial modelling, only the costs of completion of the existing airframes and engines are counted towards the investment costs of the project in the baseline version of the model. However, the appropriateness of treating prior investments into aircraft as "sunk costs" for aviation projects is also briefly touched upon in the Results section of the paper.

In general, our paper aims to contribute to the literature on financial modelling in the state-subsidized aviation sector, specifically proposing to make direct use of (structured- hierarchical) financial models to optimize route planning — which is quite feasible in the context of small regional airlines, for which spending on advanced route optimization software is beyond the budgetary reach. In the process, the paper innovates techniques for endogenizing the impact of flight-route intensities on depreciation and maintenance cost schedules of aviation-related financial models, developing an automated system of flags in this context. This is the research gap believed to be closed by the paper in the regional aviation context.

LITERATURE REVIEW

Airlines were among the early adopters of modern capital budgeting and financial modelling techniques, continuously driving their improvement [8]. Since the activities of regional airlines are largely subsidized, financial modelling for regional airline projects falls within the larger canvas of research on public-private partnerships, which is the hot-button research area in the domain of investment project appraisal [9], including for transport infrastructure-related projects [10]. Additionally, regional airlines create a web of wider economic effects and social externalities, which pose a not inconsiderable challenge to quantification and expression in value terms [11]. Notwithstanding that, yearly slightly more than a dozen academic papers are published on average on the subject of airline company valuation and financial modelling [12].[4] Research on hierarchic financial models is of specific relevance in the context of our analysis — as such models are meant to comprehensively capture lower-level operating effects (usually arising at a flight-segment level, in the case of airlines) and integrate them across time into the warp and weft of financial statements and related long-term financial performance metrics [13]. The benefits of using the class of hierarchically structured models for airlines are especially pronounced to the extent that a well-structured financial model will not only foretell a financial effect from flying over a set route map but can also be used as a tool in itself to optimize the routing maps and flight schedules.

Apart from innovative AI-based solutions,[5] there are many approaches to modelling and optimizing the routing performance of airlines. A recent meta-study [14] lists optimization techniques based on the maximization of revenue [15] and the minimum-of-costs criteria (such as popular dynamic programming algorithms, e.g. [16]), as well as manifold technical feasibility and delay criteria to achieve robustness of operations over shorter-term horizons (see also Kasturi et al [17], for a detailed big-data analysis of 3 frequently used mathematical techniques). However, comprehensive multi-period financial models relying on the 3 financial statements (the Profit and loss statement (P&L), the Balance sheet,

[3] A flight leg, or segment, is an aircraft operation from take-off to landing associated with embarkation and disembarkation of passengers.

[4] Literature on the analysis of financial stability of select airlines, including in Russia (e.g. [25]), is not included in this count.

[5] See KPMG. Aviation (2030): AI flight scheduling. URL: https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2023/01/ie-aviation-2030-jan-23.pdf (accessed on 14.08.2024).

and the Cash flow statement) can also be used in the context to achieve the optimization of flight routes based on the NPV (Net present value) or other related financial criteria — within the longer time-frame reference and given a limited set of competing flight schedules.[6] Indeed, the financial theory of a firm would suggest the use of NPV for the objective function maximization in the context, calling for the development of hierarchical financial models with flexible, modular structures for operating spreadsheets [18].

This is beyond the state of the art in the three-statement financial modelling as applied to regional airlines. The state of the art financial modelling practices are outlined in generic sources such as Damodaran [19], Pignataro [20], Tennent & Friend [21], Rees [22], Avon [23] and Swan [24], or, specifically for transport industries, the World Bank.[7] All the suggestions from these sources indicate that the three-statement financial modelling framework in nominal parameters is the best approach for generic transport-related financial models, which is also the approach we pursue.

On a more practical plane, financial model aggregator websites (such as Efinancialmodels,[8] Icrestmodels[9]) contain about a dozen of publicly available models for airlines, including a few dynamic models with some projection drivers stemming from the flight route and segment-specific levels. Specifically, we identify in the public domain 3 models relating to regional airline modelling: one air taxi model and one generic regional airline business plan model,[10] with an additional precedent attempting to use three-statement financial models in planning mergers and acquisitions for troubled airlines,[11] but all of these models don't have a sufficient operational granularity to analyze financial implications of airline operations from the level of individual routes and up. Therefore, the essential link between individual-specific flight route operations and the overall financial performance of the airline is missing in the published financial models. Without this link, integrated financial models, even if handy for financial and regulatory compliance purposes, are not very helpful for route optimization and other operations research in the airline management domain. This is also one of the key financial modelling and research gaps in the published financial modelling literature for the domain that the paper contributes towards addressing — in the belief that many operational aspects for regional airlines can be effectively optimized based on a multi-faceted financial model.

The foregoing suggests the topicality of the research area and its ripeness for exploration in the proposed framework of highly granular structured hierarchical financial models, such as [13].

The financial model described below has been commissioned from the authors and, apart from providing the platform for implementing in full the intended optimization-oriented features, has had to comply with the requirements for business plans submitted to the Russian Aviation Authority (according to Article 69 of the FAP-10 document).[12] These requirements specifically indicate that the model should report the gross funding short-fall of the project in the first projected year of the operations, and how it is expected to have it covered, net of the subsidies due.

METHODOLOGY

The case study relies on financial modelling methodologies in three statements. The case study model represents an integrated structural-hierarchical financial model with the following specifications and distinct features (see *Table 1*).

A monthly frequency stipulation for the model is due to the fact that the regional airline proposes alternate summer and winter route schedules and that

[6] Indeed, the presented model was used to select the best flight route combinations/maps among 4 initially elaborated operational plans for summer and winter flights for the project. It is a normal practice to have airline planners come up with several competing route maps/scenario visions, each of which being already optimized to some extent using the planners' intentions, algorithms or off-the-shelf software, and then have Finance vet the plans based on the financial modelling analysis criteria.

[7] World Bank. FINANCIAL ANALYSIS TRAINING: Transport Infrastructure Finance and Guarantees, October, 2021. URL: https://www.un.org/ohrlls/sites/www.un.org.ohrlls/files/session_3_financial_analysis_and_modeling_for_transport_projects_presentation_final_0.pdf (accessed on 14.08.2024).

[8] Efinancialmodels. Airlines Financial Model: All cases. URL: https://www.efinancialmodels.com/downloads/category/financial-model/transport/air/ (accessed on 14.08.2024).

[9] Icrestmodels. Start-up airlines model. URL: https://icrestmodels.com/product/start-up-airlines-model (accessed on 10.11.2024).

[10] URL: https://www.efinancialmodels.com/downloads/air-taxi-build-and-operate-business-plan-model-with-3-statements-and-valuation-387347/; https://www.bplans.com/regional-airline-business-plan/ (accessed on 08.02.2025).

[11] E.g. see Modelize Investments (2023). Airline Industry Acquisition Financial Model: A Financial Model of an acquisition in the troubled Airline industry during a global virus crisis COVID-19. URL: https://www.eloquens.com/tool/VD 00IY 99/finance/mergers-acquisitions-m-a/airline-industry-acquisition-financial-model?utm_source=chatgpt.com (accessed on 28.02.2025).

[12] Order No.10 of the Ministry of Transport of the Russian Federation dated January 12th, 2022. URL: https://docs.cntd.ru/document/728111174 (accessed on 08.02.2025).

Table 1

Distinct Features of the Proposed Financial Modelling Framework

Features of the model	Description
General description and purpose	Three-statement integrated financial model for modelling the business of a regional airline as a stand-alone incorporated entity, with the object of establishing flight fares, as well as maintenance and investment needs and outlining optimal long-term Financing policies. It also provides an Invested Capital and Equity valuation of the regional airline business
Key model features	Nominal model, denominated in local currency. Forecast period — 7 years, developed uniformly at a monthly frequency, with no terminal value
Key model output	Accounting profitability ratios, NPV, IRR, Payback period, and budgetary effect based on the net balance of explicit taxes and operating subsidies
Notable and innovative features of the model	1. The model is characterized by a hierarchical modular structure based on the aggregative “Centre” spreadsheet and operational route-specific sheets representing individual flight segments with adjustable weekly frequencies and passenger demand. It is therefore compatible with hub-and-spoke or other operating airline models and with diverse operating subsidy patterns 2. The model innovates a flag-based algorithm providing for automated maintenance, overhaul and investment schedules that recalculate following the revision of old or introduction of new route sheets 3. The model accounts for operating subsidies, value-added tax (VAT), investment credits and tax-loss carryforwards as per applicable Russian legislation. 4. The model provides flexible loan amortization schedules. New bulky investments, such as lease-purchase agreements or outright purchase of new aircraft, can be easily introduced into the model, with clear indications for the resulting funding shortfal 5. The model incorporates maintenance and overhaul provisioning into the financial statements of the model to help estimate the sustainable long-term earnings performance of regional airline projects, set against the backdrop of operating subsidies

Source: Authors.

there is seasonal variability in weather conditions (the number of expected no-fly days varies with the season since small regional aircraft can’t risk operating in bad weather conditions with poor visibility). Also, the fact that subsidy disbursements to the airline are to be made at monthly frequencies (with a 1-month lag) supports this specification for the model. The currency of the model is in roubles since it will be the ticketing currency and the currency in which both the payroll of the airline and the aircraft maintenance costs will be denominated.

The scope of the model is the entire operating business of the regional airline to be newly incorporated at the commencement date of the model (within the perimeter of the Invested capital).

Apart from the proposed hierarchical structure of the model that matches specific flight-segment sheets to specific aircraft[13] (see *Fig. 1*), the key innovative element of that model is an algorithm developed for automating maintenance, engine overhaul and investment schedules. The algorithm automatically recalculates the schedules and associated financial effects following changes in the route sheets of the model.

The route-specific tabs of the model develop estimates of flight-segment revenues and the related variable costs.

Since the principal revenue and cost drivers of the airline financial model we are contemplating will centre on the number of different flight segments covered by the planned route map of the airline, it makes sense to organize the financial model in the following way: each flight segment operation (to and fro) will be entitled to a separate tab (spreadsheet) in the model in order to elaborate — and provide a summary of — the revenues, subsidies and variable costs associated with the respective flight segment (hereinafter “the segment-specific spreadsheet”).

[13] This matching is one of the key organizational assumptions of the model, and has to be based on one-for-one mapping.

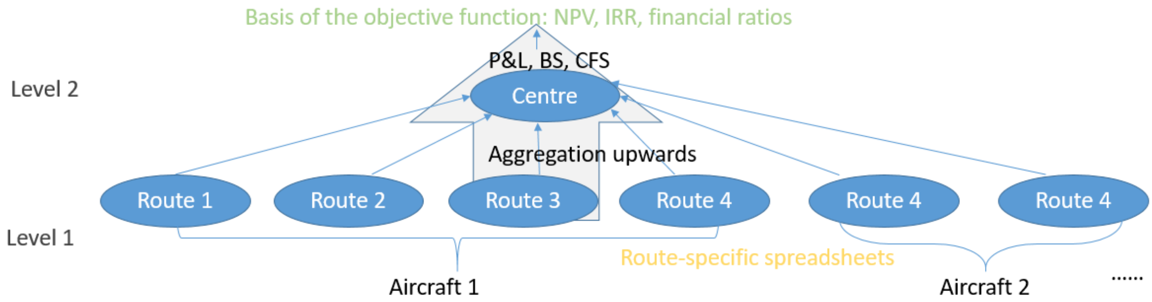

Fig. 1. **Aggregative Hierarchical Structure Used for the Regional Airline Model**
Source: Authors.

Segment-Specific Spreadsheets

In the model, segment-specific spreadsheets contain information about the Route origin and destination (Row 1) and Route specification on a month-by-month basis (Rows 63–79), including the one-way distance of the route, flight duration one way, flight frequencies to and from the destination in times per week, and average seat occupancy percentage en route. This information is then aggregated as hours-in-flight spent per specific month, passenger-miles per month and the number of passengers transported per month (Rows 68–78). Effective fares based on the regulated fare and the percentage of transit passengers en route are estimated on Rows 174–181, forming the basis of Revenue projections in Rows 83–89. Other segment-specific income in the form of subsidies is estimated on the basis of Route specification in Rows 111–115.

Segment-specific spreadsheets focus on the estimation of segment-related revenues and operational variable costs. Rows 24–62 provide the estimates, for the aircraft in question, of unit variable costs called "flight-hour costs" because the driver of most variable costs in the aviation industry is an operational flight-hour. These flight-hour costs include the variable component of pilots' salaries along with the national insurance and pension contributions on top of them (Lines 25–31), Fuel and oil costs per hour (Lines 32–42) and the cost of materials associated with Form 100 Maintenance on a per-hour basis.[14] The unit flight-hour costs are converted from Roubles/hour to their full periodic value (i.e. expressed in Roubles/month) in Rows 119–140 of the segment-specific spreadsheets by multiplying the unit costs by the hours in operation on the route segment per period (estimated in Row 68). Apart from the variable costs driven by the aircraft flight-hours, each segment also contains variable costs principally charged on a per-landing basis. We consider a plethora of navigation and airport charges under this rubric in Rows 142–164 of the segment-specific spreadsheets. The unit values for most of such charges are determined by government regulations and also depend on various aircraft parameters such as the gross landing weight, passenger carrying capacity, etc. Some segment-specific airports dispense with the use of certain charges, while others levy the whole statutorily-allowed menagerie of them. In the context of the case study, the route map of the airline in question is designed such that the aircraft usually flies onward after making a landing instead of returning to its airport of origin. Thus, the navigation and airport charges relate to the airport of origin on each segment-specific spreadsheet, because the destination airport of the first segment becomes the airport of origin in the next segment — and an effort should be made not to double-count the airport charges.

In hierarchical structural models, all segment-specific spreadsheets are designed to have an identical structure and are identified by marking them as *Mx(y)*, where *x* — is the route number for the aircraft *y*. As seen, such segment-specific spreadsheets are grouped according to an aircraft assigned to them (Cell G4 on each route-specific spreadsheet), with the groupings being bounded by blank tabs (counterfoil spreadsheets marked as П2, П3) for aggregation purposes at the central level of the model. Such groupings are required to aggregate the statistics on the planned intensity of use of each specific fleet member (aircraft) over time (in terms of flight-hours), since, as explained below, the timing of many periodic aircraft servicing and maintenance protocols depends on the flight-hours that each aircraft clocks up in operation.

Model Aggregation at the Central Level

The crucial tab of the model is the "Centre" tab (despite its arrangement as the second in order, after

[14] Since given the intensity of the aircraft use, Form 100 (hrs) maintenance is expected to be performed each month and so can be reckoned as a component of unit flight-hour costs for a financial model developed at a monthly frequency.

the specification of periodic aircraft maintenance protocols on the first "service" tab). This is where all the upper-level analysis is conducted in the model, including the integration of projected airline performance on the routes into the 3 financial statements of the model (the balance sheet, P&L statement and Cash flow statement), and the financial ratio analysis (Rows 574–585 of the "Centre" tab). In rows highlighted with the blue marker, the "Centre" tab aggregates revenues and variable costs obtained from the grouped segment-specific spreadsheets of the model, using, for example, the concise SUM function with the following syntax = SUM(П2: П3! F72), meaning that the cell containing this formula will aggregate (produce a whole sum of) the values recorded in cells F72 on the multiple segment-specific spreadsheets placed between the bounding counterfoils П2: П3, that is, all the segment-specific spreadsheets assigned to Aircraft No. 2, no matter how many route segments this aircraft performs. In Rows 175–183, the "Centre" tab presents the fixed costs of the airline, including the fixed payroll costs developed in the Payroll schedule (Rows 65–88).

The "Centre" tab follows the generally accepted structure of nominal financial models [21, 22]. It includes a dashboard of key operating assumptions applicable to the airline in general (Rows 24–34), a Macroeconomic schedule (Rows 8–23), Investment plan (Rows 36–63), Investment/Depreciation schedules (Rows 185–403), VAT schedule (Rows 411–421), P&L statements with the FCFF and FCFE cash flow conversions via the indirect method (Rows 434–500), and the subsequent Integration Part with the balance sheet and CFS.

DISCUSSION

Below we discuss key individual components of the proposed structural-hierarchical financial model, highlighting the novelty of the approach, where it exists, and distinguishing features of the components in the regional airline context.

Model Revenue and Flight Subsidies

Due to the hierarchical structure of the model, Revenue in the model is aggregated at the central level (see Rows 90–99 at the "Centre" tab of the model) but is projected at the route-specific level based on the effective fares having regard to the share of transit passengers over the route entitled to combined-route discounts and the regulated fare ceilings imposed by the subsidising authority. The exact formula used is driven by the expected monthly number of passengers transported over the route, which depends on the scheduled frequency of flights, average seat occupancy, no-fly weather allowances and some other macroeconomic (e.g. projected inflation rate), seasonal and aircraft-specific factors (see Rows 86–91 on route-specific tabs of the model).

The model accounts for the disbursement of regional flight subsidies based on every non-stop segment of flight operations of a certain distance performed by the carrier's aircraft. The exact details of subsidies are calibrated based on the legislative provisions under Regulation 1242[15] (see "FAP 1242" tab of the model) and are recorded as "Other operating income" in the P&L statements of the model with a one-period monthly lag due to the time involved between the submission of flight subsidy reports to the Aviation Authority at the close of each month and the actual disbursement/accrual of the flight subsidies (see Rows 115–116 on route-specific tabs and Rows 99,445 on the "Centre" tab). In financial accounting terms for the jurisdiction in question, operating flight subsidies represent a non-revenue income recognized on a cash basis (that is, upon actual receipt, not when the report is submitted to the Aviation Authority). Subsidies, not being revenue, are not subject to any Value-added tax (VAT). The Aviation Authority grants subsidies to the airline on the condition that the airline applies regulated fares to its ticketing operations, that is, commits that it won't sell tickets for any subsidized flight segment at a price above the maximum fare indicated in the Regulation 1242 document (see "FAP 1242" tab of the model for specification of regulated fares depending on the one-way distance of the flight segments). The airline, though, can set fares for its flight segments at a discount to the regulated fare — which it will do, for example, for transit passengers flying with stopovers to destinations at more than one

[15] In Russia, the provision of subsidy to airlines operating regional routes is regulated on the basis of the Resolution of the Government of Russia of 25.12.2022 No. 1242 (as amended on 14.10.2023) "On the provision of subsidies from the state budget to air transport companies for the implementation of regional air transportation of passengers on the territory of Russia and the formation of a regional route network". URL: https://www.consultant.ru/cons/cgi/online.cgi?req=doc&base=LAW&n=460181#sGEr2cU 6HD 7i3GQO1. The payments for each flight leg/segment being performed by the airline (the exact maximum lump sum disbursed per each flight leg depends on the seating capacity of the aircraft and the distance of the flight segment) are committed according to the approved annual plan with the post-payment scheme (with a lag of 1 month following the submission of certified flight reports to the Aviation Authority at a monthly frequency). In exchange, the government sets unconditional upper thresholds (aka "regulated fares") on the maximum fares that the airline can charge a passenger for the segment (reviewed regularly for inflation).

remove away from their original destination (and hence having to pay fares — but now with some equitable discount — for every flight segment of the way).

The model allows for the VAT accounting features on flight fare revenues in respect of their offsets by the input VAT on various costs. Structurally, this is implemented in the designated VAT schedule (Rows 411–421 on the "Centre" tab) which accumulates and offsets input vs. output VAT amounts generated across route-specific tabs of the model and transfers them to the Cashflow statements of the model (Rows 543–567 of the "Centre" tab of the model). However, in the jurisdiction in question, aviation fares are currently exempt from VAT taxation, so the entire amount of input VAT is accumulated on the balance sheet of the model for potential future offsets elsewhere in the Carrier's business (Row 519 of the "Centre" tab).

Variable Costs

In the model, some of the variable costs of aircraft operations (fuel, oil, variable per-hour components of 1st and 2nd pilot salaries, as well as some maintenance and check-up costs[16]) are aggregated into the unit flight-hour costs (Rows 25–54, and 60–61 on route-specific tabs), which are multiplied by the hours-in-flight to generate month-by-month estimates of variable costs on each route-specific tab of the model (Rows 119–140 of route-specific tabs). Flight-hour driven variable costs are then complemented by additional other variable costs driven by the number of landings/takes-offs or flight-segments undertaken, such as statutorily-set traffic control and navigation charges (Rows 141–145 on route-specific tabs), airport and service charges (Rows 146–164), as well as the variable Amadeus booking fees (Rows 165–170).

Finally, route-specific revenues and subsidies minus all the route-specific variable costs constitute the gross profit estimates for each route recorded at the lower hierarchy level of the model (see Row 172 on route-specific sheets).

Central level aggregation of variable costs estimated at the route-specific level of the model is recorded in Rows 153–172 of the "Centre" tab. Additional variable costs developed at the central level of the model and pertaining to the servicing of each individual aircraft involved in the performance of flights are estimated in Rows 102–152 of the "Centre" tab relying on the automated time flags for each less frequent service protocol to be administered for each aircraft, as explained immediately below.[17]

Aircraft Maintenance Features and Depreciation

The structure of the model is flexible in terms of the number of aircraft in service with the airline and currently provides structural undergirding for the fleet of 4 TVS-2DTS, 12-seater single-engine turboprops[18] (of which the initiator of the project is already in full ownership). Originally intended for charter operations, these aircraft will form an equity contribution to the opening balance sheet of the regional airline project, but won't require any material investment outlays in cash for re-commissioning. Each of the turboprops is going to be operated by the 1st and 2nd pilots, and maintained by 2 engineers and 6 technicians. As already noticed, the pilots' salaries have a fixed and variable component (per flight hours put in), whilst engineers and technicians work on a fixed salary.

As usual in civil aviation in the jurisdiction in question, the aircraft components are accounted for on the balance sheet and depreciated separately in a straight-line depreciation pattern with zero residual value: the airframe is assumed to have a useful life of 12 years (see related depreciation schedules on Rows 185–293 on the "Centre" tab), whilst the engine and the propeller are assumed to have useful lives of 10 years (and so can be lumped together and depreciated jointly for accounting purposes — see Rows 297–383 on the "Centre" tab of the model). The airframes and engines are subject to the following maintenance and overhaul protocols, mandatory once the aircraft reaches the stipulated increments in the cumulative hours-in-operation (see *Table 2* and the "Services" tab of the model).

Since we don't know in which month (period) each aircraft in the model will reach the hours in operation warranting appropriate maintenance,[19] the financial model has to consider the inflation-adjusted estimation

[16] Costs for all the maintenance protocols for the type of the aircraft used are stated in the model on the opening "services" tab. (see also *Table 2*).

[17] Given the monthly frequency of the model and as seen on its 'Service' tab, intra-month aircraft servicing protocols (the cost of services under "Form B" and "Form 100 hrs") are a part of the flight-hour costs, while the less frequent inter-month maintenances under "Form 200, 400 and 800 hrs" protocols deserve an individuated inter-temporal placement on the monthly grid of model for each aircraft involved, which the model automates.

[18] This turbo-prop represents a modern modification of a famous but antiquated AN-2 biplane equipped with a modern and fuel-efficient turboprop engine.

[19] Depending on the intensity of their utilization by the airline, different aircraft will obviously clock up the servicing thresholds in different model periods.

Table 2

Maintenance and Overhaul Protocols for the TBC Airframes and Engines (with Costs Stated at Year 2023 Prices)

<table>
<tr><th>Maintenance protocol</th><th>Maintenance frequency</th><th>Accounting treatment in the model</th><th>Material costs, incl. VAT, in roubles</th><th>Labour costs incl. VAT, in roubles</th></tr>
<tr><td>Form B (Engine Frame)</td><td>Every week</td><td rowspan="2">Intra-monthly: a part of the flight-hour costs</td><td>0</td><td rowspan="5">Not relevant in terms of variable costs since the engineers and technicians performing maintenance will be compensated on the basis of a fixed salary</td></tr>
<tr><td>Form 100 (Engine and frame)</td><td>Every 100 flight hours</td><td>40 000</td></tr>
<tr><td>Form 200 (Engine and Frame)</td><td>Every 200 flight hours</td><td rowspan="6">Inter-monthly: timed maintenance projected by a system of automated binary flags in the model</td><td>40 000</td></tr>
<tr><td>Form 400 (Engine and Frame)</td><td>Every 400 flight hours</td><td>40 000</td></tr>
<tr><td>Form 800 (Engine and Frame)</td><td>Every 800 flight hours</td><td>40 000</td></tr>
<tr><td>Engine Inspection 3500</td><td>Every 3500 hrs</td><td colspan="2">271 000</td></tr>
<tr><td>Airframe Overhaul 2000</td><td>After 2000 hours</td><td colspan="2">6 500 000</td></tr>
<tr><td>Engine Overhaul 7000</td><td>After 7000 hours</td><td colspan="2">11 603 000</td></tr>
</table>

Source: Technical specifications and service manuals for subject aircraft.

and timing of the inter-monthly maintenance costs. The best way to do this is with the use of *flags* (1/0 binaries).

The maintenance timing flags are grafted onto the Investment/Depreciation schedules of the model (for example, in Airframe No. 2 Investment/Depreciation schedule on Rows 215–219 we find that flags are used to account for the activation of periodic maintenance costs (under Forms 200–800 and for Airframe Overhaul 2000) once the respective cumulative flight hours are reached.

This process is instrumented as follows: again, using the example of the Airframe No. 2 Investment/Depreciation schedule (on Rows 211–234), note that Row 214 aggregates cumulative flight hours for Aircraft No. 2 across the assigned route-specific spreadsheets using the SUM-across-spreadsheets protocol [e.g. = SUM('П2: П3'! F69) command in Excel]. On Rows 215–219, we have a system of trigger flags (i.e. 1/0 binaries) for the respective maintenance protocols that are devised using the QUOTIENT divisor in Excel. It is a very helpful command in the context. For example, if we divide 7 by 2 writing in Excel "= 7/2", we will get 3,5. But recording the division process instead as "= QUOTIENT(7;2)" we will get only 3, i.e. the integer component of the real number that results from the division of 7 by 2. This property of the Excel QUOTIENT function is helpful in developing the maintenance trigger "flags" for the model:

= IF (QUOTIENT (G214;200) — QUOTIENT (F214; 200) >= 1; 1;"no").

If you apply the above Form 200 maintenance trigger flag expression to Row 214, i.e. the Row that records the progressive cumulative flight hours for Aircraft No. 2 over time, two possible IF function scenarios result. Under Scenario One in period G Aircraft No. 2 clocked 365 flight hours in use while in the preceding month (period F) it cumulatively clocked 290 flight hours in use. The 200-base quotient of 365 hours in Period G is 1 (i.e. the aircraft should have undergone one Form 200 maintenance in some prior period); the 200-base quotient for the prior period F (290 hours) is also 1. Obviously, the difference in cumulative flight hour quotients between these two adjacent periods [1–1] is zero, and the above IF formula will return "no" as the Form 200 service trigger flag for period G (with 365 cumulative flight hours) to which the formula applies. For an alternate Scenario Two, suppose that in the next period H the aircraft clocks 410 in cumulative flight hours and the formula above is re-applied to period H. The period H Quotient (for 410 hours) will now register "2" (the integer for 410/200), with the quotient difference vs. the prior period G now standing at [2–1] = 1. Since it is TRUE that 1 >= 1, the IF function will produce "1" (i.e. the "yes" flag to Maintenance Form 200). Hence, Aircraft No. 2 should be grounded for a few days of maintenance in Period H. The formula, thus, automates/endogenizes the temporal placement of servicing event flags in the model. What remains is to consistently multiply the product of the trigger flag formula (1 or "no" [with "no" equalling 0]) by the expected Form 200 maintenance cost for the period (adjusted for inflation) to place the forecast maintenance cost figure in the correct model interval (see Row 110 for the total costs of Maintenance 200 protocol thus estimated for all the aircraft in the model). The same procedure applies to other maintenance Forms and Overhauls (both in the Airframe and Engine Investment schedules). This is, we believe, one notable feature of the model not considered in published research on regional airline financial modelling.

Since the model is developed in nominal terms and at monthly frequencies over the forecast period of 7 years, it covers at least one full overhaul cycle for both the engine and the airframe.[20] This justifies yet another refinement —overhaul cost provisioning — included in the model with the impact on the taxation of profits generated by the airline.

Profit and cash management framework: Provisioning for engine and airframe overhauls, Tax loss carryforwards, and interest receivable on idle cash balances

Small-time airlines with scant fleets are especially sensitive to financial impacts arising from big one-time costs associated with overhauls to Airframes and Engines. The "Centre" tab of the model includes a *provisioning schedule* to accumulate internal financial resources for the Overhauls 2000 of the Airframes and Overhauls 7000 of the Engines (Rows 404–408). Provisions are usually formed in order to mollify the impact of large-cost events on the P&L bottom line. It makes sense, whenever possible, to make a series of constant provisioning charges against P&L. Whenever a provisioning charge is made, it depresses operating profit (EBIT) somewhat for the period in question, but helps accumulate a stock of provisions sufficiently large to eventually reduce the negative effect of large, one-time, overhaul costs on the P&L figures. Indeed, when a provision is made through the incurrence of regular provisioning charges,[21] the costs of the overhaul event, once it happens, won't be charged against P&L to dramatically depress EBIT profit in the period to which the overhaul relates, but instead will be absorbed by the write-down of the accumulated provision (on Row 407) matched to the investment cash outflows (On Row 557). The stock of accumulated provisions is a balance sheet item (close in economic nature to Equity due to its being predictably carried long-term as a funding source). Thus, we have to record the closing balance of the Provisioning schedule (Row 408) as a balance sheet item to follow right after Equity on Row 526. This begs the question of how to estimate the regular provisioning charges to keep the provisioning schedule purposely tailored to the needs of fully absorbing the expected overhaul costs.

The regular provisioning charges (of equal value within each provisioning cycle) are also estimated in the individual Investment/Depreciation schedules for the Airframes and the Engines using flags (such as those in Row 194 for the Airframe No. 1 overhaul) and a special formula (such as one in Row 196), based on those flags, to count the number of periods elapsing over time between any two consecutive overhauls. Due to inflationary pressures, the nominal costs of the overhauls increase with the passage of time and the next provisioning cycle after an overhaul should be able to account for this expected cost escalation. To automate these adjustments, the use of Excel formulas LARGE and SMALL, which can return the 1st, 2nd, 3rd etc. largest, or, respectively, smallest number in a given line/array, comes in very handy, e.g. in Cell C 196 and Row 197 of the Airframe No. 1 Investment schedule (the same applies to other individual Investment schedules for Airframes and Engines).

Finally, given the monthly frequency of our model, the structure of the TLC (Tax Loss Carryforwards) schedule (Rows 452–464) should be noted. In many jurisdictions, including the case study one, initial operating losses generated in the first year from airline operations can be carried forward to offset future profit tax liabilities (up to a certain percentage) whenever the profit arises in subsequent years of airline operations. This is modelled by an accumulative-type schedule, not much unlike the VAT one, which accumulates and depletes TLCs in offsets against the

[20] Aircraft and aircraft engines can have their assigned useful lives extended and continue in operation after undergoing major overhauls, at least once over their lifetime. In our example, the airframes have to be overhauled every 2000 in-flight hours and the engines have to be overhauled after every 7000 hours spent in flight.

[21] Provisioning charges, like depreciation charges, are non-cash items within P&L, so an indirect method derivation for FCFF and FCFEs must be adjusted for such non-cash items (Lines 481 and 496).

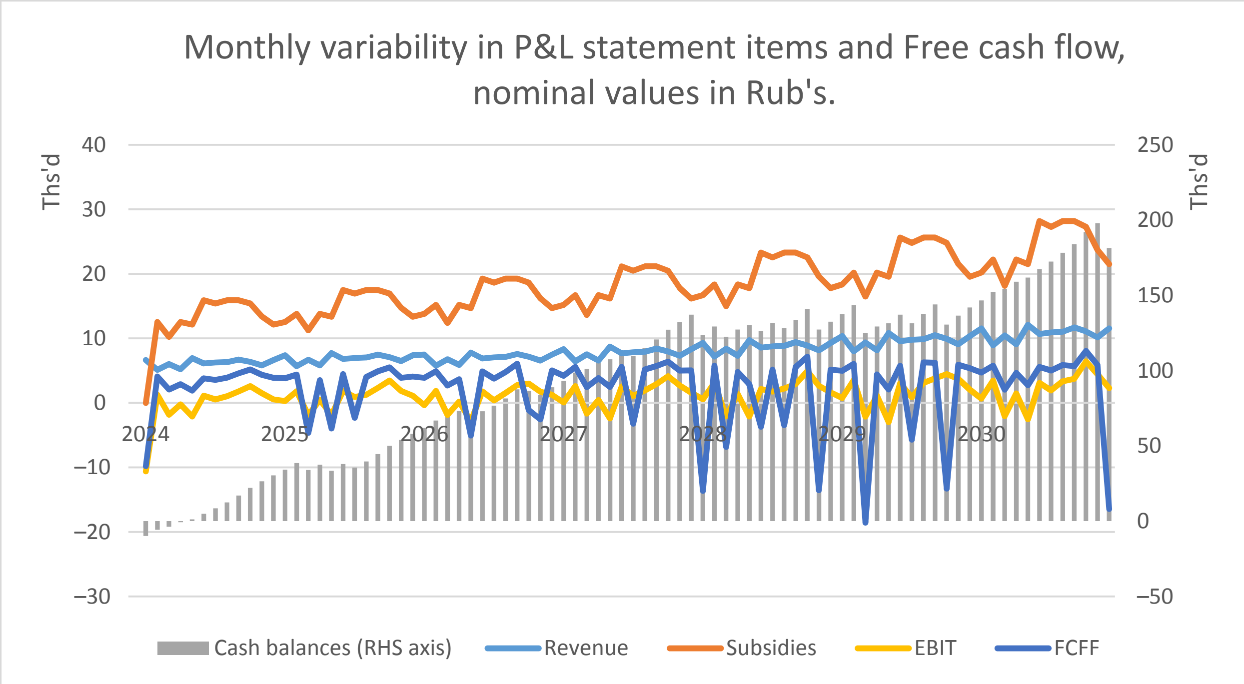

Fig. 2. **Monthly Values and Variabilities in Key Operating Parameters for the Regional Airline Project — Sales, Subsidies, EBIT, Free Cash Flow (FCFF) and Accumulated Cash Balances Treatment of Project Funding Gaps and Non-Cash Contributions of Equity**

Источник: Authors' financial model.

current profit tax liabilities. The depletion of TLCs happens whenever two conditions are simultaneously met: the profit is generated in the accounting period and the balance of TLCs at the start of the accounting period is available to reduce the taxable basis of profit downwards by the permissible offset percentage (50% in the jurisdiction in question). The programming of such schedules is well-described in the literature.[22] The actual contribution of taxes on profit to the budget by adjustable monthly advances with final reconciliations happening at the year's end, however, complicates the design of the schedule, requiring the use of profit tax accruals (Rows 471–474).[23]

Cash balances are managed in the model by the placement of excess cash above a certain designated operating needs threshold (Row 511) on deposit at an assumed depositary interest rate, thereby generating interest received as "other income" P&L item for the airline (Row 447). This is modelled in the Cash deposit schedule on Rows 511–514 of the "Centre" tab and results in the extra cash income for the airline, starting from the date when excess cash balances come into evidence.

RESULTS

Below we provide the results for a model configuration based on flying 3 turboprop aircraft over 27 routes connecting — with summer and winter schedule specifications — towns, settlements and resorts located in three adjacent regions of Russia (see *Fig. 2*). The route map configuration, as seen in the final version of the model has been optimized based on three alternative long-term route-map configurations proposed by the Marketing team for the airline project. The optimization (maximization) criterion was the Return on the invested capital (ROIC averaged over the forecast span of the model), given obvious problems with the usage of the NPV/IRR family of criteria whenever the sunk costs of non-cash equity contributions are involved (as discussed below). The hierarchical structure of the model with easily adjustable and removable route-specific spreadsheets makes the route-optimization process a user-friendly effort, requiring a minimum investment of time (1–2

[22] E.g. see Financial modelling Academy (2024). Coding — Loss carryforwards. URL: https://www.financialmodelingacademy.com/loss-carryforward (accessed on 15.11.2024).

[23] Under the tax administration scheme, Tax loss carry-forwards, if any, can only be made use of at each year's end. Additionally, the monthly tax advances have to be transferred to the budget within a month, so we had to incorporate a one-period lag into the model between the accrual of the monthly profit tax liabilities and their actual settlement. This gives rise to on-balance-sheet tax liabilities associated with the lag (Row 530, in the balance sheet).

Table 3

Summary Financial Ratios and Parameters Estimated by the Regional Airline Model

Financial indicator	Value (average for annual values over the duration of the entire forecast period)
Accrual based metrics:	
ROS	10.8%
ROE, % per annum	2.8%
Average Invested Capital (average over the forecast period), RUB. ths'd.	334 455
ROIC	3.5%
ROA (including cash into the assets)	2.5%
Return on PP&E items, % p.a.	6.9%
FCFF metrics:	Value (over the full duration of the model's forecast period)
NPV based on FCFF (at 15% per annum discount rate), RUB ths'd	108 872
IRR (including initial sunk investments in aircraft), % p.a.	4.6%

Source: Financial model results.

days) and dispensing with the need to use any other route-optimization software packages, such as SABRE or AIMS, the implementation costs for which are sometimes beyond the affordable for small regional airline budgets.

Figure 2 projects that, with operating subsidies in place (the average size of which in terms of monthly accounting periods, by estimate, exceeds revenues by 2,26 times), the airline generates positive monthly EBITs resulting in a gradual build-up of cash balances over the projection period of the model.

As seen in *Fig. 2*, we are intentionally leaving "cash holes" at an initial opening in the balance sheet of the model (Line 524 of the "Centre" tab). The maximum cash deficit — RUB 9 mln — is observed in the first months of operations before subsidies start being received: the airline will have to demonstrate to the Aviation Authority that it has that much available funding at its disposal before the Aviation Authority gives clearance to the business plan based on the financial model — thus indicating the parameters of the necessary additional equity/debt contribution in the form of cash to follow at the date of actual incorporation of the project. One way to have sufficient disposable funds at the incorporation date is to provide for the borrowing of funds — in this instance, the loan schedule of the model (Rows 425–431) won't be left blank and FCFF and FCFE cashflows for the project (Rows 569–572) will differ.

As it is, the project is analysed without an allowance for any debt leverage.[24] Still, the Weighted average cost of capital (WACC) rate of the initiating party has to be applied in order to estimate its Net cash flow Present value (NPV (FCFF)) appropriately. In *Table 3,* we provide a single schematic estimate of the NPV (FCFF) for the airline project (Row 487), but bifurcate Internal rate of return (IRR) estimates to have them expressed "with" (Cell D 490) and "without" (Cell D 488) the "sunk costs" in the form of non-cash contribution of aircraft to project's equity[25]: without an explicit consideration of the aircraft's contribution as the project's investment cost, actual cash investments into the project look small, misleading us to anticipate a high IRR for the project. In such situations, the final analysis should also be guided by annual accrual-based financial ratios — such as ROIC, Return on equity (ROE), Return on Total Assets (ROA), or the return on fixed assets — in this case (Rows 580–584 of the "Centre"

[24] Note that the impact of any initially required debt on the performance ratios of the model (such as those reported in Table 3) is bound to be small, firstly, because the amount of cash deficits at launch in proportion to the total balance sheet assets — standing at a ratio of just 3% — is not material, and, secondly, because of the interest rate subsidies that can be additionally applied for by the airline following its actual incorporation.

[25] Since the aircraft are always capable of being used in alternative projects (e.g. through leasing), economic capital encapsulated in them can never be considered a bona fide "sunk cost" and disregarded for the analysis of project returns (see Damodaran [19]).

tab, see also *Table 3*). Reviewing them and placing special emphasis on ROIC [Return on Invested Capital], we can say that the extent of operating subsidies for regional airlines in the jurisdiction in question is tailored to make what at first sight appear to be loss-making civil aviation projects, just about rewarding for their initiators in terms of ROIC and IRR metrics. However, given the latest inflationary spurts in the economy, it can be opined on the basis of the case study results that the rate of regional airline subsidies should be increased in real terms, and not just pari passu with inflation, for such subsidies to play an explicitly stimulating, rather than a mere band-aid role.

CONCLUSIONS

In furtherance of our prior research [13], the paper has reported a case study of a novel use for structured-hierarchical financial models that are directly designed for optimizing the flight segments of regional airlines on a long-term basis. Apart from its capacity to provide long-term optimization for route maps and regional airline operating schedules, as well as estimate the working capital needs at different stages of regional operations from launching them, the practical relevance of the model is that it enables regional airlines to estimate the necessary fares to achieve the minimum required return on equity and the invested capital, given a prevailing level of operating subsidies for regional airlines. Similarly, given the imposition of regulated fares, it is capable of analyzing the minimum level of subsidies required by the regional airlines, allowing also for seasonal and combined-segment discounts. Recording and aggregating long-term passenger travel projections over each incorporated route/flight segment, the model also provides a platform for evaluating budgetary and public effects from regional airline projects in terms of travel-time savings, regional economic multiplier effects associated with enhanced tourism, etc. This way, the model can also suggest, or justify, optimal flexible budgetary patterns for allocating operating flight subsidies, including with the incorporation of seasonal fluctuations.

In terms of limitations and avenues for future research, the model at present is mostly limited by the consideration of commercial and taxation effects from regional airline activities, but has all the relevant drivers, and therefore much potential, to be developed further in the direction of analysis of public externalities, providing comprehensive monetized public value measurements for regional airline projects.

The paper has substantively contributed to the literature on the financial modelling of regional airline businesses by innovating the system of automated flags to endogenize the impact of variable flight intensities on otherwise static investment, depreciation, and maintenance cost schedules of airline-related financial models, as well as making the analysis of regional airline financial models amenable in the framework of structural — hierarchical financial models. Thus, we consider that our contribution is helpful to the extent it reveals how the full potential of integrated financial models can be utilized for solving actual routing and optimization problems confronted by regional airlines, including at the early conceptual and planning stages.

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O. Ganiev — literature review, description of the results and development of the research conclusions, tabular and graphical presentation of the results.
O.E. Medvedeva — formulation of the research problem, collection of statistical data, tabular and graphical presentation of the results.

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